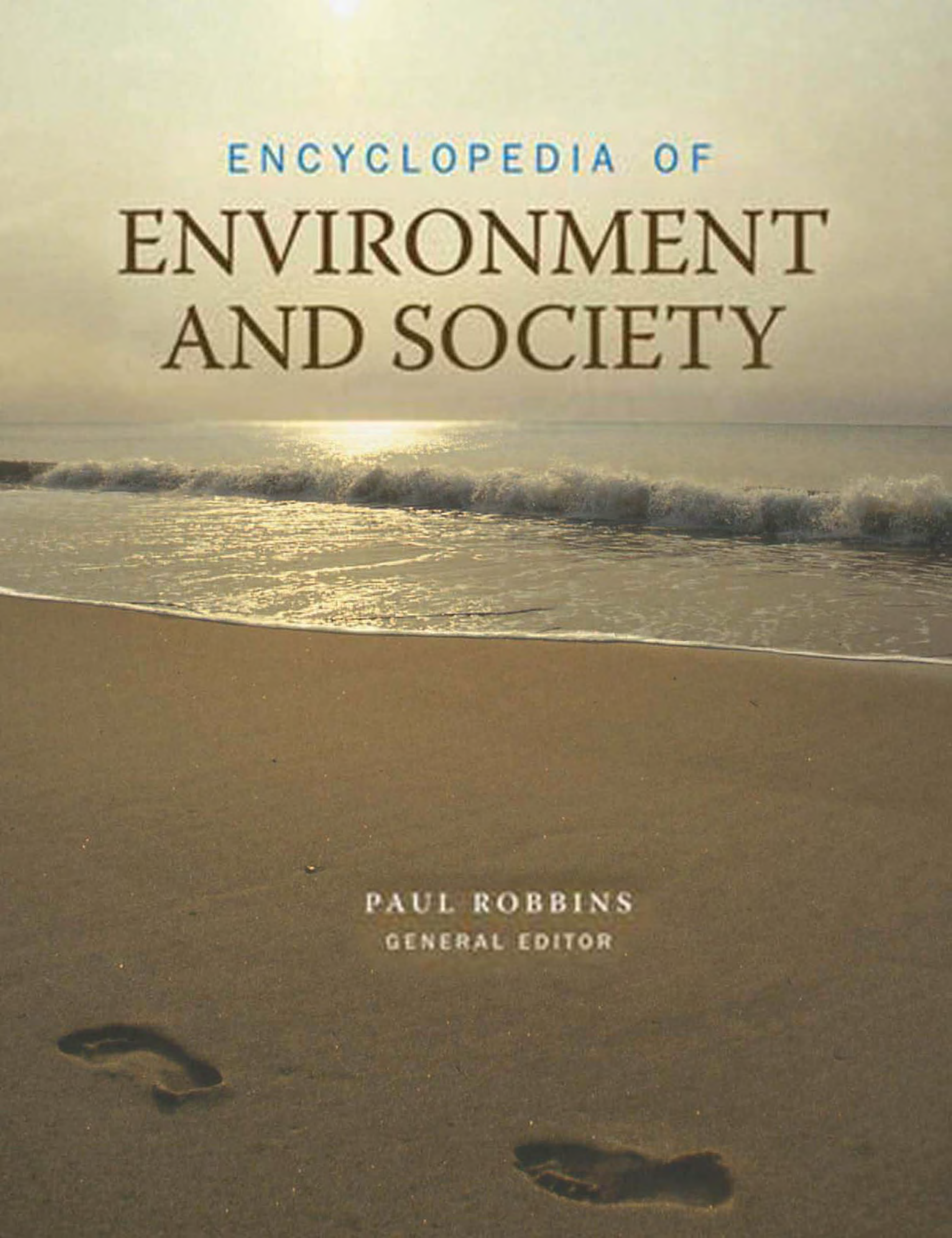
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PAUL ROBBINS
GENERAL EDITOR

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ENCYCLOPEDIA OF

ENVIRONMENT AND SOCIETY

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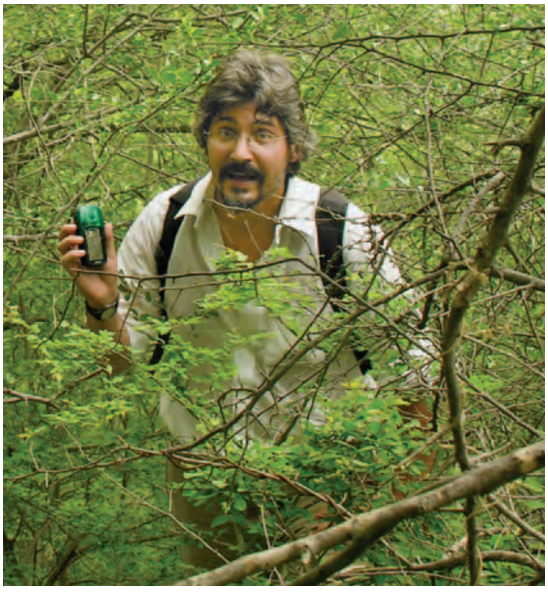

PAUL ROBBINS was raised in Denver, Colorado, but has lived in India, New England, the U.S. Midwest, and the deserts of the U.S. Southwest. He received his Ph.D. in Geography from Clark University in 1996 and is currently Professor in the Department of Geography and Regional Development at the University of Arizona. His research centers on the relationships between individuals (homeowners, hunters, professional foresters), environmental actors (lawns, elk, mesquite trees), and the institutions that connect them. Working with interdisciplinary teams in the fields of biology, economics, climatology, and entomology, his projects have examined chemical use in the suburban United States, elk management in Montana, forest product collection in New England, wolf conservation in India, and mosquito borne illness and management of insect hazards in the US Southwest. His expertise includes the fields of conservation policy, grasslands ecology, and institutional ethnography. He is author of *Political Ecology: A Critical Introduction* (2004) and *Lawn People: How Grass Weeds and Chemicals Make Us Who We Are* (2007) and has served as an editor for the journal *Geoforum*.

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Introduction

WHERE DOES THE environment leave off and society begin? If the major crises and curiosities of the early 21st century are any indication, it would be foolish to attempt to demark any such boundary. When expanding production and consumption drives greenhouse gas emissions that warm the planet, which in turn influence the conditions (and limits) of economic expansion, it is unclear where the climate ends and the economy begins. If transgenic species of upland rice are designed for cold tolerance employing genes from Alaskan cold-water fish, where does the "natural" process of evolution stop and the "social" process of agricultural intensification begin? In a certain sense, owing to the intense entanglement of human beings (congressmen, farmers, veterinarians, nurses, SUV drivers, plumbers, attorneys) with nonhumans (turfgrasses, bacteria, factories, atmospheric pressure cells, weeds, elk, trees), the question seems unanswerable at best, or misleading at worst.

Ironically, this fact is not new to our era, as thousands of years of human interaction with the world around us can attest. It is notable, however, that our social and natural sciences have only recently come to grips with the incredible complexity of the world described by understanding the environment and society as being of a piece. In the last decade, there has been as a result, a perhaps unprecedented explosion of new concepts, theories, facts, and techniques that follow from such an understanding. So too, there have been remarkable efforts to move beyond the "social" and "environmental" sciences in order to pursue research and problem-solving using a new kind of knowledge. This approach to socio-environmental problems and issues explicitly does *not* seek to distinguish "social aspects" of environmental problems or "environmental components" of social issues, but instead seeks to explain and cope with the enormous implications of this inevitable complexity.

THE ENCYCLOPEDIA

In this sense the 1,200 entries, written for these volumes by experts from an incredible diversity of fields, are a first step toward diving into the deep pool of emerging knowledge. As the volumes intend, it has become increasingly essential to bring these multiplying issues, concepts, theories, examples, problems, and policies together in one place, with the goal of clearly explicating an emerging way of thinking about people and nature.

To that end, the encyclopedia was designed to include a vast range of different types of entries, including key individuals, polices, problems, processes, and theoretical concepts that sit astride what has traditionally been known as "society" and the "environment." The wealth of topics here therefore includes what the editors believe captures an integrated vision. This encyclopedia represents more than a catalogue of terms. Rather, it captures the spirit of the moment, a fascinating time when global warming and genetic engineering represent only two of the most obvious examples of socio-environmental issues. Consider fire ants, air conditioning, oil spills, and aquariums (all represented in entries here) as embodiments, objects, and artifacts of a world co-created and co-inhabited by people and nonhumans.

If it is a new world of problems and situations, it is also one of new and integrative ideas. As the "environment" becomes a concern for economists, political scientists and anthropologists, "social" forces are increasingly a concern of conservation biologists and geneticists. The result has been a great many new ideas about how the world works, what creates the daunting problems of our time, and how such issues might be addressed, whether by regulation, markets, or new ethics. Many of these ideas, of course, are not mutually harmonious and compatible. As entries in this volume demonstrate, theories of environmental management based on market efficiency may not be easily reconciled with those that focus on population, and both may certainly diverge from those centering on ethics, justice, or labor. Nevertheless, all these emerging voices and ideas are very much of their moment, and are part of a conversation that an environmentally literate citizen or student ignores at their own risk.

As such, our authors include geographers, political scientists, chemists, anthropologists, medical practitioners, development experts, and sociologists, among many others. We were fortunate, in this regard, to find experts in their fields of specialty, and to be able to draw especially upon researchers with direct fieldwork experience. Many country entries were written by authors with years (or decades) of field experience in these locations, while entries on emerging techniques and technologies were penned by designers and innovators, wherever possible.

Given that, however, all topics and issues are essentially socio-environmental ones, the process of assembling such a group of entries and authors presented certain hard choices. The choices made here reflect many of the biases of its General Editor, and an imagined and intended audience. Specifically, readers will notice that despite a great many global policy documents and treaties, the preponderance of environmental legislation and legal decisions presented here, from the Winters Doctrine to the Clean Air Act, come from the United States and other Common Law countries. So too, while countries of the world are represented, regions of North America are treated in greater detail. And while the problem of global conservation is discussed at length, most of the key examples of national parks included here are from the United States. This is because the book was firstly intended for North American readers, but also because many of these practices, theories, and laws from the North American context are being extended to (and in many cases arguably foisted upon!) other parts of the world. I would hope that while readers from the United States and Canada would learn a great deal about their own environment and society problems from reading these entries, therefore, the encyclopedia might also be useful for readers in Chile living with the environmental policy effects of University of Chicago economic theory or readers in India importing the "Yellowstone model" of national park management.

The decision to include entries for individual countries, rather than global eco-regions, was one made again with an audience in mind as well, someone who might want to know the specific conditions in Gambia for example or China. While such a decision does, at some level, reinforce a state-centered view of the world—one that is subverted precisely by environmental problems that do not respect national boundaries—it is our intention to provide a comprehensive picture that approaches, as effectively as possible, a cohesive global vision. We hope that our survey of conditions around the world strikes familiar notes for comparison and contrast, drawing some patterns from the details of regional experience.

SIGNALS AMIDST THE NOISE

And to a great degree, despite (and in part because of) the diversity of entries assembled here, it is possible to identify some constant global themes that thread through the encyclopedia. Two of the most prominent are: (1) the emerging socio-environmental problems that we face in the next century, and (2) the shifting and expanding theoretical tools available for explaining tackling these problems.

The problems that receive a great deal of attention in the encyclopedia differ greatly than those that might have been highlighted a quarter century ago. At that time, not long after the first Earth Day, an encyclopedia on environment and society might have focused more exclusively on regional and local environmental problems and their apparent intractability. At this time, the foul air hanging over American metropolises was emblematic of a fouled world, stubbornly locked into place by human activity; a nature almost irreversibly dominated by society.

Remarkably, many of these problems, while still serious issues, have actually given way to solutions, however. While many argue about the overall efficiency of the Clean Air Act, for example, it is quite clear it has had a profound positive effect on urban air quality. Deforestation is ongoing around the world, but so is reforestation, and for reasons that remain a matter of debate.

At the same time, however, issues like global warming and genetic engineering, while envisioned by the more forward-thinking observers of the century prior, could not possibly have afforded the immense amount of attention and number of related entries we see today. Nor could the concept of environmental justice, which is so clearly a part of contemporary urban environmental issues, have been so fully articulated and acknowledged. The problems and issues that we see here are definitely the greatest challenges of our time, therefore but they would have been hard to fully anticipate not very long ago. This cautions us against any self-congratulatory sense that any accounting of socio-environmental condition, no matter how comprehensive, can be a document that exists outside of its historical moment.

Similarly, the volume is brimming full of an extremely diverse and vibrant range of theoretical tools to help explain and cope with our current world, many of which simply were not "on the map" even a few years prior. The debates of 25 years ago involved pitched arguments between self-described environmentalists ("greens") and those ("browns") who argued for a protection of economic interests and growth against so-called luddites.

John McPhee's classic book *Encounters with the Archdruid*, detailing debates between David Brower's environmentalism and Floyd Dominy's pro-growth dam-building, set the tone for the period. And within each of these camps, it would not be exaggerating much to say theoretical diversity was less well developed than it is today. "Greens" often held to traditional population-based explanations of environmental crises (as many do today of course), while "browns" clung to ideas that environmental protection was in contradiction to human economic interests.

A quick perusal of the entries in this volume suggests that we live in a very different world. As environmentalists come to understand the relationship between poverty and problems in conservation, new ideas emerge from the mix. From the other side of the argument, green capitalism is offered as a bringing together of ecological and economic incentives. From the mix we see pages filled with insights from deep ecologists, Marxists, feminists, anarchists, bioregionalists, pragmatists, free marketeers, and reconciliation ecologists (among many others) offering entirely new visions of our socio-environmental condition.

And in a very real sense, we are *all* environmentalists now, a situation that is ironically both a source of a new consensus and the seed of new, more profoundly divisive debate. This revolution in thinking is by no means restricted to the so-called "social sciences," moreover. Ecologists as a prominent example, who long clung to mechanical models of equilibrium in environmental systems, have begun to shift towards more biocomplex ways of thinking about environmental conditions and change and the human role in evolution and nature.

In this sense, we think the encyclopedia is not only current and packed with essential and up-to-date information on the state of the global socio-environment, we also imagine the work to be a time capsule of its historic moment, and a record of where we stand at the start of the 21st century. From an optimistic point of view, we can only hope that the emergence of environmental debates and discourses around the world—provoked by some of the greatest calamities and problems of written memory—provides an opportunity for more new ways for thinking, behaving, and living in a more-than-human world.

We are cursed to live in interesting times. The editors hope that the *Encyclopedia of Environment and Society* helps to map out, explain, and challenge our collective thinking at this difficult juncture for our environment.

Paul Robbins
General Editor

Reader's Guide

This list is provided to assist readers in finding articles related by category or theme.

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Independent Scholar

Himley, Matthew
Syracuse University

Hintz, John
Bloomsburg University

Hoeschele, Wolfgang
Truman State University

Holifield, Ryan
University of Minnesota

Holst, Arthur
Widener University

Horowitz, Leah S.
University of Leeds

Howard, Jeff
University of Texas, Arlington

Hossain Monir, Moni
Waseda University, Japan

Houghton, Jennifer
University of KwaZulu, Natal

Hume, Douglas
University of Connecticut

Hurley, Patrick T.
College of Charleston

Husseini, Abdullatif
Institute of Community and Public Health, Birzeit University

Jackson, Wendy
Independent Scholar

Jepson, Wendy
Texas A&M University

Jindrich, Jason
University of Minnesota

Johnston, Lucas F.
University of Florida

Jokisch, Brad
Ohio University

Jonna, Ryan J.
University of Oregon

Kahn, Richard
University of California, Los Angeles

Kalipeni, Ezekiel
University of Illinois, Urbana–Champaign

Kannada, S.
Arkansas State University

Kariyeva, Jahan
University of Arizona

Keese, James R.
California Polytechnic State University

Keys, Eric
University of Florida

Khanna, Vikas
Ohio State University

Kich, Martin
Wright State University, Lake Campus

King, Brian
University of Texas, Austin

Kirkham, W. Stuart
University of Maryland

Kirsch, Scott
University of North Carolina Chapel Hill

Klepek, James
University of Arizona

Klooster, Dan
Florida State University

Knapp, Gregory
University of Texas, Austin

Krohn, Raymond
Purdue University

Krueger, Robert James
Independent Scholar

Kull, Christian A.
Monash University, Australia

Laberge, Yves
Institut québécois des hautes études internationales

Laney, Rheyna
Sonoma State University

Lange, Mark D.
Independent Scholar

Linehan, Denis
University College Cork

Litrico, Mary Elizabeth
University of Florida

Loi, Nguyen Van
Flinders University, South Australia

Nominé, Loykie L.
Independent Scholar

Low, Nick
Independent Scholar

Lowe, Marie
University of Alaska, Anchorage

Luzar, Jeff
Simon Fraser University

Malanson, George P.
University of Iowa

Mann, Geoff
Simon Fraser University

Mannion, A.M.
University of Reading, England

Mansvelt, Juliana
Massey University, New Zealand

Markantonatou, Maria
Independent Scholar

Marks, Brian
University of Arizona

Mason, Michael
London School of Economics

Maxwell, Keely
Franklin and Marshall College

McAfee, Kathleen
San Francisco State University

McChesney, Ron
Ohio Wesleyan University

McGregor, Kent
University of North Texas

McManus, Phil
University of Sydney, Australia

McSweeney, Kendra
Ohio State University

Meehan, Katharine
University of Arizona

Merrett, Christopher
Western Illinois University

Miller, DeMond Shondell
Rowan University

Minor, Jesse
University of Arizona

Mitchell, Ross E.
Alberta Research Council

Moore, Sarah
University of Arizona

Morley, Ian
Chinese University of Hong Kong

Moseley, William G.
Macalester College

Muehlenhaus, Birgit
Macalester College

Muehlenhaus, Ian Alexander
University of Minnesota

Mulvaney, Dustin
University of California, Santa Cruz

Murguía, Diego I.
Universidad de Buenos Aires, Argentina

Mustafa, Daanish
King's College, London

Mutersbaugh, Tad
University of Kentucky

Myers, Ethan
University of Massachusetts, Amherst

Nash, Alan
Concordia University, France

Natadecha-Sponsel, Poranee
Chaminade University of Honolulu

Nawrocka, Magdalena
Florida International University

Negi, Rohit
Ohio State University

Neumann, Caryn E.
The Ohio State University, Newark

Neumann, Roderick P.
Independent Scholar

Neves-Graca, Katja
Concordia University, France

Noonan-Mooney, Kieran
Concordia University

Norgaard, Kari Marie
Whitman College

Novogradec, Ann
York University, England

Nursey-Bray, Melissa
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Obach, Brian
State University of New York

O'Brien, Colleen M.
University of Georgia

Offen, Karl
University of Oklahoma

Ogburn, Stephanie P.
Yale School of Forestry and Environmental Studies

O'Reilly, Kathleen
University of Illinois, Urbana–Champaign

O'Sullivan, John
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Ouzts, Clay
Gainesville State College

Overton, John
Massey University

Ozler, S. Ilgu
State University of New York, New Paltz

Padula, Alessandra
Universitá Degli Studi–L'Aquila, Italy

Pal, Viktor
University of Tampere

Paleo, Urbano Fra
University of Extremadura

Palis, Joseph
Independent Scholar

Palmer, Robert
Research Strategy Training

Paradise, Thomas
University of Arkansas

Parnell, Darren B.
Salisbury University

Parsons, Chris
University of London

Parsons, E.C.M.
George Mason University

Pavri, Firooza
University of Southern Maine

Pearce, Joshua M.
Clarion University of Pennsylvania

Pedersen, Anders Branth
University of Aarhus, Denmark

Pero, Lionel
University of Queensland

Perz, Stephen G.
University of Florida

Phillips, Rod
Michigan State University

Pincetl, Stephanie
University of California, Los Angeles

Pitchon, Ana
University of Georgia

Pitzl, Gerald R.
New Mexico Public Education Department

Porinchu, David F.
Ohio State University

Prudham, Scott
University of Toronto, Canada

Purcell, Mark
University of Washington

Purdy, Elizabeth
Independent Scholar

Quick, Denise
Community College of Vermont

Raento, Pauliina
University of Helsinki, Finland

Ramkissoon, Jennifer
Independent Scholar

Regnery, Rebecca
George Mason University

Reyes, Jessica Wolpaw
Amherst College

Rice, Jennifer L.
University of Arizona

Richards, Noel
Flinders University, South Australia

Roark, Kelly
University of Wisconsin

Robbins, Paul
University of Arizona

Robertson, Morgan
University of Kentucky

Roche, Michael
Massey University

Rollins, D.M.
Independent Scholar

Romero, A.
Arkansas State University

Rose, Naomi A.
Humane Society International

Rowe, William C.
Louisiana State University

Rupar, Verica
Victoria University of Wellington

Russill, Chris
University of Minnesota

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Sauri, David
Universitat Autònoma de Barcleona

Sayre, Nathan F.
University of California, Berkeley

Schelhas, John
University of Queensland

Schneider, Laura C.
Rutgers University

Schneller, Andrew J.
Independent Scholar

Sellen, Jeff
Washington State University

Shao, Yang
University of North Carolina

Sherman, Heidi M.
University of Wisconsin, Green Bay

Shrivastava, Rahul J.
Florida International University

Shumway, Matthew
Independent Scholar

Simon, Gregory
University of Washington

Simsik, Michael J.
U.S. Peace Corps

Sinclair, Amber Hughes
University of Georgia

Skop, Emily
University of Texas, Austin

Slocombe, Scott
Wilfrid Laurier University

Smith, Dana C.
Th!nk

Smith, Helen
University of Georgia

Smith, Timothy F.
Commonwealth Scientific and Industrial Research Organization

Sneddon, Chris
Dartmouth College

Sodikoff, Genese
Rutgers University

Spangler, Jonathan
University of Glasgow

Sponsel, Leslie E.
University of Hawaii

Steinberg, Phillip E.
Florida State University

Stewart, Kristin
Florida State University

Stone, Glenn Davis
Washington University

Storey, Donovan
Massey University

Sultana, Farhana
King's College, London

Taff, Gregory N.
University of North Carolina

Thiet, Rachel K.
Antioch University

Thompson, Alexander
Ohio State University

Thornbrugh, Casey
University of Arizona

Traub-Werner, Marion
University of Minnesota

Uejio, Christopher
University of Arizona

Unruh, Jon D.
McGill University

Varady, Robert G.
University of Arizona

Wainwright, Joel
Ohio State University

Wallace, Gillian
University of Cambridge

Wallmo, Kristy
National Marine Fisheries Service

Walsh, John
Shinawatra University, Thailand

Walsh, Stephen J.
University of North Carolina

Walzer, Norman
Western Illinois University

Warren, W. A.
Independent Scholar

Waskey, Andrew J.
Dalton State College

Welsh, William F.
Western Michigan University

Whalen, Ken
University of Florida

Wheeler, Samuel P.
Southern Illinois University

White, Damian
Independent Scholar

White, Kristopher
Kazakhstan Institute of Management, Economics, and Strategic Research

Whitehead, Judith
Independent Scholar

Whitehead, Mark
University of Wales, Aberystwyth

Whitford, Andrew B.
University of Georgia

Wikle, Thomas A.
Oklahoma State University

Wilcox, Sharon E.
University of Texas, Austin

Williams, Charles E.
Clarion University of Pennsylvania

Williamson, Margaret H.
Gainesville State College

Wilson, Randall K.
Gettysburg College

Winnegge, Ruger
University of Siegen, Germany

Wittman, Hannah
Simon Fraser University

Wolford, Wendy
University of North Carolina

Wong, Theresa
Ohio State University

Woodhouse, Edward
Rensselaer Polytechnic Institute

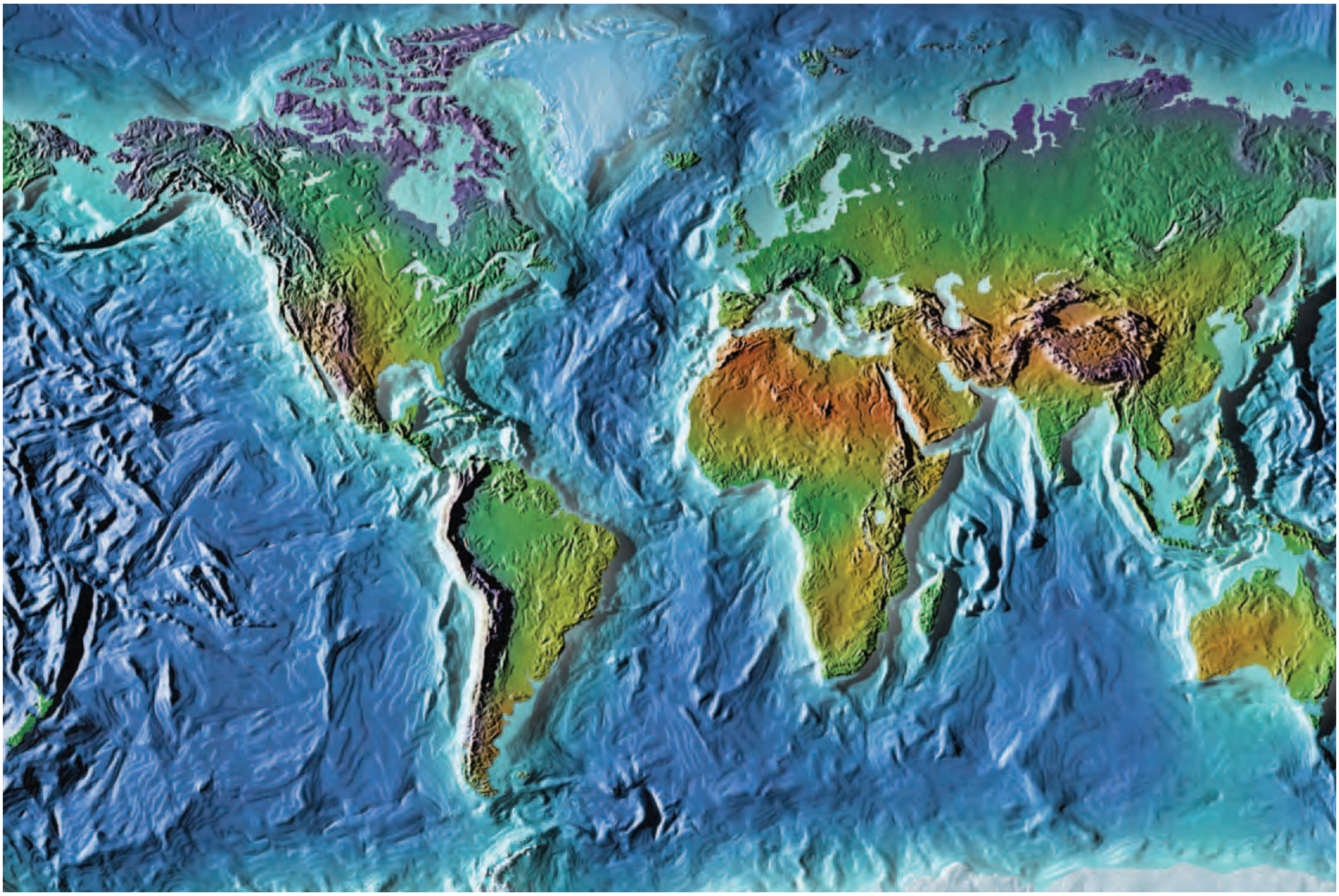
Yeh, Emily T.
University of Colorado, Boulder

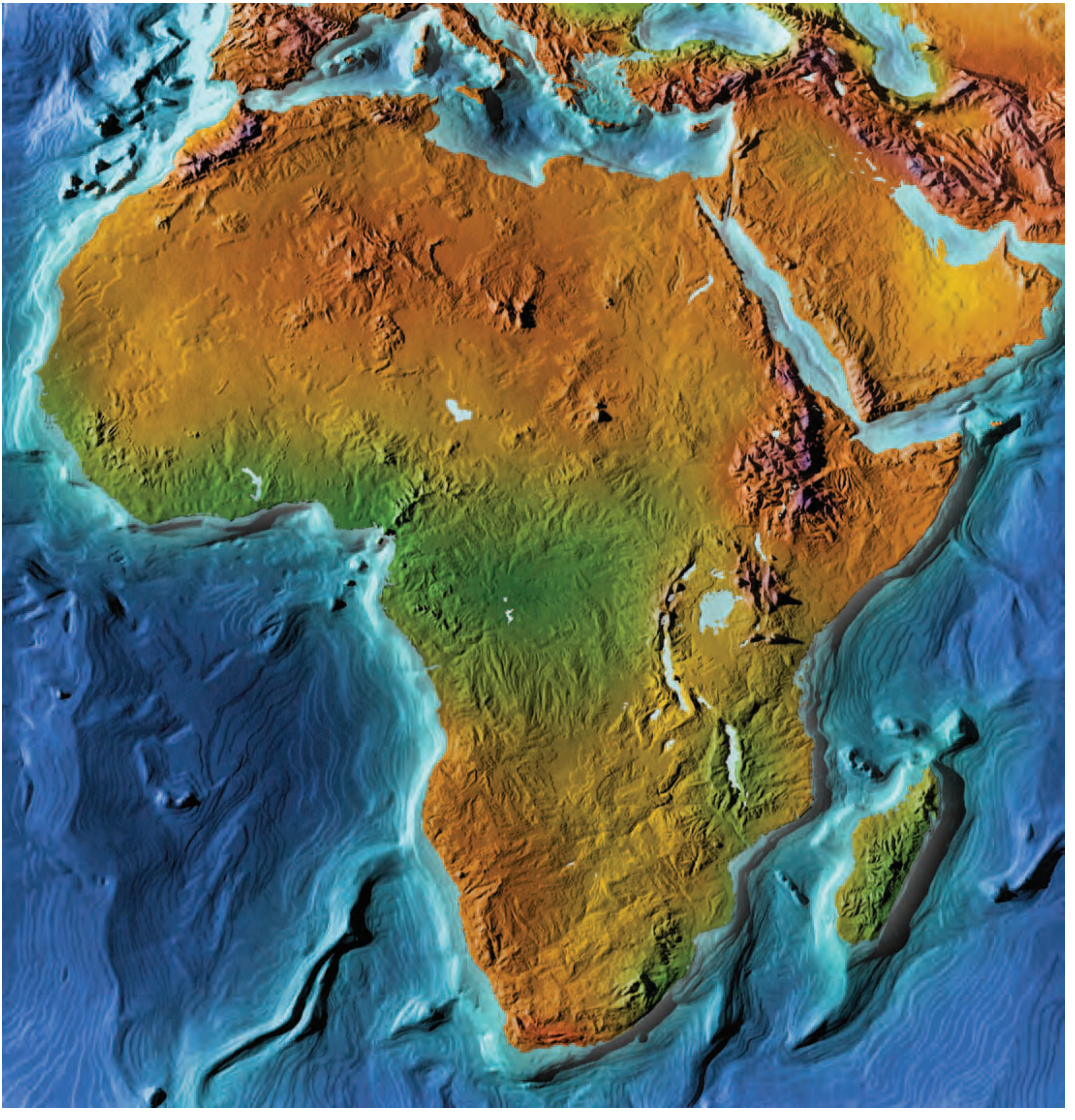
Young, Nancy
University of Minnesota

Zhang, Yi
Ohio State University

Ziliotto, Veronica M.
Universidad de Buenos Aires, Argentina

Maps





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YUGOSLAVIA
BULGARIA
ALBANIA
MACEDONIA
Istanbul
GEORGIA
ARMENIA
AZERBAIJAN
Baku
TURKMENISTAN
Ankara
GREECE
Athens
TURKEY
Gibraltar
Str. of Gibraltar
Algiers
Annaba
Tunis
Tetouan
Rabat
Oran
Constantine
Madeira
Casablanca
MOROCCO
ATLAS MOUNTAINS
Sfax
TUNISIA
Tripoli
MEDITERRANEAN SEA
CYPRUS
LEBANON
SYRIA
Tehran
IRAN
Canary Is.
Misratah
Benghazi
Alexandria
ISRAEL
IRAQ
JORDAN
Cairo
Giza
Suez
KUWAIT
El Aaiun
Ghadâmes
ALGERIA
LIBYA
El Faiyum
WESTERN SAHARA
In Salah
Western Desert
Asyut
Nile
SAUDI ARABIA
BAHRAIN
QATAR
Dakhla
Marzuq
Luxor
EGYPT
RED SEA
Riyadh
UNITED ARAB EMIRATES
F'Dérik
AHAGGAR
Mt. Tahat
Libyan Desert
Aswan
Lake Nasser
Cap Blanc
MAURITANIA
SAHARA DESERT
TIBESTI
Wadi-Halfa
ASIR MTNS.
OMAN
Nouakchott
MALI
Nubian Desert
RUB AL KHALI
Sénégal
Timbuktu
Niger
NIGER
Port Sudan
Dakar
SENEGAL
Atbara
Kassala
GAMBIA
Banjul
Kayes
Ségou
Niamey
Maradi
Zinder
CHAD
JEBEL MARRA
Khartoum
Asmera
ERITREA
YEMEN
Bissau
Bamako
BURKINA FASO
Lake Chad
El Fasher
Wad Medani
Gulf of Aden
Socotra
GUINEA-BISSAU
GUINEA
Ouagadougou
Kano
Ndjamena
El Obeid
Lake Tana
DJIBOUTI
Djibouti
Caseyr
Conakry
Bobo Dioulasso
BENIN
Kaduna
Chari
SUDAN
Berbera
Freetown
CÔTE D'IVOIRE
GHANA
Abuja
NIGERIA
Blue Nile
Addis Ababa
SOMALIA
SIERRA LEONE
Lake Volta
TOGO
Ibadan
Benue
CENTRAL AFRICAN REPUBLIC
ETHIOPIAN HIGHLANDS
ETHIOPIA
Eyl
Monrovia
Yamoussoukro
Lomé
Lagos
LIBERIA
Abidjan
Accra
Porto Novo
Port Harcourt
Bamenda
White Nile
C. Palmas
Bight of Benin
Douala
Bangui
Bomu
GULF OF GUINEA
Bight of Bonny
Yaoundé
CAMEROON
Congo
EQUATORIAL GUINEA
UGANDA
KENYA
Baidoa
Mogadishu
Libreville
Kisangani
Kampala
Marka
São Tomé & Principe
Mbandaka
Kisumu
Baraawe
Cap Lopez
GABON
REPUBLIC OF CONGO
Margherita Peak
Tana
DEMOCRATIC REPUBLIC OF CONGO (ZAIRE)
RWANDA
Kigali
Lake Victoria
Kirinyaga
Nairobi
Kismayu
Bukavu
Mwanza
INDIAN OCEAN
Brazzaville
Bujumbura
BURUNDI
Kilimanjaro
Mombasa
Kinshasa
SEYCHELLES
Matadi
Kananga
Dodoma
Lake Tanganyika
Rufiji
Zanzibar
Dar-es-Salaam
ATLANTIC OCEAN
Luanda
ANGOLA PLATEAU
TANZANIA
Lake Mweru
Aldabra Is.
Likasi
Lake Nyasa
Cabo Delgado
Lobito
ANGOLA
Lubumbashi
Farquhar Is.
Huambo
Ndola
MALAWI
COMOROS
C. d'Ambre
Lilongwe
Antisiranana
Namibe
Cubango
ZAMBIA
Moçambique
Lusaka
Blantyre
Zambezi
MOZAMBIQUE
Mozambique Channel
Mahajanga
NAMIBIA
Livingstone
Harare
ZIMBABWE
Okavango Delta
Bulawayo
Beira
Antananarivo
Namib Desert
Windhoek
BOTSWANA
MADAGASCAR
Limpopo
Fianarantsoa
Mauritius
Réunion
Kalahari Desert
Gaborone
Tshwane (Pretoria)
Johannesburg
Maputo
Mbabane
SWAZILAND
C. Ste. Marie
Orange
Maseru
LESOTHO
Durban
SOUTH AFRICA
DRAKENSBERG
Great Karoo
East London
Cape Town
Port Elizabeth
Cape of Good Hope
Cape Agulhas
Cape St. Francis
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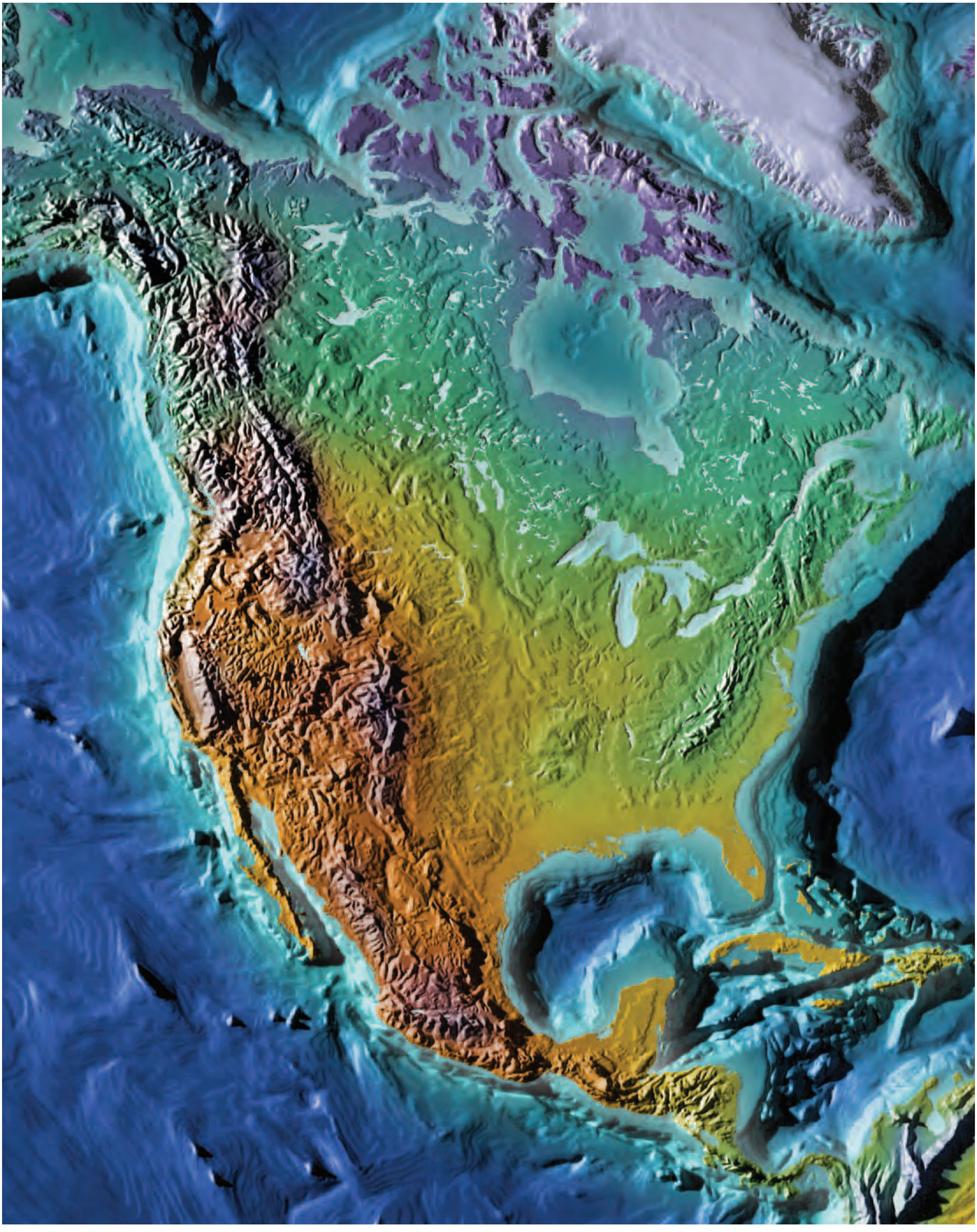


CHUKCHI SEA
BEAUFORT SEA
Baffin Bay
GREENLAND
Pt. Barrow
Barrow
ALASKA (USA)
Mt. McKinley
Fairbanks
Anchorage
Yukon
Porcupine
Ft. McPherson
Inuvik
Victoria Island
Baffin Island
Cape Dyer
Kap Fervel
Great Bear Lake
Mackenzie
Ft. Norman
MACKENZIE MOUNTAINS
NUNAVUT
Iqaluit
NORTHERN TERRITORIES
Mt. Logan
YUKON TERRITORY
Whitehorse
NORTHWEST TERRITORIES
Yellowknife
Kangiqliniq (Rankin Inlet)
Cape Chidley
LABRADOR SEA
GULF OF ALASKA
Juneau
Great Slave Lake
Hudson Bay
BRITISH COLUMBIA
QUEBEC
Labrador
Goose Bay
NEWFOUNDLAND
Cape Bauld
Newfoundland
Churchill
MANITOBA
Belcher Is.
Peace
ALBERTA
Athabasca
QUEEN CHARLOTTE ISLANDS
Prince Rupert
ROCKY
CANADA
Edmonton
N. Saskatchewan
SASKATCHEWAN
Moosonee
Saskatoon
Calgary
ONTARIO
PRINCE EDWARD IS.
NEW BRUNSWICK
NOVA SCOTIA
Halifax
Vancouver
S. Saskatchewan
Regina
Winnipeg
Cape Flattery
Seattle
Olympia
Mt. Rainier
WASHINGTON
Missouri
Thunder Bay
L. Superior
MAINE
Augusta
Montreal
Ottawa
VERMONT
Montpelier
Cape Sable
NEW HAMPSHIRE
Concord
NORTH DAKOTA
Bismarck
MINNESOTA
Helena
MONTANA
Salem
CASCADE RANGE
OREGON
Boise
IDAHO
WYOMING
SOUTH DAKOTA
Pierre
St. Paul
WISCONSIN
Madison
MICHIGAN
Lansing
Detroit
L. Michigan
Toronto
Albany
NEW YORK
Hartford
Boston
MASSACHUSETTS
Cape Cod
Providence
RHODE ISLAND
CONNECTICUT
New York
Cape Mendocino
PENNSYLVANIA
Harrisburg
Trenton
NEW JERSEY
Dover
DELAWARE
WASHINGTON D.C.
MARYLAND
Annapolis
IOWA
Des Moines
Chicago
Springfield
ILLINOIS
INDIANA
Indianapolis
OHIO
Columbus
WEST VIRGINIA
Charleston
Richmond
VIRGINIA
Mississippi
Platte
Cheyenne
NEBRASKA
Lincoln
Great Salt Lake
Salt Lake City
SIERRA NEVADA
Sacramento
Carson City
San Francisco
NEVADA
UTAH
Denver
COLORADO
Topeka
KANSAS
Jefferson City
St. Louis
MISSOURI
Frankfort
KENTUCKY
Arkansas
Colorado
Mt. Whitney
Las Vegas
Pt. Arguello
CALIFORNIA
NORTH CAROLINA
Raleigh
Cape Hatteras
UNITED STATES OF AMERICA
Nashville
TENNESSEE
ARIZONA
Santa Fe
Canadian
OKLAHOMA
Oklahoma City
ARKANSAS
Little Rock
Columbia
SOUTH CAROLINA
Cape Fear
Los Angeles
San Diego
Phoenix
NEW MEXICO
TEXAS
Red
Atlanta
GEORGIA
Savannah
ATLANTIC OCEAN
Alabama
Jackson
Montgomery
ALABAMA
MISSISSIPPI
LOUISIANA
Ciudad Juárez
El Paso
Dallas
Jacksonville
Baton Rouge
Tallahassee
Austin
Houston
New Orleans
Orlando
Baja California
GULF OF CALIFORNIA
Hermosillo
Chihuahua
Rio Grande
San Antonio
Mississippi Delta
Tampa
FLORIDA
Punta Eugenia
Miami
BAHAMAS
Torreón
Monterrey
GULF OF MEXICO
Habana
DOMINICAN REPUBLIC
Cabo Falso
MEXICO
CUBA
HAITI
Port-Au-Prince
Santo Domingo
Tampico
PACIFIC OCEAN
Mérida
Yucatan Peninsula
Guadalajara
Leon
JAMAICA
Kingston
Cabo Corrientes
Mexico City
CARIBBEAN SEA
Acapulco
BELIZE
HONDURAS
Tegucigalpa
GUATEMALA
Guatemala
EL SALVADOR
NICARAGUA
Managua
Maracaibo
COSTA RICA
San José
Panama
PANAMA
Apure
Medellín
Meta
COLOMBIA
Bogotá
Guaviare
0 500 1000 1500 2000 Miles
0 500 1000 1500 2000 2500 3000 Kilometres


COSTA RICA
CARIBBEAN SEA
Pta Gallinas
LESSER ANTILLES
Gulf of Venezuela
Netherlands Antilles
Barranquilla
Maracaibo
Caracas
Port of Spain
TRINIDAD & TOBAGO
Lake Maracaibo
PANAMA
Gulf of Panama
Delta del Orinoco
Orinoco
ATLANTIC OCEAN
Medellín
VENEZUELA
Georgetown
Paramaribo
Cabo Corrientes
GUYANA
FRENCH GUIANA
Cayenne
Bogotá
GUIANA HIGHLANDS
SURINAM
Magdalena
Cali
Orinoco
Huila
COLOMBIA
Branco
Punta Galera
Macapá
B. de Marajó
Quito
Negro
I de Marajó
Chimborazo
Japurá
Belèm
Guayaquil
ECUADOR
Putumayo
Manaus
Amazona
B. de São Marcos
São Luis
Tocantins
Fortaleza
I Fernando de Noronha
Marañón
Xingu
Cabo de São Roque
Punta Aguja
SELVAS
Tapajós
Juruá
Madeira
Purus
Recife
CAATINGAS
Araguaia
Parnaiba
Nevado Huascarán
ANDES MOUNTAINS
Barragem de Sobradinho
São Francisco
Maceió
BRAZIL
Arinos
PERU
SIERRA DOS PARECIS
Lima
Guaporé
Salvador
Mamoré
PLANALTO DE MATO GROSSO
Lake Titicaca
Nevado Ancohume
Brasília
BRAZILIAN HIGHLANDS
SERRA DO MAR
La Paz
CAMPOS
BOLIVIA
Arica
ATACAMA DESERT
ALTIPLANO
Lake Poopó
PACIFIC OCEAN
CHACO
Paraná
Represa Ilha Grande
Belo Horizonte
Cabo de São Tomé
PARAGUAY
São Paulo
Cabo Frio
Rio de Janeiro
Antofagasta
Pilcomayo
Itaipu Res
Santos
GRAN CHACO
Asunción
Volcán Llullaillaco
Salado
Nevado Ojos del Salado
ANDES MOUNTAINS
Uruguay
ATLANTIC OCEAN
CHILE
Mar Chiquito
Pôrto Alegre
Lagôa dos Patos
ARGENTINA
Lagôa Mirim
Salado
Rosario
URUGUAY
Buenos Aires
Montevideo
Cerro Aconcagua
La Plata
Rio de La Plata
Santiago
PAMPAS
Cabo San Antonio
Colorado
Bahia Blanca
Bahia Blanca
Negro
Golfo San Matias
Pena Valdés
Isla de Chiloé
Chubut
Golfo de San Jorge
ARCHIPELAGO DE LOS CHONOS
Lago Buenos Aires
C Tres Puntas
FALKLAND/MALVINAS ISLANDS
Bahia Grande
West Falkland
East Falkland
0
500
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ARCHIPELAGO REINA ADELAIDE
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Punta Arenas
Tierra del Fuego
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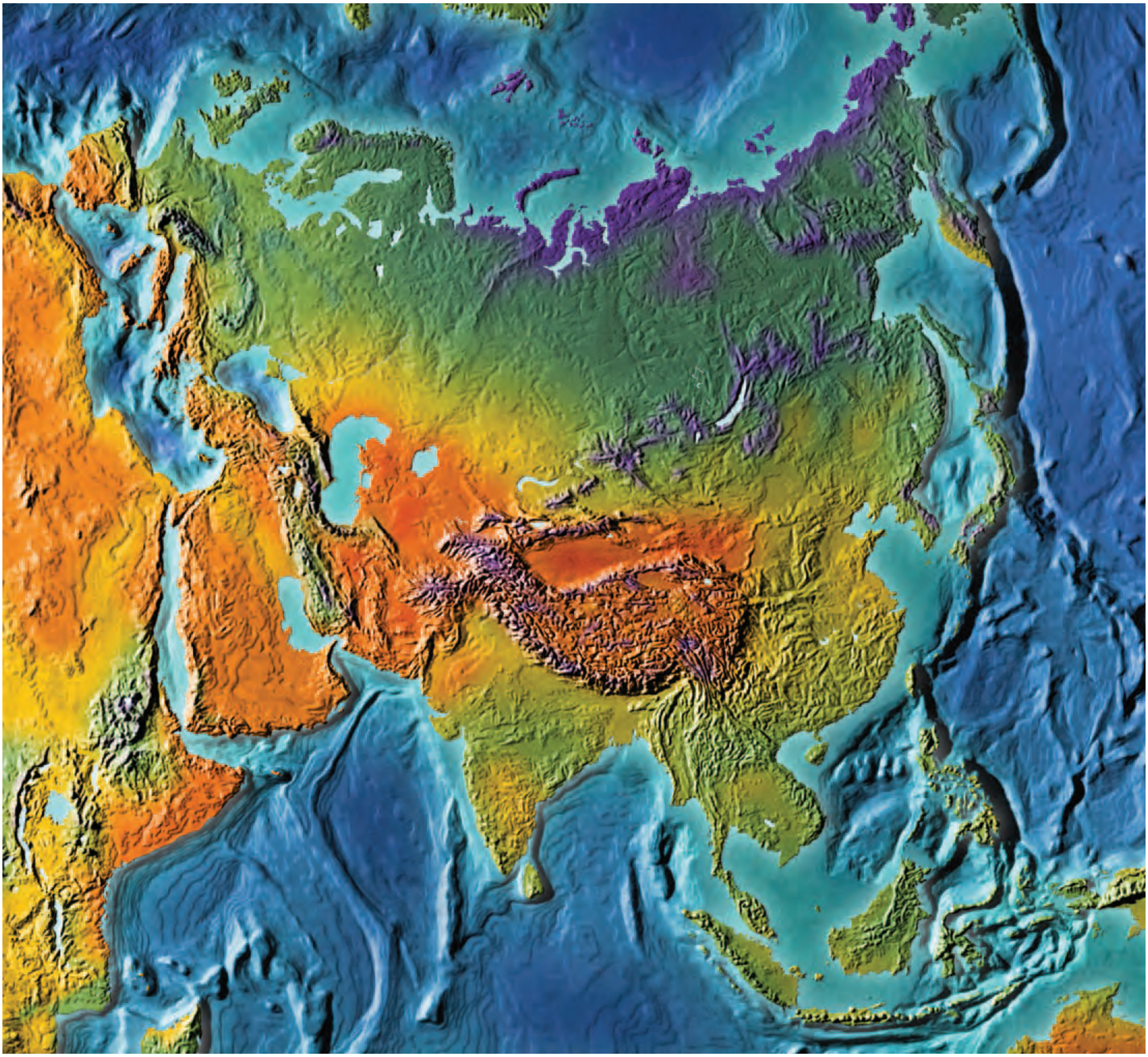
South Georgia
Cape Horn
SCOTIA SEA




ARCTIC OCEAN
Norwegian Sea
North Sea
Barents Sea
Kara Sea
Laptev Sea
East Siberian Sea
Chukchi Sea
Bering St.
Bering Sea
ALEUTIAN ISLANDS
Svalbard
Zemlya Frantsa Iosifa
Novaya Zemlya
Severnaya Zemlya
Novosibirskiye Ostrova
Kolyma
Kolyma Lowland
Lapland
Loire
ALPS
ESTONIA
LATVIA
LITHUANIA
RUSSIA
BELARUS
Dnepr
UKRAINE
MOLDOVA
Mediterranean Sea
Black Sea
CAUCASUS MTS.
Volga
Pechora
URAL MOUNTAINS
Ural
Ob'
Siberian Lowland
Yenisey
CENTRAL SIBERIAN PLATEAU
Nizhnyaya Tunguska
RUSSIA
Angara
Lena
Sea of Okhotsk
Amur
Lake Baykal
Tobol
Ishim
Irtysh
SAYAN
Manchurian Plain
TURKEY
ANATOLIAN PLATEAU
Qattara Depression
LEBANON
ISRAEL
SYRIA
JORDAN
Euphrates
Tigris
IRAQ
KUWAIT
Caspian Sea
Aral Sea
KAZAKHSTAN
Lake Balkhash
Syr Dar'ya
UZBEKISTAN
TURANIAN PLATEAU
Amu Dar'ya
TURKMENISTAN
KYRGYZSTAN
TAJIKISTA
TIEN SHAN
ALTAI
MONGOLIA
Gobi Desert
Sea of Japan
NORTH KOREA
SOUTH KOREA
JAPAN
Yellow Sea
Tarim Basin
Huang He
Great Basin
ZAGROS MTS
IRAN
AFGHANISTAN
HINDU KUSH
KUNLAN SHAN
PLATEAU OF TIBET
CHINA
Chang Jiang
East China Sea
PACIFIC OCEAN
Nile
Red Sea
SAUDI ARABIA
QATAR
UNITED ARAB EMIRATES
PAKISTAN
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HIMALAYA
NEPAL
Mt. Everest
BHUTAN
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ETHIOPIAN HIGHLANDS
YEMEN
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Gulf of Aden
Arabian Sea
Deccan
Ganga
BANGLADESH
Irrawaddy
INDIA
BURMA
Salween
LAOS
Mekong
South China Sea
Philippine Sea
Bay of Bengal
THAILAND
CAMBODIA
VIETNAM
PHILIPPINES
L. Victoria
L. Tanganyika
Kilimanjaro
SRI LANKA
INDIAN OCEAN
BRUNEI
Celebes Sea
MALAYSIA
SINGAPORE
INDONESIA
EAST INDIES
L. Nyasa
Mozambique Ch.
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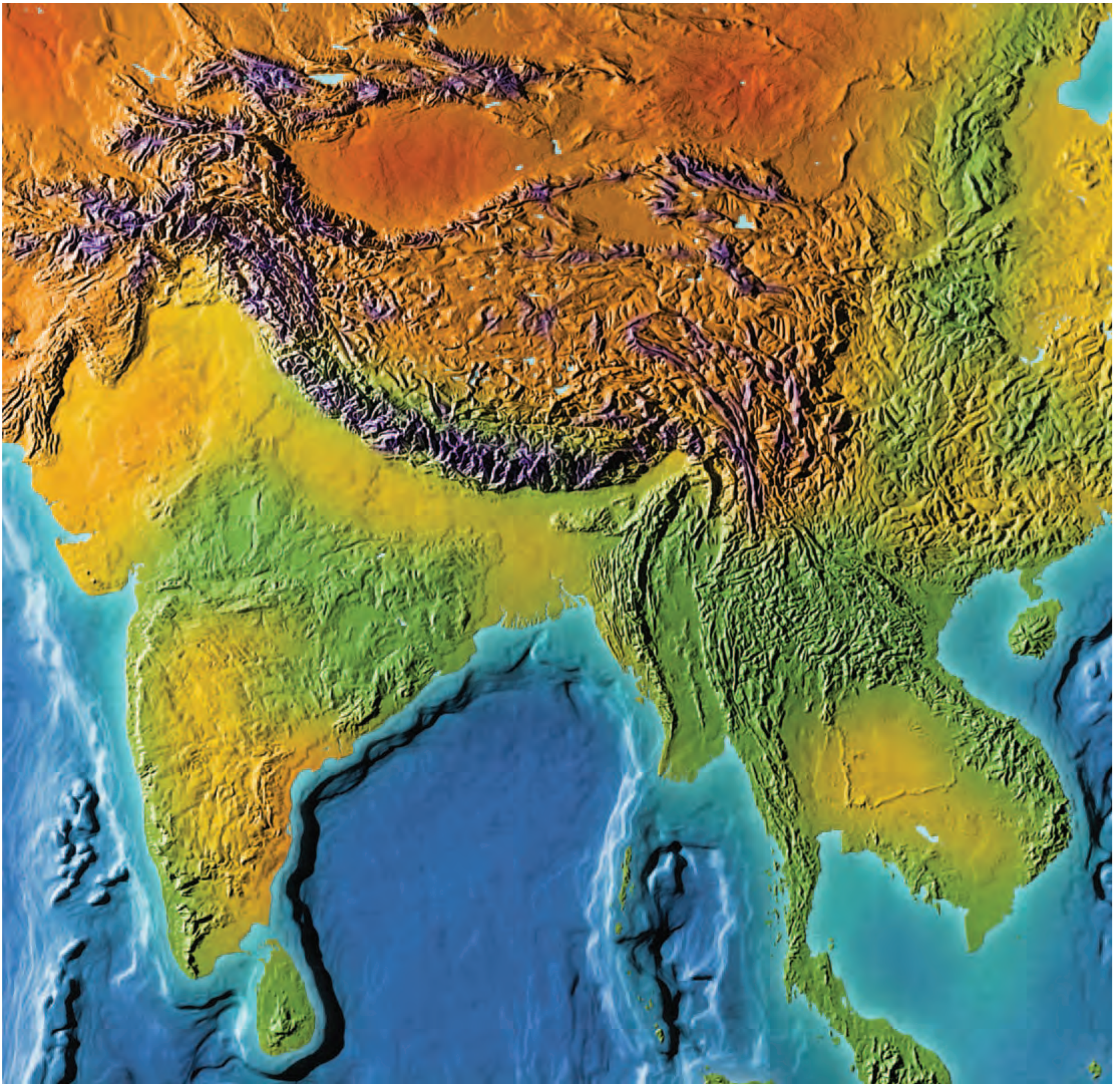


UZBEKISTAN
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MONGOLIA
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Dzungaria
Ürümqi
SHAN
Hami
Turfan Depression
Bishkek
Almaty
Oz. Issyk Kul'
KYRGYZSTAN
Tashkent
Bukhara
Samarkand
Aksu
TURKMENISTAN
Dushanbe
TAJIKISTAN
Shebergan
HINDU KUSH
TARIM PENDI
ALTUN SHAN
QILIAN SHAN
Qinghai Hu
Yumen
ORDOS
Yinchuan
Baotou
Beijing
Tianjin
Bo Hai
Shijiazhuang
Taiyuan
Hwang Ho
Zhengzhou
Luoyang
Xi'an
Lanzhou
Hotan
AFGHANISTAN
Kabul
Khyber Pass
KARAKORAM
KUNLAN SHAN
Srinagar
Islamabad
Qandahar
SULAIMAN RANGE
Quetta
Indus
Lahore
Multan
Sutlej
Bahawalpur
PAKISTAN
KIRTHAR RA.
Sukkur
Hyderabad
HOH XILSHAN
QINGZANG
BAYAN HAR SHAN
Tongtian He
Huang He
HUA SHAN
DABA SHAN
CHINA
Chang Jiang
Wuhan
Dongting Hu
Changsha
TANGGULA SHAN
Chengdu
RED BASIN
Chongqing
Qamdo
HENGDUAN SHAN
DALOU SHAN
Hengyang
Guiyang
GANGDISE SHAN
HIMALAYA
Annapurna
NEPAL
Mt Everest
Katmandu
Thimphu
BHUTAN
Xigaze
Lhasa
New Delhi
Jodhpur
Jaipur
Ajmer
Yamuna
Lucknow
Ghagara
Kanpur
Allahabad
Varanasi
Ganges
Patna
Udaipur
Brahmaputra
Gauhati
NAGA HILLS
Imphal
Kunming
Liuzhou
Nanning
Gulf of Kachch
Ahmadabad
Jamnagar
Bhavnagar
Vadodara
Son
Narmada
BANGLADESH
Dhaka
Jamshedpur
Kolkata (Calcutta)
Chittagong
Surat
INDIA
Gulf of Khambhat
Nagpur
Raipur
Mahanadi
Mouths of the Ganges
Cuttack
BURMA
Mandalay
ARAKAN YOMA
Irrawaddy
PEGU YOMA
Akyab
Zhanjiang
Hanoi
Halphong
Haikou
Gulf of Tongkin
Hainan
Louang Prabang
TANEN R.
Vinh
Mumbai (Bombay)
Pune
DECCAN
Godavari
Solapur
Kolhapur
Hyderabad
Krishna
WESTERN GHATS
EASTERN GHATS
Vishakhapatnam
Vijayawada
Hubli-Dharwar
Kurnool
BAY OF BENGAL
Prome
Henzada
Bassein
Yangon
Moulmein
Mouths of the Irrawaddy
Gulf of Martaban
Chiang Mai
M.Lampang
LAOS
Vientiane
Mekong
DAWNA RANGE
Hue
Da Nang
THAILAND
Nakhon Ratchasima
VIETNAM
Qui Nhon
INDIAN OCEAN
Nellore
Mangalore
Koramangala (Bangalore)
Chennai (Madras)
Mysore
LACCADIVE IS.
Kozhikode
Coimbatore
Tiruchchirappalli
Madurai
Jaffna
Thiruvananthapuram
C. Comorin
Trincomalee
Gulf of Mannar
SRI LANKA
Kandy
Colombo
Galle
Dondra Head
ANDAMAN IS.
Andaman Sea
MERGUI ARCHIP.
Ten Degree Channel
Tavoy
BILAUKTAUNG R.
Mergui
PHANOM DANG
Bangkok
CAMBODIA
Chu Yang Sin
Nha Trang
Battambang
Kampong Cham
Phnom Penh
Ho Chi Minh City
Can Tho
Mouths of the Mekong
Gulf of Thailand
Mui Bai Bung
Nakhon Si Thammarat
Phuket
Songkhla
Kota Baharu
Georgetown
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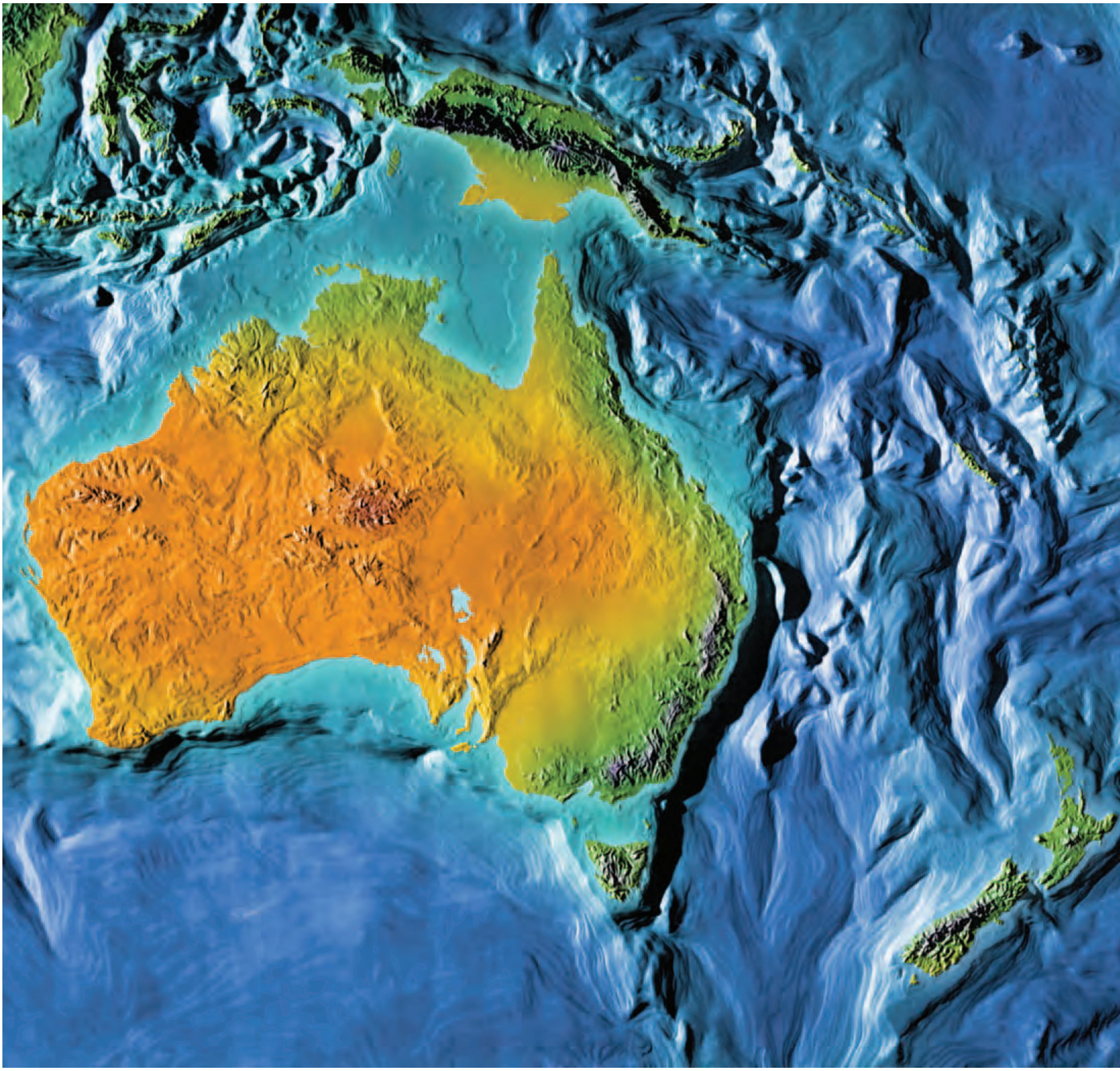


Makassar Strait
Halmahera
Sulawasi
SERAM SEA
Buru
Seram
Jayapura
PEGUNUNGAN MOAKE
Pk. Jaya
Bismarck Archipelago
New Ireland
BISMARCK SEA
New Britain
P A C I F I C
O C E A N
Bougainville I.
Choiseul
Ujung Pandang
BANDA SEA
I N D O N E S I A
FLORES SEA
Wetar
PAPUA NEW GUINEA
SOLOMON SEA
SOLOMON ISLANDS
Santa Isabel
Malaita
Sumbawa
Flores
Mataram
Timor
Gulf of Papua
ARAFURA SEA
Guadalcanal
San Cristobal
Sumba
Kupang
TIMOR SEA
Torres Strait
C. York
Port Moresby
Melville I.
Bathurst I.
Darwin
Arnhem Land
Gulf of Carpentaria
Groote Eylandt
Great Barrier Reef
I N D I A N
O C E A N
Daly
Roper
Wyndham
Espiritu Santo
VANUATU
Malakula
C. Lévêque
Derby
Kimberley Plateau
Fitzroy
Barkly Tableland
Mitchell
GREAT DIVIDING RANGE
Cairns
CORAL SEA
Flinders
Townsville
NORTHERN TERRITORY
Georgina
Great Sandy Desert
Port Headland
Fortescue
Mt. Bruce
Belyando
MACDONNELL RANGES
Alice Springs
Diamantina
Thomson
Rockhampton
NEW CALEDONIA
Barcoo
Gibson Desert
Carnarvon
Simpson Desert
Fraser I.
QUEENSLAND
WESTERN AUSTRALIA
Murchison
SOUTH AUSTRALIA
L. Eyre
Brisbane
Great Victoria Desert
Geraldton
Darling
NEW SOUTH WALES
Nullarbor Plain
L. Everard
L. Torrens
Kalgoorlie-Boulder
GREAT DIVIDING RANGE
L. Gairdner
Lachlan
Newcastle
Perth
Fremantle
Great Australian Bight
Sydney
Elizabeth
Adelaide
Canberra
Wollongon
Murray
AUSTRALIAN CAPITAL TERRITORY
C. Leeuwin
Albany
Kangaroo I.
VICTORIA
Mt. Kosciusko
Ballarat
Melbourne
C. Howe
Geelong
Auckland
North Island
King I.
Bass Strait
Flinders I.
TASMAN SEA
L. Taupo
NEW ZEALAND
Ruapehu
S O U T H E R N
O C E A N
Launceston
TASMANIA
Hobart
Wellington
South Island
SOUTHERN ALPS
Christchurch
Stewart I.
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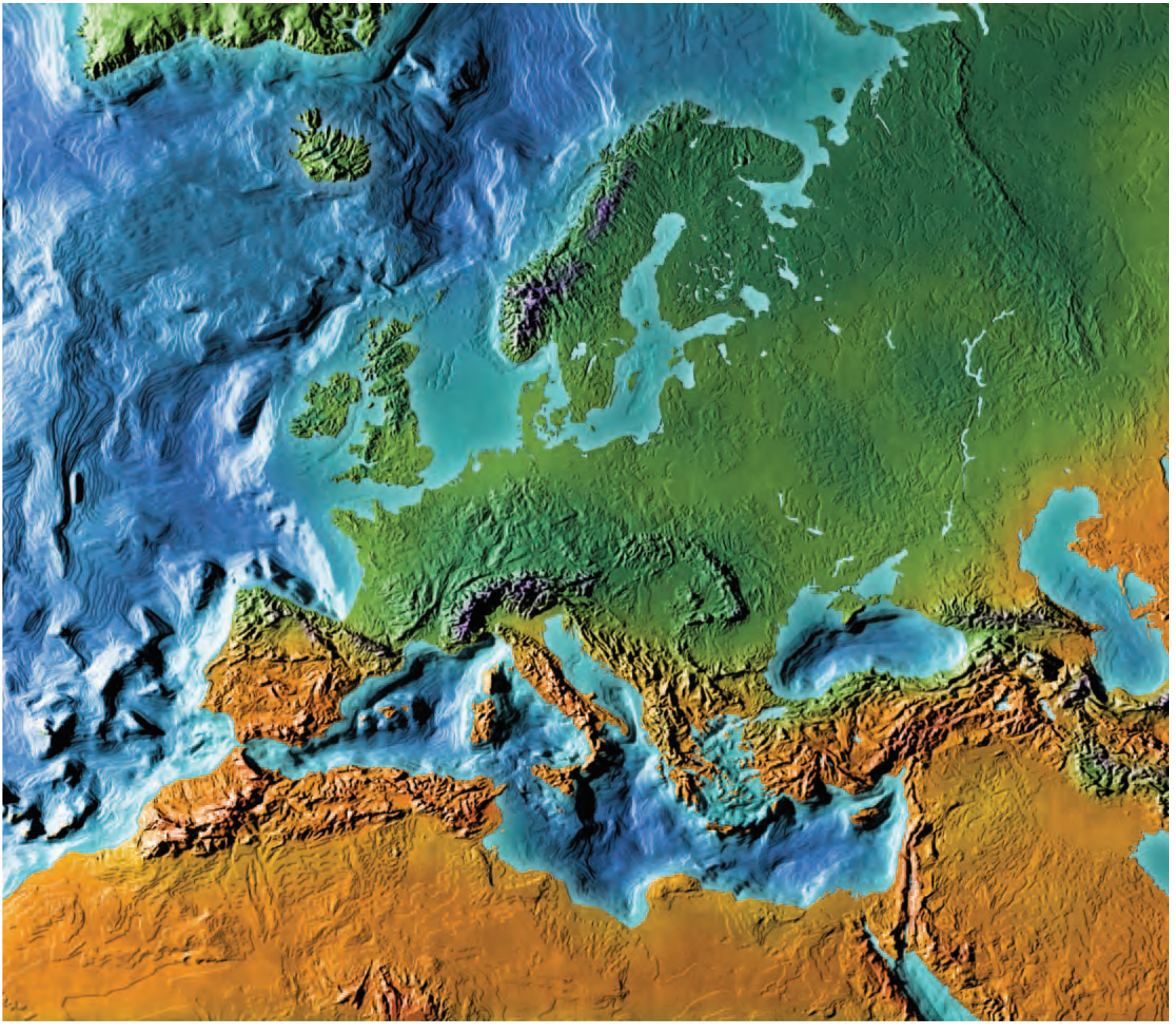


GREENLAND
GREENLAND SEA
ARCTIC OCEAN
BARENTS SEA
Denmark Strait
Ostrov Kolguyav
Reykjavik
ICELAND
NORWEGIAN SEA
Murmansk
KOLA PENINSULA
Arkhangel'sk
Severnaya Dvina
FAEROES
SHETLAND IS.
ORKNEY IS.
HEBRIDES
SCOTLAND
Edinburgh
NORTH SEA
ATLANTIC OCEAN
IRELAND
Belfast
Dublin
WALES
Cardiff
ENGLAND
London
NORWAY
Oslo
SWEDEN
Stockholm
Göteborg
Gulf of Bothnia
FINLAND
Helsinki
L.Onega
L.Ladoga
Sankt-Peterburg
Tallinn
ESTONIA
LATVIA
Riga
LITHUANIA
Vilnius
RUSSIA
Skagerrak
DENMARK
Copenhagen
BALTIC SEA
Sukhona
URAL MOUNTAINS
WEST SIBERIAN PLAIN
Ob'
Irtysh
Tobol
Yekaterinburg
RUSSIA
Kazan
Magnitogorsk
Volga
Samara
Moscow
Minsk
BELARUS
Pripyat
Desna
Don
KAZAKHSTAN
Ural
NETHERLANDS
The Hague
Berlin
BELGIUM
Brussels
GERMANY
Luxembourg
LUXEMBOURG
Paris
Seine
Prague
CZECH REP.
Warsaw
POLAND
Kiev
UKRAINE
Dnepr
Dnestr
MOLDOVA
Kishinev
Odessa
Loire
FRANCE
Bay of Biscay
Bilbao
MASSIF CENTRAL
Rhône
SWITZERLAND
Bern
ALPS
Donau
Vienna
Bratislava
SLOVAKIA
Budapest
HUNGARY
AUSTRIA
Ljubljana
SLOVENIA
CROATIA
CARPATHIANS
Prut
ROMANIA
Bucharest
Sevastopol'
CAUCASUS
GEORGIA
Tbilisi
Baku
AZERBAIJAN
Yerevan
ARMENIA
CASPIAN SEA
BLACK SEA
Porto
PORTUGAL
Lisbon
Duero
Tajo
Madrid
SPAIN
Andorra la Vella
ANDORRA
Barcelona
Monaco
Po
San Marino
Corsica
ITALY
Rome
BOSNIA-HERZEGOVINA
Sarajevo
Belgrade
YUGOSLAVIA
BULGARIA
Sofiya
Skopje
MACEDONIA
Tirane
ALBANIA
Istanbul
Ankara
TURKEY
L.Van
TOROS DAGLARI
Izmir
GREECE
Athens
Crete
MADEIRA IS.
Sevilla
Malaga
Gibraltar
Strait of Gibraltar
Sardinia
BALEARIC IS.
MEDITERRANEAN SEA
Sicily
MALTA
Algiers
Tunis
TUNISIA
Casablanca
Rabat
MOROCCO
Marrakech
CANARY IS.
Las Palmas
HAUT ATLAS
ATLAS SAHARIEN
El Aaiun
WESTERN SAHARA
MAURITANIA
ALGERIA
Tripoli
LIBYA
Gulf of Sirte
Benghazi
Alexandria
Cairo
Suez
EGYPT
Nile
RED SEA
Nicosia
CYPRUS
Beirut
LEBANON
Damascus
SYRIA
Jerusalem
ISRAEL
Amman
JORDAN
Baghdad
Euphrates
Tigris
IRAQ
Al Basrah
Al Kuwayt
KUWAIT
Tehran
IRAN
ZAGROS MOUNTAINS
SAUDI ARABIA
Riyadh
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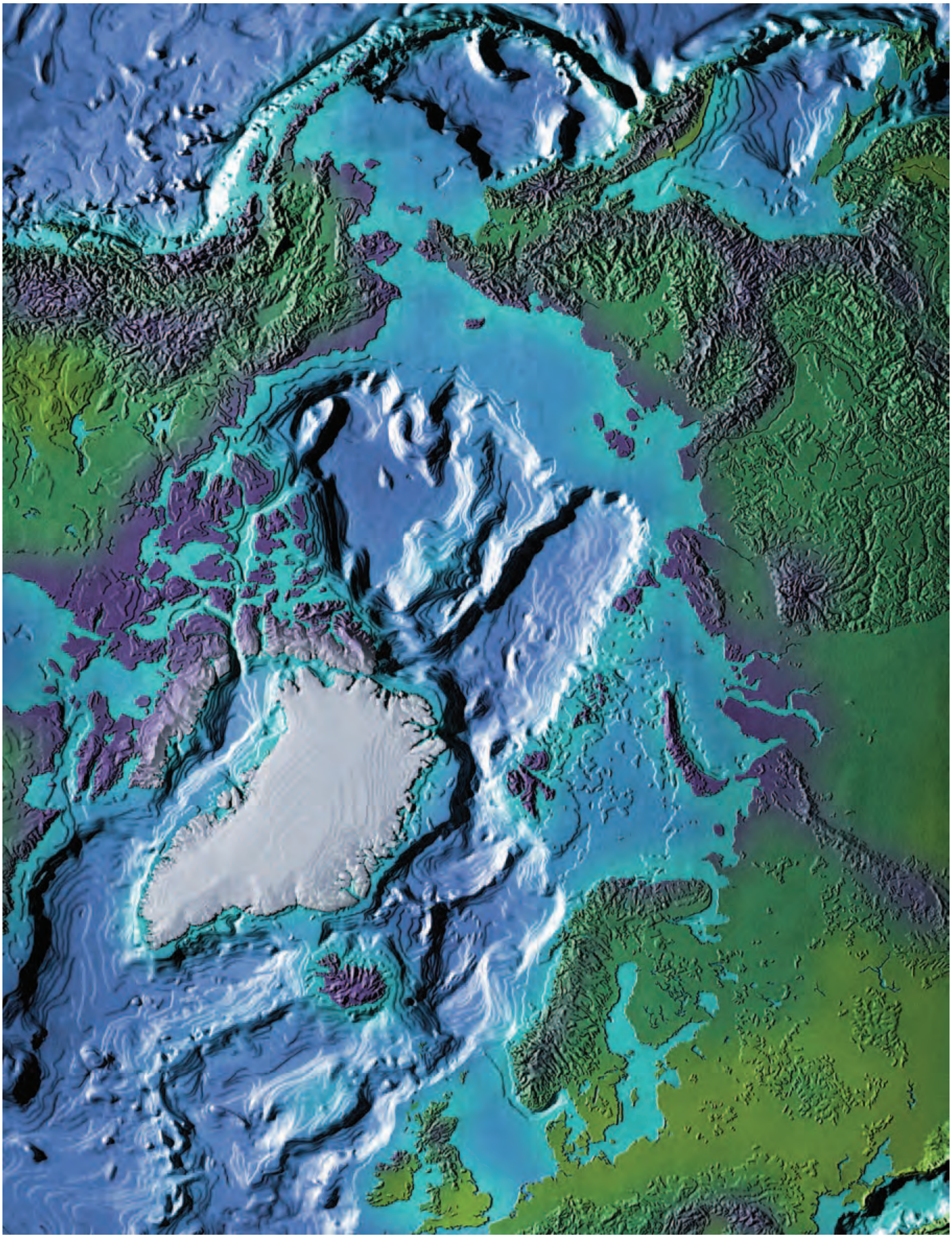

PACIFIC OCEAN
Bering Sea
Sea of Okhotsk
Gulf of Alaska
Alakanuk
Anadyr'
Anchorage
Yukon
Bering Strait
Fairbanks
ALASKA (USA)
C.Lisburne
Point Hope
Dawson
Fort Yukon
Ambarchik
Kolyma
Chukchi Sea
O.Vrangelya
M.Shelagskiy
East Siberian Sea
Indigirka
Aldan
CANADA
Pt. Barrow
Barrow
Lena
Mackenzie
Beaufort Sea
Great Slave Lake
Great Bear Lake
C.Bathurst
Novosibirskiye Ostrova
Vilyuy
Banks Island
McClure Strait
Laptev Sea
Victoria Island
ARCTIC OCEAN
Nordvik
Nizhnyaya Tunguska
North Magnetic Pole
Queen Elizabeth Islands
M.Chelyuskin
Severnaya Zemlya
Hudson Bay
North Pole
Ellesmere Island
Average permanent extent of sea ice
Dikson
Yenisey
RUSSIA
Foxe Basin
Lincoln Sea
Mys Zheleniya
Zemlya Frantsa Iosifa
Baffin Bay
Kara Sea
Baffin Island
Novaya Zemlya
Ob'
Svalbard
Davis Strait
80°
GREENLAND
Greenland Sea
Barents Sea
Pechora
Nordkapp
Godthåb
Murmansk
Arkhangel'sk
Denmark Strait
70°
Kazan
Norwegian Sea
Reykjavik
ICELAND
Arctic Circle
FINLAND
Nizhniy Novgorod
St Peterburg
SWEDEN
Helsinki
Saratov
Volga
Moscow
Tallinn
ATLANTIC OCEAN
NORWAY
Stockholm
ESTONIA
Oslo
LATVIA
Riga
60°
Vilnius
LITHUANIA
Minsk
Copenhagen
RUSSIA
Edinburgh
BELARUS
Kaliningrad
Donetsk
Glasgow
DENMARK
NETHERLANDS
Warsaw
UKRAINE
IRELAND
UNITED KINGDOM
POLAND
Dublin
MOLDOVA
Odessa
GERMANY
Kishinev
Amsterdam
London
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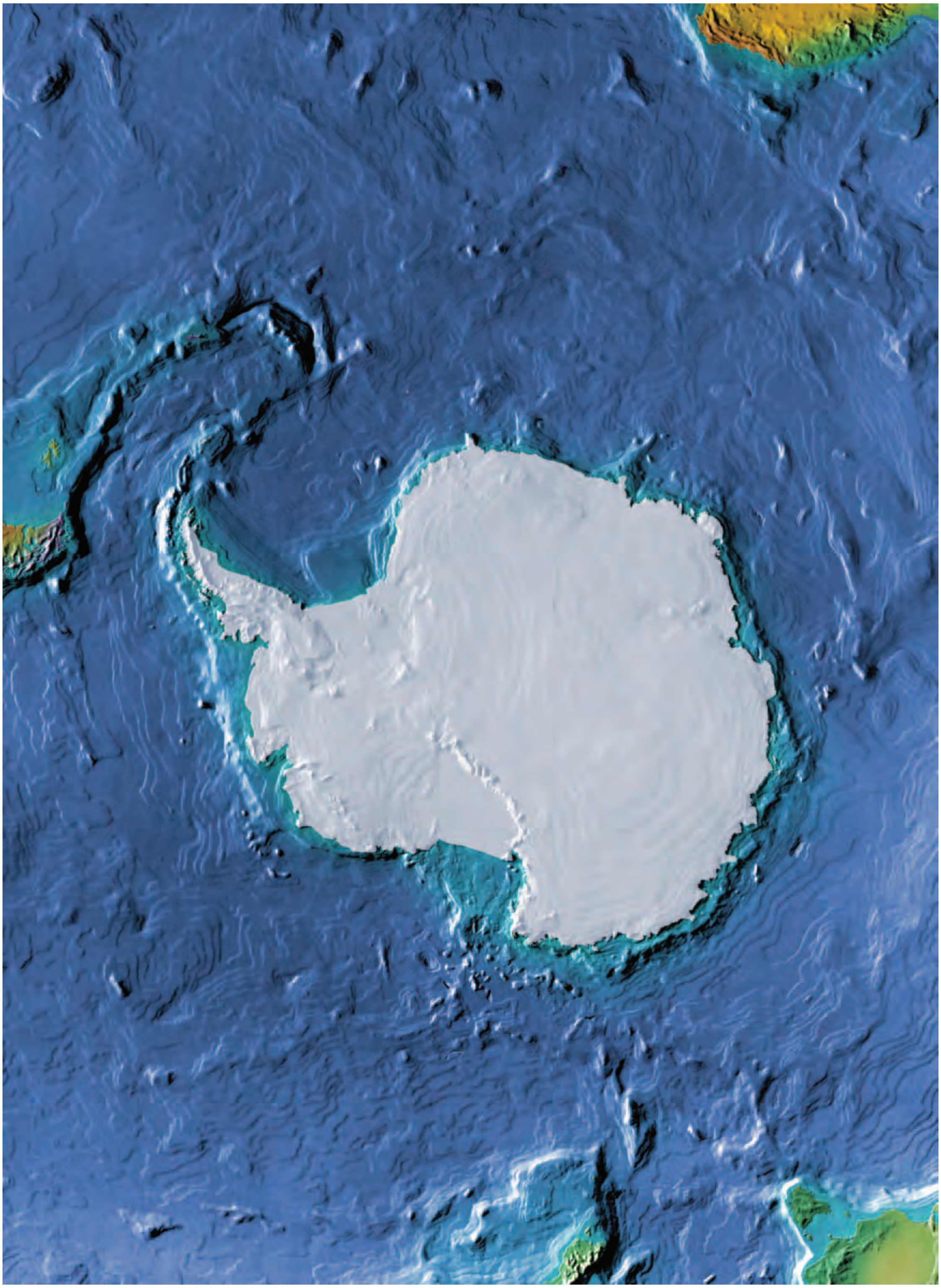

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SOUTH AFRICA
A T L A N T I C O C E A N
I N D I A N O C E A N
P A C I F I C O C E A N
South Georgia
NORWEGIAN DEPENDENCY
ARGENTINE CLAIM
S. Orkney Is
Falkland Is
Scotia Sea
S. Shetland Is
ARGENTINA
Tierra del Fuego
CHILE
Drake Passage
Graham Land
Antarctic Peninsula
Palmer Archipelago
Weddell Sea
C. Norvegia
Coats Land
Dronning Maud Land
Average permanent extent of sea ice
Enderby Land
BRITISH ANTARCTIC TERRITORY
Palmer Land
Berkner I.
Alexander I.
Charcot I
Bellinghausen Sea
Ronne Ice Shelf
PENSACOLA MTNS.
Mac Robertson Land
PR. CHARLES MTNS
C. Darnley
Amery Ice Shelf
AMERICAN HIGHLAND
CHILEAN CLAIM
Ellsworth Land
Vinson Massif
South Pole
G R E A T E R A N T A R C T I C A
AUSTRALIAN ANTARCTIC TERRITORY
Peter I fly
Mt. Seelig
Queen Mary Land
Shackleton Ice Shelf
L E S S E R A N T A R C T I C A
Thurston I.
Walgreen Coast
TRANSANTARCTIC MOUNTAINS
QUEEN MAUD MTNS
Mt. Kirkpatrick
Knox Coast
Amundsen Sea
Marie Byrd Land
Mt. Markham
Ross Ice Shelf
Wilkes Land
Mt. Sidley
Siple I.
Roosevelt I.
C. Colbeck
C. Poinsett
Victoria Land
Ross Sea
Terre Adélie
George V Land
Dates Land
C. Adare
South Magnetic Pole
Scott I.
Sturge I.
Balleny Is
FRENCH TERRITORY 'TERRE ADÉLIE'
Antarctic Circle
ROSS DEPENDENCY (NEW ZEALAND)
AUSTRALIAN ANTARCTIC TERRITORY
Macquarie Is
Campbell I.
Auckland I.
Tasmania
Antipodes Is
NEW ZEALAND
AUSTRALIA
0 1000 2000 Miles
0 1000 2000 3000 Kilometres

Abbey, Edward (1927–89)

EDWARD ABBEY WAS a working novelist, philosopher, lover of unfenced country, adventurer, river runner, desert rat, self-proclaimed extremist, redneck, and "agrarian anarchist." He was a man of many philosophies, peppered with contradictions and complexities. His writings criticized government, technology, corporate greed, and the unfortunate destruction of wilderness, but he also poked fun at vegetarians, made sexist comments, littered beer cans out the window of his automobile, and was a member of the National Rifle Association. James Bishop says, "He was neither left-wing nor right-wing, nor was he an outlaw. Abbey was a genuine rebel who simply did not believe in the moderns' industrial way of life."

In describing his life's work, Abbey notes, "I wrote once that environmental journalism isn't a very cheerful field of work. But I guess there was a little self-pity in that remark. I've had a hell of a good time with it, actually. I enjoy stirring people up, and I've always enjoyed making certain people angry. I write to amuse my friends and to aggravate our enemies, to give them ulcers, if possible. I make terrible threats that I have no means of carrying out…like getting rid of their Glen Canyon Dam. I like to make the opposition worry and lie awake at night, force them to hire more security guards, and the like."

Abbey's writings include over 21 books of both fiction and nonfiction. His first nonfiction work, *Desert Solitaire,* was published in 1968 and beautifully reflects his love of the nature he explored during two summers hiking and camping in southeastern Utah's canyonlands:

> In the desert I am reminded of something quite different—the bleak, thin-textured work of men like Berg, Schoenberg, Ernst Krenek, Webern and the American, Elliot Carter. Quite by accident, no doubt, although both Schoenberg and Krenek lived part of their lives in the Southwest, their music comes closer than any other I know to representing the apartness, the otherness, the strangeness of the desert. Like certain aspects of this music, the desert is also a-tonal, cruel, clear, inhuman, neither romantic nor classical, motionless and emotionless, at one and the same time—another paradox—both agonized and deeply still.

One of Abbey's more infamous fictional pieces is the 1975 novel *The Monkey Wrench Gang*, a comical thrill ride adventure about "eco warriors" Dr. A.K. Sarvis, George W. Hayduke, "Seldom Seen" Smith, and Ms. Bonnie Abbzug. This cast of characters travels around the American Southwest resorting to destructive direct action, or "monkeywrenching," of power plants, fences, vehicles, and dams to slow technological assaults on the environment. The book fueled a movement of nonviolent direct-action environmentalism; many have even called it the inspiration for the Earth First! movement: "And in that novel I tried to make a clear distinction between sabotage and terrorism. My 'monkeywrenchers' were saboteurs, not terrorists. Sabotage is violence against inanimate objects: machinery and property. Terrorism is violence against human beings. I am definitely opposed to terrorism, whether practiced by the military and state—as it usually is—or by what we might call unlicensed individuals."

Yet not all of Abbey's writings embody runaway cynicism, and often his respect and awe of the natural world shines through in vivid descriptions of plants, canyons, and rivers. Although he refused to call himself a naturalist, Abbey's books can transport readers to remote desert canyons and mountaintop lookouts. Nonetheless, there's always an ethic embodied in his work that the reader might take away in the name of wilderness protection: "A true civilization, for me, embraces tolerance as one of its cardinal virtues: tolerance for free speech and differences of opinion among humans, and tolerance for other forms of life … bugs and plants and crocodiles and gorillas and coyotes and grizzly bears and eagles, and all of the other voiceless, defenseless things everywhere that are in our charge. Any true civilization must provide for those other life-forms. And the only way to do that is to set aside extensive areas of the earth where humans don't interfere, where humans rarely even set foot."

Abbey said he wanted his body transported in the bed of a pickup truck and buried in an old sleeping bag, no coffin: "I want my body to help fertilize the growth of a cactus or cliff rose or sagebrush or tree." In March of 1989, about 200 people gathered in Saguaro National Monument, near Tucson, Arizona, for a celebration of the late Ed Abbey: "There were great tubs of a hot desert stew, concocted from meat of mysterious provenance ('poached slow elk', in the terms of this recipe) by Doug Peacock. Another close friend blew taps on a trumpet. There were grief and booze and chilies. There were bagpipes. There was joy at the privilege of having known this man, at having heard his inimitable voice." His body lies somewhere in the Cabeza Prieta Desert.

SEE ALSO: Desert; Earth First!; Ecotage; United States, Southwest (Arizona, Nevada, New Mexico, Utah).

BIBLIOGRAPHY. Edward Abbey, *Desert Solitaire* (McGraw Hill, 1968); Abbey's Web, "Edward Abbey Biography," www.abbeyweb.net (cited April 2006); James Bishop Jr., *Epitaph for a Desert Anarchist* (Touchstone, 1995); *Mother Earth News,* "The Plowboy Interview—Ed Abbey" (#87 May/June 1984), www.motherearthnews.com (cited April 2006).

Andrew J. Schneller
Independent Scholar

Acid Rain

ACID RAIN BROADLY refers to acidic precipitations—in wet form such as acidic rain, fog, and snow; or in dry form such as acidic gases and particles. Acid rain was first noticed in the late 1960s, when declining fish stocks were observed in Scandinavian lakes, and precipitation was found to be more acidic. Acid rain has also destroyed forests and acidified lakes in Canada as well.

The term *acid rain* is a misnomer, because even uncontaminated rain has a pH level below 7 and is therefore acidic. The addition of sulphurous and nitrous gases to the atmosphere causes precipitation to become even more acidic as they combine with water. The natural pH of rainwater is about 5.6, but the pH of acidic rain is 4.0–5.0. A decrease of one pH unit represents about a tenfold increase in the acidity of rain.

Acid rain occurs when sulfur dioxide (SO_2) and nitrogen oxides (NOx), released from fossil fuel burning and industrial processes, react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. Sunlight increases the rate of most of these reactions. The result is a mild solution of sulfuric acid and nitric acid. When this acidic precipitation reaches the ground, it affects plants, animals, fishes, and other living things to varying degrees.

About half of the acidity in the atmosphere is composed of dry depositions blown by the wind onto buildings, homes, trees, etc. When the other half arrives in the form of rain, all of these dry deposits are also washed out. This, in turn, makes the runoff even more acidic and harmful to the environment.

High-altitude vegetation communities are more at risk from acidification because they may be exposed to the cloud bases, which have low pH values due to the acids produced by the reaction of acidification gases with hydroxyl radicals and monatomic oxygen. Areas with "acid" bedrock are also more at risk because they lack buffering capacity; this means these soils are already acidic and hence lack cations such as calcium, which react with acid soil and groundwaters to raise the pH in drainage waters.

Acid rain causes corrosion of buildings in urban areas; reduced visibility; forest damage from occult precipitation; acidification of lakes, rivers and ground water; decline in fish population (or decline in aquatic ecology); and changes in soil flora and fauna (forest and terrestrial ecosystem damage). Acid rain also damages forests by damaging tree leaves, thus limiting available nutrients, or by exposing trees to toxic substances slowly released from the soil.

Acid rain can also cause extensive damage to buildings, marble sculptures (such as Taj Mahal), limestone, slate, and mortar. These materials become pitted and weakened mechanically as the soluble sulphates are leached out by rainwater. Acid rain also increases the process of weathering.

ACID RAIN AND EUTROPHICATION

ACID RAIN IS also known to increase eutrophication. The deposition of nitrogen compounds might favor forest growth, but it disrupts ecosystems on land and in the sea. Although phosphates are the main cause of eutrophication in fresh water, nitrogen (oxides of nitrogen) is the limiting factor on land and in the sea. Nitrogen (in the form of oxides and ammonia) acts as a fertilizer in nature, but this generally means the growth of certain species at the expense of others. The impoverishment of ecosystems that results is also a real and serious problem, and the increased growth rate also increases biological acidification.

As acid rain flows through soils, both the decreased pH and increased aluminum cause chronic ecosystem stress.

Acid rain causes a cascade of effects in aquatic ecosystems that can harm or kill fishes, reduce fish populations, or even completely eliminate some fish species, thus altering the ecosystem and decreasing biodiversity. As acid rain flows through soils, the element aluminum is released into water bodies in the watershed. Both the decreased pH (high acidity) and the increase in aluminum cause chronic stress on the water ecosystem, which can either kill certain plants and fishes or limit the ability of small fish to compete for food and habitat.

Acid rain causes poor visibility and has an impact on human health. It is known to cause respiratory problems such as dry coughs; asthma; headaches; and eye, nose, and throat irritation. Sulphur dioxide mixes with water vapors and other chemicals in the air, forming sulphate particulates (smog), which is particularly harmful to people with breathing problems.

Acid rain can also harm people through the atmosphere or through the food chain—crops grown in the toxic soil, animals consumed by humans, and by drinking water. This contaminated food has been cited as causing nerve or brain damage in children.

A concern about acid rain and acidification was first raised by a Swede, Svante Oden, in the 1960s. Oden also pointed out that because the cause of acid rain is not just domestic, but due to other countries' windborne pollution, intergovernmental action was needed to solve such problems. On July 1972, 33 nations convened in Stockholm to draw world attention to acid rain's ecological threat to Scandinavian countries and Canada. Interestingly, the venue received a heavy downpour of acid rain for the entire week.

An overall understanding of the causes and effects of acid rain, and the remedial actions required, have advanced since the 1960s. Emission controls in both Europe and North America have reduced deposition rates significantly in some parts of the world, and an effort has also been made to recover damaged aquatic ecosystems. In other countries, however, further sulphur reductions are needed to stop the acidification damage to forests, soils, and lakes.

As a society, certain steps can be taken to limit acid rain by controlling the emission of gases such as sulphur dioxide and nitrous oxides (dioxide, monoxide) from fossil fuel burning and industrial processes. The best options are alternative sources of energy—apart from fossil fuels—such as wind energy, hydro power, nuclear energy, and solar energy. Automobile options include more fuel-efficient cars; hybrid vehicles; and natural-gas powered, fuel-cell powered, or battery-powered vehicles.

Another alternative is better emission-control technology, such as improved smokestack and exhaust pipe scrubbers, and using sulphur-reduced coal. Because acid rain is also linked to other environmental problems, such as climate change, society and individuals must try to help control acid rain.

SEE ALSO: Eutrophication; Groundwater; Industrialization.

BIBLIOGRAPHY. Leslie R. Alm, *Crossing Borders, Crossing Boundaries: The Role of Scientists in the U.S. Acid Rain Debate* (Greenwood Publishing, 2000); A.K. De, *Environmental Chemistry* (Wiley Eastern Ltd., 1993); Sally Morgan, *Acid Rain* (Sea to Sea Publication, 2007).

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Acquired Immune Deficiency Syndrome (AIDS)

AIDS IS AN acronym that stands for Acquired Immune Deficiency Syndrome, or Acquired Immunodeficiency Syndrome. This disease is caused by the infection of a retrovirus known as the Human Immunodeficiency Virus (HIV)—a virus that attacks and weakens the human immune system. Over time, opportunistic infections and diseases that can lead to severe illness or death may affect a weakened immune system. While there is no cure for HIV/AIDS, there are treatments to help manage or suppress symptoms. The best "cure" is considered to be awareness and prevention through safe sex, abstinence, and use of sterile needles.

Approximately 8,000 people die each day of AIDS-related diseases, according to World Health Organization (WHO) statistics. It is estimated that more than 25 million people have died of AIDS since it was first recognized on June 5, 1981, and that by 2007, over 65 million people have been infected with HIV. Therefore, it is not surprising that HIV/AIDS is considered to be one of the worst pandemics to affect humankind, despite global efforts for control, treatment, and prevention. This epidemic stands in the way of many countries' Millennium Development Goals (MDGs) set forth in 2002 by the United Nations (UN). In fact, one of the proposed MDGs is to halt and reverse the spread of HIV/AIDS (along with other diseases) by 2015. However, the impact of this disease is far-reaching and will continue to have detrimental social, political, economical, and environmental repercussions for decades to come.

The tragic loss of human life and the hindrance placed on societies have been devastating, but the real long-term effects are not easily predictable due to the complex nature of the disease. Infected people debilitated by the disease face incredible physical and emotional adversity. Developing nations have experienced the heaviest HIV/AIDS burden, in addition to contending with the ill effects of extreme poverty and inequalities. The social, historical, and economic roots of problems within the developing world are inextricably linked to an increased susceptibility of this disease. Sub-Saharan Africa, one of the poorest regions in the world, has been the hardest hit by the HIV/AIDS epidemic, and is home to more than 64 percent of all people living with HIV (approximately 24.5 million). South and southeast Asia follow as the next most affected regions, with over seven million people infected with HIV. North America, in comparison, has relatively low numbers with around one million infected, an HIV prevalence rate of 0.3 percent.

Young adults are the most susceptible group to be infected, leaving the elderly and child populations more vulnerable. Globally, AIDS has created nearly 13.2 million orphans, causing a breakdown in traditional family structures. Often, this leads to a displacement of children onto the streets, where they may prostitute themselves or engage in illegal activities for survival. Poor infrastructure, lack of resources and services, little political interest, stigma, denial, and discrimination are the challenges in providing effective HIV/AIDS prevention and treatment to local populations. Controversial pharmaceutical companies that refuse to make drugs more affordable to the poor, yet conduct questionable drug testing trials on the very same populations, further aggravate these frustrations.

In a recent effort to curb this crisis, the United Nations Joint Program on HIV/AIDS (UNAIDS) and WHO launched the "3 by 5" initiative in 2003, which focused on making life-prolonging antiretroviral treatment (ART) more accessible to three million of the world's poorest by 2005. While this target was not reached, the number of people receiving treatment therapy increased significantly. In 2005 alone, 8.3 billion dollars were spent on anti-AIDS initiatives. However, while many financial resources have been invested, most HIV/AIDS prevention and control programs have failed. This is partly attributed to Western-focused agendas and a lack of cultural and political understanding. One of the most important lessons is that behavioral and biomedical interventions alone cannot be successful in addressing this epidemic. In order to combat this global crisis, it is important for national leadership and political commitment to be strengthened, and for all nations to adopt a multisectoral approach.

SEE ALSO: Disease; United Nations; World Health Organization.

BIBLIOGRAPHY. Tony Barnett and Alan Whiteside, *AIDS in the Twenty-First Century: Disease and Globalization* (Palgrave MacMillan, 2002); Michael H. Merson, "The HIV/AIDS Pandemic at 25: The Global Response," *New England Journal of Medicine* (v.354/23, 2006); Denis Nash and Batya Elul, "The Impact of HIV on Cities in the Era of Treatment: A Global Perspective," *Technology in Society* (v.28, 2006); UNAIDS (Joint United Nations Programmes on HIV/AIDS), www.unaids.org (cited July 2006); World Health Organization (WHO), www.who.int (cited July 2006).

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Adaptation

ADAPTATION IS BROADLY understood to refer to the response to some type of change by organisms, individuals, and systems. How do organisms respond to habitat loss in the Amazon, and what are the implications for their reproductive success? How will humans react to climate modification in the American Midwest? What livelihood strategies will indigenous communities in Indonesia craft to address the localized effects of globalization? While these questions all direct attention to adaptations, this description of adaptation belies a contested history and the diverse views about the underlying mechanisms that determine responses to change.

Dictionary definitions of adaptation refer to the process of being adapted or adapting in order to make more suitable and improve "fit." Most environmental science and related texts are consistent with this broad interpretation and define adaptation as the genetically controlled physiological, structural, or behavioral attribute of an organism that helps it survive and reproduce in a given set of environmental conditions. This scientifically-derived explanation of adaptation is traceable largely to Charles Darwin (*The Origin of Species,* 1859) and the nearly concurrent research of Alfred Wallace in present-day Indonesia and Malaysia. Prior to this work, the adaptation of organisms to their environment was explained primarily through supernatural design and creationist interpretations.

Darwin's study of Galapagos finches, for example, revealed how subtle adaptations in beak structure through selective pressure and speciation enabled the successful exploitation of food resources and greater reproductive success. Organisms adapt in order to cope with physical change, better obtain essential resources, avoid predation, attract mates, or pollinate. Our understanding of adaptation has evolved considerably since the time of Darwin and Wallace, as modern scientific inquiry now provides far more detailed information on DNA, genetics, and mutations.

ADAPTATION AND THE SOCIAL SCIENCES

Biologically derived concepts of adaptation have also been applied to the social sciences, including those with a historical focus on environment and society, such as cultural ecology, ecological anthropology, and geography. In particular, the prominent work of Julian Steward (1955) envisioned culture as a central component of human adaptation, much like the role of genetic-information transfer in biological evolution and adaptation. Cultural adaptation as derived from a biological reference encouraged a view of adaptation as a largely functional (i.e., adaptive behavior in closed human systems was oriented toward the maintenance of stability) and rational response by individuals to change.

When derived from the biological sciences, however, meanings ascribed to adaptation only partially explain these mechanisms in human societies. In fact, there is no widely accepted explanatory framework for adaptation across the natural and social sciences, and interpretations are contested across and even within disciplines. In particular, the strict conceptualization of biological adaptation applied to human contexts has been criticized as overly "adaptationist."

First, this perspective implies that all behavioral responses can be reduced to serve some functional purpose. Yet, even in the biological sciences, the view that all features of an organism are optimally produced by natural selection has been critiqued as incomplete. Adaptive traits may arise by means other than natural selection, and thus, may include behavioral or physical modifications without a genetic mechanism. Second, those critical of applying biological concepts of adaptation to explain environment-society interactions point to the role of history, social and political contexts, and the limits of imagining human societies as closed, autonomous systems. For many scholars with Marxian roots, the starting point for adaptation is not the functional or rational response of individuals to change, but rather, social relations of production, and the manner in which adaptation is shaped by social and economic inequality.

In the social sciences, concepts of cultural and human adaptation that reflect a dialectical relationship between environment and society, the importance of social context in understanding cultural adaptation, and the influence of human agency in determining responses to change are now common. It is also recognized that individuals may adapt passively to change, but they are also likely to anticipate and respond proactively.

A variety of more recent subdisciplines and applied fields addressing environment and society relationships continue to emphasize the role of adaptation, including climate change studies, adaptive management and social learning, adaptive governance, and resilience and adaptive capacity. The climate change literature, in particular, has developed an explicit adaptation focus. It has helped to draw attention to the variable stimuli for adaptation (and whether such stimuli are anticipated); the dimensions of whom or what is adapting, and over what period of time; and the process of adaptation. With respect to the latter, adaptations may be spontaneous or deliberate, concurrent, or anticipatory. They may also be short- or long-term in scope, be localized or widespread, and reflect a range of modifications—behavioral, technological, and institutional.

While adaptation may never become an indisputable concept, the rich tradition of adaptation research will continue, remaining a key tool for those seeking to understand, explain, and predict environment-society relationships.

SEE ALSO: Adaptive Management; Evolution; Social Darwinism.

BIBLIOGRAPHY. W.M. Denevan, "Adaptation, Variation, and Cultural Geography," *Professional Geographer* (v.35, 1983); D.L. Hardesty, "Rethinking Cultural

Adaptation," *Professional Geographer* (v.38, 1985); R. Neumann, *Making Political Ecology* (Hodder Arnold, 2005); M.R. Rose and G.V. Lauder, *Adaptation* (Academic Press, 1996); B. Smit, I. Burton, R. Klein and J. Wandel, "An Anatomy of Adaptation to Climate Change and Variability," *Climatic Change* (v.45, 2000); J. Steward, *Theory of Cultural Change: The Methodology of Multilinear Evolution* (University of Illinois Press, 1955).

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Adaptive Management

ADAPTIVE MANAGEMENT IS a policy framework designed to utilize scientific information in formulating and improving management strategies of complex systems. Adaptive management helps policymakers and managers learn from programs so they can take systematic action to continually improve management policies. This process involves changing assumptions and interventions in order to better respond to new information. Ultimately, adaptive management is learning by doing, and it is proactive in that it does not postpone management actions until complete data or information is gathered; essentially, it is experimentation that affects social arrangements and individual lives.

Adaptive management has been defined in various ways since its development in the late 1960s. Its most effective form—"active" adaptive management—employs management programs designed to experimentally compare selected policies or practices by evaluating alternative hypotheses.

An adaptive management system has two elements: a monitoring system to measure key indicators, and a response system to modify those indicators. Principles of adaptive management include: doing it yourself, promoting innovation, valuing and learning from failures, acknowledging that decisions are made with incomplete information, and considering all events to be learning opportunities. Adaptive management is flexible, encourages public input, and monitors the results of actions for the purpose of adjusting plans and trying new or revised approaches.

CHARACTERISTICS OF ADAPTIVE MANAGEMENT

CHARACTERISTICS OF ADAPTIVE management include: acknowledgement of uncertainty concerning the most appropriate policy for a management issue, thoughtful selection of the practices to be applied (assessment and design), careful implementation of a plan of action designed to reveal the critical missing knowledge, monitoring of key response indicators, analysis of the management outcomes in consideration of the original objectives, and incorporation of the results into future decisions.

While it was first developed for ecosystem management, principles of adaptive management have also been used in other fields. For example, the concept of learning organizations in business management, learning in the social sciences, and the scientific method all draw from principles of adaptive management. More recently, adaptive management has also been applied to conservation projects.

Adaptive management is an inductive approach, relying on comparative studies that blend ecological theories with observation, the design of planned interventions in nature, and the understanding of human response processes. Adaptive management treats management policies as experiments that probe the responses of ecosystems as human behaviors change. Adaptive management is bioregional in scope, collaborative in governance, and adaptive with respect to management perspective. As its use has become more widespread and diverse in meaning, it is also referred to as adaptive environmental assessment and management, or AEAM.

Adaptive management incorporates research into conservation action. The testing of assumptions, necessary in order to adapt and learn, involves a six-step iterative process: 1) problem assessment or outline purpose; 2) model design of the system in question, and a management plan; 3) implementation of the plan; 4) monitoring of activities that test assumptions; 5) evaluation of activities and analysis of collected data; and 6) using results to adjust or adapt the project and to learn from the experience, then repeating the cycle to further improve management efforts. The key to successful adaptive management is to complete all six steps to understand which actions work or do not work, and why.

Adaptive management became an important concept in U.S. resource management when Kai N. Lee introduced it to the Northwest Power Planning Council in 1984. Lee used the metaphor of compass and gyroscope to emphasize the integration of scientific analysis and civic participation in adaptive management. The compass, grounded in the scientific method, warns when the direction is off course, while the bounded conflict of the democratic process lends stability to humans' turbulent encounters with nature. Subsequently, different forms of adaptive management have become part of the resource planning processes of numerous federal, state, and private sector entities throughout the 1990s. A schematic appraisal of adaptive management includes four dimensions of policy design: 1) Conceptual soundness—is the idea sensible? 2) Technical—is the idea translated into practice well? 3) Equity—who are the winners and losers? 4) Pragmatic—does it work?

There are a few critiques of adaptive management. One critique is that since it is experimental, it is impossible to know which "experiment" is best for obtaining a desired management outcome. People may not desire to experiment or learn by doing, particularly if they know ahead of time the outcome they are seeking. Another critique is that the pressure to implement management strategies with limited resources is not conducive to the adaptive management process, which requires time to determine experimental outcomes as well as resources for continuous monitoring. A third critique of adaptive management is that it is not capable of fully handling the complexity of biocultural systems.

SEE ALSO: Adaptation; Management, Environmental; Policy, Environmental.

BIBLIOGRAPHY. Lance Gunderson, C.S. Holling, and S.S. Light, *Barriers and Bridges to Renewal of Ecosystems and Institutions* (Columbia University Press, 1995); C.S. Holling, *Resilience and Stability of Ecosytems* (International Institute for Applied Systems Analysis, 1970); C.S. Holling, ed., *Adaptive Environmental Assessment and Management* (John Wiley & Sons, 1978); Kai N. Lee, *Compass and Gyroscope: Integrating Science and Politics for the Environment* (Island Press, 1993); Carl Walters, *Adaptive Resource Management* (Macmillan, 1986); Carl Walters, "Challenges in Adaptive Management of Riparian and Coastal Ecosystems," *Conservation Ecology* (v.2/1, 1997).

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Addams, Jane (1860–1935)

JANE ADDAMS WAS an urban reformer who actively worked for social justice, particularly in the rapidly growing urban area of Chicago, Illinois

Born September 6, 1860 in Cedarville, Illinois, Jane Addams received her A.B. from Rockford College (then Rockford Seminary) in 1882. After a few years at the Women's Medical College of Philadelphia, she became ill and abandoned her studies in favor of travel. After observing the social experimentation at Toynbee Hall in London in 1887, she established Hull House, a settlement house that acted as a base for her and other women activists' pursuits. On September 18, 1889, she picked the location on Halstead Street because it was in a relatively run-down, poor, and largely immigrant part of Chicago. While the overall goal of the project was to provide diverse individuals enough space to interact with one another, thus producing socially functional citizens, the specific undertakings of Addams and her colleagues can be seen as the root of urban environmental justice movements, public health, and social work.

It is clear that the problems of the poor in industrial Chicago in the late 19th and early 20th centuries were more than social. They were also related to health and the environment. In *Twenty Years at Hull House,* Addams notes this in her description of the neighborhood around Halstead Street: unspeakably filthy roads, the obvious lack of enforcement of sanitary legislation, poorly lit streets, foul stables, and houses without sewer connections.

It was for this reason that Jane Addams and other members of her settlement house thought it essential to fight for increased labor protection and sanitary services for all neighborhoods. This fight was undertaken on many fronts. First, the women of Hull House performed in-depth epidemiological studies linking diseases, such as Phossy Jaw, to their industrial causes. They were then able to get legislation passed banning the use of certain substances in manufacturing. Second, Jane Addams and other members of the settlement house took active steps in cleaning up the neighborhood in which they lived, as Addams felt that the garbage problem was a great threat to her wards. These activities, along with city-wide studies of sanitation, led to the appointment of Addams to garbage inspector for her ward. In this role, she kept a close eye on the garbage trucks; mapped their comings and goings; made citizens' arrests of landlords who did not dispose of garbage; and eventually, provoked the city to restructure its collection system.

In addition to working in Chicago, Addams was also interested in national politics. In 1912 she acted as a delegate to the first national convention of the Progressive Party. In 1915, she founded The Women's League for Peace and Freedom. Her work in this area, with women and men, led to her become a co-winner of the Nobel Peace Prize in 1931, the first woman to receive that honor.

Among Jane Addams's many books are *Democracy and Social Ethics* (1902), *Newer Ideals of Peace* (1907), *Twenty Years at Hull House* (1910), *The Second Twenty Years at Hull House* (1930), *The Excellent Becomes the Permanent* (1932).

Jane Addams died in Chicago on May 21, 1935. She was 74 years old.

SEE ALSO: Garbage; History, Environmental; Justice.

BIBLIOGRAPHY. J. Addams, *Twenty Years at Hull House* (The New American Library, 1960); R. Gottlieb, *Forcing the Spring* (Island Press, 1993); L. Knight, *Citizen: Jane Addams and the Struggle for Democracy* (University of Chicago Press, 2005).

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Afghanistan

AFGHANISTAN IS A landlocked country in central Asia with an area of 251,772 square miles and a population of 29.9 million (2005 estimate). Important cities include Kabul, the capital, Kandahar, Herat, and Mazar-i Sharif. Afghanistan is bordered by Pakistan, Iran, Turkmenistan, Uzbekistan, Tajikistan, and by China on the narrow Wakhan Corridor (a relic of the Great Game). High mountains and deserts dominate the landscape, with narrow river valleys providing most of the arable land. The largest agricultural region, irrigated by the Kunduz River, is in the north around the cities of Kunduz and Taloqan.

Twenty-three years of near-continuous conflict has shattered both Afghanistan's economy and infrastructure.

Socially, Afghanistan is comprised of many ethnic groups, the largest of which are the Pashtun, Tajiks, Hazara, and Uzbeks. The Pashtun and Tajiks speak distantly related Iranian-based languages. The Hazara, though believed to be ethnically related to the Mongols, speak the same form of Persian as the Tajiks. The Uzbeks speak Uzbeki, an Altaic language. The major language group is Persian, though administratively it is equal to Pashtu. Most of the population is Sunni Muslim although the Hazara and smaller groups in the northeast are Shi'a Muslims.

Though the area comprising Afghanistan shares a long history with both central Asia and south Asia, it was because of British fear that the region would provide a land route for a Russian attack on India that the era known as the Great Game evolved between competing Russian and British attempts to influence central Asia. Russia took over the areas north of the Amu Darya and the two competitors carved out Afghanistan as a buffer state between them. Pashtun kings ruled Afghanistan until an unpopular communist regime took power in 1978. Widespread dissatisfaction with the government caused the Soviet Union to invade and begin a 10-year occupation. This saw the rise of the *mujahidin*, traditionalists and Islamists who drove out the Soviets with the aid of the United States and other Muslim countries. A civil war erupted after this victory that augmented a major humanitarian crisis of millions of refugees scattered worldwide. This period of civil chaos allowed a group known as the Taliban to take control of much of the country. Many of the warring factions from the civil war coalesced into the Northern Alliance, which battled the Taliban until September 11, 2001, when al-Qaeda, a Taliban client, attacked the United States. With aerial and ground aid from the United States, the Northern Alliance overcame the Taliban.

Twenty-three years of near-continuous conflict has shattered both Afghanistan's economy and infrastructure. The majority of people are employed in agriculture, though it remains dangerous because of the large number of landmines that are leftover from the conflicts. Security also remains precarious as the Taliban have been allowed to reform and warlords dominate much of the countryside. These well-armed men rely on revenue from poppy crops that provide an estimated 85 percent of the world's heroin. For many farmers, this is the only crop that will grow in the rocky soils of the mountains. However, this provides a difficult challenge for the new government, who cannot hope to rule effectively while this narco-economy prevails.

Afghanistan's environment is so degraded by two decades of warfare that it now presents a major barrier to the nation's efforts at reconstruction. Combined with years of drought, the conflicts have drained the nation's wetlands and caused much of Afghanistan's wildlife to vanish. A United Nations Environment Programme (UNEP) Post-Conflict Environment Assessment report shows how conflict has put previous environmental management and conservation strategies on hold, brought about a collapse of local and national governance, destroyed infrastructure, hindered agricultural activity and driven people into cities already lacking the most basic public amenities.

SEE ALSO: Iran; Pakistan; Turkmenistan; Tajikistan; Uzbekistan.

BIBLIOGRAPHY. Jason Elliot, *An Unexpected Light: Travels in Afghanistan* (Picador, 1999); Martin Ewans, *Afghanistan: A Short History of Its People and Politics* (HarperCollins, 2002); Peter Hopkirk, *The Great Game: The Struggle for Empire in Central Asia* (Kodansha, 1992); Khaled Hosseini, *The Kite Runner* (Riverhead, 2003); Barnett R. Rubin, *The Fragmentation of Afghanistan, 2nd edition* (Yale University Press, 2002).

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Agenda 21

AGENDA 21 IS an internationally agreed action plan for the worldwide implementation of sustainable development. Alongside the Forest Principles and the Rio Declaration on Environment and Development, it was among the most important outcomes of the United Nations (UN) Conference on Environment and Development held in Rio De Janeiro, Brazil, in 1992. Agenda 21 is a nonlegally binding international agreement, meaning that its signatories are not legally obliged to implement it. However, as an example of soft law, it establishes a set of international norms and expectations that can influence government policy.

Agenda 21 contains provisions relating to human development policy and numerous aspects of resource management, including deforestation, biodiversity, agriculture, and water; and it arguably represents the most comprehensive attempt by the UN to ensure that the global economy (society) does not adversely affect the global environment (nature). Agenda 21 offers a good example of what Steven Bernstein has dubbed *liberal environmentalism*—the compatibility of economic growth and environmental protection—and codifies this relationship into a series of normative policy directions for the 21st century. For instance, it stipulates that an equitable and nondiscriminatory multilateral trading system is crucial for achieving sustainable development. The assumption here is that such a system will not only extend the benefits of trade to the world's poor, but will result in environmentally benign growth as well. Agenda 21 also specifies that trade liberalization—the removal of import and export restrictions and subsidies—will hasten the implementation of sustainable development, and calls on governments to implement sustainable development in developing countries by providing debt relief, bilateral and multilateral assistance, development financing through regional development banks, and new and additional resources. More specific provisions recognize the need to reduce unsustainable consumption, especially in industrialized economies; and that women play a vital role in implementing sustainable development. It also calls on governments to reduce perverse subsidies, decentralize natural resource management to the community level, and extend land rights to indigenous peoples.

Needless to say, the governments that drafted Agenda 21 had lofty ambitions. Many hoped that the adoption of Agenda 21 would usher in a new era of environmental sustainability around the world, while at the same time greatly reducing poverty. Sadly, although some gains have been made in both areas of development, notably chemicals management, many of the world's most pressing development and environmental problems continue unabated almost 15 years after the signing of Agenda 21. Moreover, the multilateral trading system is showing very few signs of improving market access conditions for agricultural products from developing countries. These developments have led to claims that Agenda 21 has been largely unsuccessful, and that some alternative development trajectory must be found.

Agenda 21 established the UN Commission on Sustainable Development, which was given the task of overseeing the implementation of Agenda 21. In 2002, the UN held the World Summit on Sustainable Development (dubbed "Rio+10") in Johannesburg, South Africa, to review the implementation of Agenda 21 and forge a new implementation strategy.

SEE ALSO: Sustainable Development; Trade, Free; United Nations.

BIBLIOGRAPHY. Steven Bernstein, *The Compromise of Liberal Environmentalism* (Columbia University Press, 2001); Pamela S. Chasek, David L. Downie, and Janet Welsh Brown, *Global Environmental Politics* (Westview, 2005); Matthias Finger and Pratap Chatterjee, *The Earth Brokers: Power, Politics and World Development* (Routledge, 1994); Jonn Bellamy Foster, "A Planetary Defeat: The Failure of Global Environmental Reform," *Monthy Review* (v.54, 2003); International Institute for Sustainable Development, "Summary of the First Session of the Commission on Sustainable Development," *Earth Negotiations Bulletin* (v.5, June 1993).

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Agent Orange

AGENT ORANGE IS a colorless, liquid herbicide used by the U.S. Army during the Vietnam War to reduce foliage of inland forests and coastal mangroves that concealed North Vietnamese fighters. The name comes from the colored stripes emblazoned on the 55-gallon drums in which it was stored and transported.

Agent Orange is a 1:1 mixture of two Phenoxy herbicides: 2, 4-D (2, 4-dichlorophenoxy acetic acid) and 2, 4, 5-T (2, 4, 5-trichlorophenoxy acetic acid). First manufactured in the United States in the 1940s, it became widely used in agriculture by the mid-1950s and continues to be used in various parts of the world. When applied to broadleaf plants, the agent dries out leaves and causes them to drop off, though they usually regenerate within 4–6 months.

U.S. herbicidal warfare against the North Vietnamese began in 1961 with the deployment of a unique army aircraft unit, implemented under Operation Ranch Hand, which executed 6,000 spraying missions between 1965–71. Nineteen million gallons were sprayed over 10 percent of Vietnam's landmass by 1970. Specially equipped C-130 aircraft dispersed 90 percent, while backpacks, small trailers, and helicopters did the rest. Agent Orange was sprayed in 11.2 million gallons over 450,000 acres, which included—most famously—parts of the rainforest canopy covering the Ho Chi Minh Trail running through Cambodia, Laos, and Vietnam. By military standards, the operation was a success because it enhanced U.S. military offensives. The agent itself was most effective as a defoliant, because unlike many of its color-coded kin, Agent Orange is oil-based, rather than water-soluble. The chemicals were regularly mixed with diesel fuel, which provided an oil substrate not easily washed away from the waxy, tropical flora of Vietnam.

But Agent Orange has a darker side: Dioxin TCDD (2, 3, 7, 8-tetrachlorodibenzo-para-dioxin), a byproduct of its manufacturing process, has proven to be a human carcinogen. In 1969, a study by the National Cancer Institute released to the Department of Defense linked Agent Orange exposure to various health problems. These findings, along with public outcry against the U.S. government for the deliberate spraying and the diminishing support for the "Vietnamization" of the war, all helped end the military's use of Agent Orange in Southeast Asia.

In 2004, the Vietnam Association for Victims of Agent Orange/Dioxin (VAVA) sued several U.S. companies for "liability in causing personal injury, by developing and producing the chemical." Since the end of the war in 1975, American GIs, suffering from diseases such as Hodgkin's and leukemia, have won numerous court cases against chemical companies that resulted in financial compensation without admission of company wrongdoing. Similarly, VAVA provided evidence linking Agent Orange to human maladies; in particular, birth defects and mental disabilities. A year later, however, the VAVA case was dismissed on the grounds that companies that produced the Agent were not liable for the method of its use by the government. For many in Vietnam, full reconciliation with the United States will only come through a fair resolution of the Agent Orange matter.

SEE ALSO: 2, 4-D; Herbicides; Vietnam War.

BIBLIOGRAPHY. British Broadcasting Corporation, "Agent Orange Case to Open in US," http://news.bbc.co.uk (cited February 2005); British Broadcasting Corporation, "Agent Orange Legal Case Dismissed," http://news.bbc.co.uk (cited February 2005); British Broadcasting Corporation, "The Legacy of Agent Orange," http://news.bbc.co.uk (cited April 2005); Patrick Brogan, *World Conflicts* (Bloomsbury Publishing, 1998); Spencer C. Yucker, *Encyclopedia of the Vietnam War* (Oxford University Press, 2000).

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Agriculture

AGRICULTURE IS THE practice of cultivating plants and herding animals for food, fiber, and other products. Agriculture is the single largest land use in the world and it is the single greatest employer. Nearly 38 percent of the earth's land area is in agriculture. In 2004, more than 2.6 billion people, or 42 percent of the world's population, were engaged in agriculture. 10,000 years ago, only a trivial fraction of the earth's surface was dedicated to agriculture. Since then, agriculture has replaced prairies, wetlands, forests, and other ecosystems, allowing the global population to exceed 6.3 billion. Agriculture features prominently in many debates linking environment and society. It is blamed for reducing biodiversity, polluting aquatic ecosystems with eroded soils and toxic chemicals, and contributing to global climate change. Agriculture is also at the center of the debate about genetically altered food, trade, and globalization. Developing more sustainable agricultural systems will be required to reduce the impact of agriculture on the environment and provide enough food for the projected 8 billion people who will inhabit the planet by 2036.

ORIGINS AND DIFFUSION

The first Agricultural Revolution was the transition of societies from hunting and gathering to agriculture. This transition occurred independently in numerous locations around the world, but emerged first about 10,000–12,000 B.C.E. in the Fertile Crescent in the present-day countries of Syria, Turkey, and Iraq. Plants and animals have been bred to exhibit traits that are useful to people, called domestication. It is likely that favorable environmental factors, the availability of wild plants, complex social groups, and food surplus and sedentary livelihoods were important in this revolution. The rise of agriculture is considered revolutionary because of the changes it spawned: population growth, the development of cities, and a greater specialization of labor. People's ability to transform the earth increased markedly with agriculture. The need to feed greater populations created a greater need to transform ecosystems into agricultural systems.

Paddy rice cultivation is an important agricultural system in east and southeast Asia. Small plots of land are flooded for much of the growing season, which requires careful water management—but it is highly productive and feeds millions.

Trade, warfare, and migration diffused agricultural plants and animals. The European discovery and conquest of the Americas (1492–1533) was an important moment in agricultural diffusion. The exchange of plants and animals between the Old and New Worlds is called the Columbian Exchange, after Christopher Columbus. Maize (corn), tomatoes, potatoes, cotton, cassava, and tobacco were unknown in the Old World, and commodities such as wheat, sugar, coffee, cattle, and pigs were unknown in the Americas. This exchange radically changed diets, ecologies, and even demands for labor. For example, to satisfy European demand for sugar, Africans were brought as slaves to the Caribbean and Brazil to work on a new agricultural system—the plantation.

The Columbian Exchange was equally important in Europe. Maize and potatoes became critical components of the Second Agricultural Revolution, which occurred from approximately the late 17th century to the mid-19th century in Great Britain. Agricultural production increased substantially; rotating crops, using new crops, and early mechanization allowed farmers to grow enough food for an expanding urban population. The Second Agricultural Revolution made the Industrial Revolution possible. Although the Columbian Exchange made more crops and animals available in the Old and New Worlds, humans have come to rely on fewer crops for the majority of their diet. About 200 of the 300,000 terrestrial species of plants have been domesticated. Humans rely most heavily on about 20 species for their diets, with corn, wheat, rice, soybeans, potatoes, and cassava (yucca) being the most important staple crops.

INDUSTRIALIZATION OF AGRICULTURE

During the 19th and first half of the 20th century, many technological and scientific advances were made in agriculture, especially in the United States. The steel plow, tractor, combine, and hybrid corn are examples. These technologies were the predecessors of substantial changes in agriculture that occurred after 1940 in the United States, and soon thereafter in Europe, Japan, and other developed countries. World War II and its aftermath precipitated the industrialization of agriculture, with breeding technologies, mechanization, science, and economies of scale. Until the 1940s, most agriculture utilized organic fertilizers (manure), heirloom seeds, and human and animal labor. Mules and horses pulled plows and combines; people weeded and harvested the crop by hand. Many farmers were generalists, planting several crops and raising a variety of livestock.

From 1940 to 1970, machines (tractors) and synthetic fertilizers and pesticides, or agrochemicals, replaced many of the people who worked in agriculture. Fossil fuels became the main energy source. New varieties of crops that responded well to nitrogen were developed. Fertilizer applications to U.S. farmland increased nearly 700 percent. DDT and other pesticides became common. Farmers were forced to expand their operations (economy of scale). The number of farms in the United States dropped in half, but their size more than doubled. Many farmers also became specialists, focusing on producing only a few crops or livestock. Yields increased substantially; yields for wheat and cotton doubled and potato yields tripled. Farmers relied more on inputs from other sectors of the economy, such as industry for tractors and chemical companies for fertilizers and pesticides. Similarly, crops became inputs into processed foods and other products. Soy, for example, is processed into hundreds of products, from salad dressing to tofu.

Hybrid corn exemplifies the impact of the industrialization of agriculture. Farmers became dependent on annual purchases of hybrid seed and the fertilizer it requires. Hybrid corn—produced when two stunted varieties of corn are bred—came from advances in agronomic science at the start of the 20th century, and essentially replaced nonhybrid corn by 1960. The result is high yields, but only one generation of high-yielding corn. Thus, farmers must purchase hybrid seed corn annually. To obtain high yields, many farmers apply anhydrous ammonia, a powerul nitrogen fertilizer. Some of this nitrogen has seeped into groundwater, rivers, and lakes, creating serious pollution of aquatic ecosystems. Very little harvested corn is consumed directly; approximately half of all U.S. yield is fed to livestock, especially cattle. Corn is also an important ingredient for high-fructose corn syrup.

THE DEVELOPING WORLD

Because industrial agriculture in the developed world has replaced most human labor with machines and other fossil-fuel technologies, less than three percent of the workforce in Western Europe and the United States is engaged in agriculture. Even though these farmers are very productive, agriculture accounts for a small part of the Gross Domestic Product (GDP)—less than 3 percent. In the developing world, however, agriculture remains an important employer and component of the economy. At least one third, and as much as 75 percent of the work force, are engaged in agriculture. Agriculture accounts for at least 20 percent and as much as 75 percent of the GDP of these countries.

There is considerable diversity among farmers in the developing world, in part because each agricultural system is dependent on the environment and economy. Farmers typically have relatively small plots of land and live in basic conditions or poverty. They produce both for their families' consumption (subsistence) and to sell (market). Agricultural labor utilizes people and animals, although agrochemicals and mechanization are increasingly common. Many households combine off-farm employment with semi-subsistence agriculture. One or more of the adults and the eldest children may work for wealthier farmers or migrate to a city temporarily. In much of northern China, south Asia, southern Mexico, the Andes, and parts of Africa, farmers grow grains (wheat, corn, rice, barley, sorghum); and/or root crops (potatoes, cassava); and raise livestock, especially cattle, pigs, and sheep. Farmers commonly intercrop fields, planting several crops to diversify their diet, reduce risk, and improve the soil.

Paddy rice cultivation is an important agricultural system in east and sSoutheast Asia. Small plots of land, typically close to rivers, are flooded for much of the time the rice is growing. This system requires careful water management and constant maintenance, but it is highly productive and feeds millions of people. In tropical climates, farmers are able to multi-crop, which means harvesting at least two crops in less than one year. Another common agricultural system in developing countries in the tropics is shifting cultivation. In this system, farmers cut trees and brush on a field and burn them when they dry. This process transfers the nutrients from the vegetation to the soil; seeds are planted in the ash. Farmers will commonly cultivate the field for a few years, and then allow it to return to brush and eventually forest (fallow). This system makes use of infertile tropical soils and can be sustainable if the length of the fallow is sufficient.

Plantation agriculture is also found in many developing countries in the tropics. In this system, wealthy and sometimes foreign owners control large stretches of fertile land and plant crops for export. Cocoa, palm oil, bananas, and coffee are examples. Plantation agriculture uses cheap labor, but also very modern agricultural technologies.

FACTORY FARMING

Factory farming became the logical extension of applying industrial practices to agriculture. Factory farming broadly describes agricultural systems that are intensive, usually large-scale, and designed to produce a product at the least cost in the shortest time possible. Factory farms use practices common in industry and rely on veterinary and agronomic science and agrochemicals. The term is most commonly applied to large animal confinements and greenhouses with highly controlled environments. The term is sometimes used to describe any agricultural system that is large-scale, relies on agrochemicals and monocropping (growing one crop in a field) and is either highly mechanized or uses cheap labor. This would include vegetable farming in California, fruit orchards in Spain or Israel, and soybeans in Argentina. Most of the food consumed in the developed world is produced in this fashion.

Animal confinement operations group large numbers of animals in closely controlled operations. U.S. beef cattle spend most of their lives on pasture, but when they reach a certain age and weight they are commonly shipped to large feedlots on the Great Plains—Texas, Nebraska, Kansas, and Colorado. The largest feedlots hold more than 100,000 cattle. The cattle will spend up to two months on the feedlot before they are sent to a nearby meatpacking plant, where they are slaughtered, packaged, and sent to retail outlets. The meatpacking plants are also built for economy of scale, some slaughtering more than 3,000 head per day.

This method of producing beef requires large quantities of fossil fuel energy, making it highly energy inefficient. In the case of the Great Plains, cattle are shipped hundreds of miles. Since cattle are poor converters of the energy in grains, much is wasted. Traveling great distances is stressful to cattle, making them vulnerable to illness. When they arrive at a feedlot, they are often given antibiotics. This concentration of cattle produces an enormous amount

The Green Revolution

Many of the breeding and agrochemical technologies associated with industrial agriculture were applied to crops in the developing world, starting in the 1960s. The Green Revolution refers to a major transformation in agricultural practices in the developing world based on a specific technological and institutional package, including high-yielding variety seeds (HYVs), fertilizers, and irrigation. In the late 1960s, millions of hectares of HYVs of wheat and rice varieties were planted in south and southeast Asia. The Green Revolution allowed countries to stay ahead of population growth, but it caused serious environmental problems. Most of the beneficiaries of the Green Revolution were relatively well-off farmers and the companies that sold the equipment and chemicals. The most disadvantaged, in particular women who grew subsistence crops and did not have secure land tenure, bore the greatest burdens of the Green Revolution. The Green Revolution continues, with new crops, newly targeted areas, and recognition that the impact of agricultural development must be more socially conscious and environmentally friendly.

of organic waste. Feedlots typically sell the manure to farmers, but if waste management is poor, surface and groundwater contamination will occur.

The concentration of the beef industry and the conditions in the meatpacking plants is controversial. Starting in the 1980s, the industry consolidated, meaning that companies merged or were purchased by larger companies. This left few companies to purchase cattle; only four meatpacking plants control nearly 80 percent of all cattle slaughtered, prompting complaints from farmers that the concentration has driven down prices. Concentration is also found in the pork industry, where four companies control approximately 63 percent of all hogs slaughtered. Many of the workers in the plants are poorly paid immigrants from Latin America.

Industrial practices have been applied to the chicken industry as well. Almost all chickens in the United States are raised under a system called production contract farming. A company contracts with a "grower" to raise chickens. The company provides the animals, feed, and medicine, and remains the owner of the animals. The grower provides the land, buildings, and the management/labor. The grower is paid on a predetermined price. More than half of the country's chickens come from relatively few growers who sell more than 500,000 a year.

In the developing world, many tropical fruits, such as bananas and flowers, are grown with industrial practices. Most cut flowers, such as roses and carnations sold in Europe and North America, come from Colombia, Ecuador, or East Africa. They are raised on good soils in large and highly controlled greenhouses. Agrochemicals are used to produce a "flawless" product for demanding, overseas consumers. Corporations own the rights to certain varieties of flowers, and require a royalty on every flower sold. These greenhouses are controversial for their heavy use of agrochemicals; relying on cheap, female labor; and the fact that some of the best land in poor countries is used to raise a luxury item.

Factory farming has been accompanied by the increase of corporate influence. In the latter half of the 20th century, transnational corporations (TNCs) that purchase and processes agricultural products developed global strategies, and now a few enormous corporations exert considerable control. Cargill, for example, has economic interests in many agricultural sectors around the world. They have offices in more than 60 countries and are major purchasers and processors of cocoa, wheat, soybeans, and fruit juices. They own the second-largest meat processing and turkey processing companies in the United States. For many agricultural products there are few purchasers, raising the concern that farmers are not receiving a fair price.

Only four meatpacking plants control nearly 80 percent of all cattle slaughtered, sparking price controversies.

GENETICALLY MODIFIED ORGANISMS

A more recent and controversial trend in agriculture is the increasing use of genetically modified organisms (GMOs) in agriculture. A GMO is a plant that has been altered using scientific techniques—other than breeding—to change the genetic makeup of the plant. One common form of a GMO is a transgenic plant, which received the gene(s) of a completely different species. The two most common applications of GMOs in agriculture are herbicide tolerance and insect resistance. Herbicide-tolerant soybeans tolerate an herbicide called glyphosate. Fields can then be sprayed with glyphosate, killing the weeds, but not the crop. Insect-resistant corn contains a gene from a soil bacterium called Bt (*Bacillus thuringiensis)* that produces a protein that kills a larva that would otherwise destroy the plant.

Adoption of these "biotech" crops has been remarkable since their introduction in 1996. In 2005, 8.5 million farmers in 21 countries planted more than 90 million hectares (1 hectare = 2.47 acres), half of which was planted in the United States. Soybeans, corn, and cotton account for the vast majority of the crops. The proportion grown in developing countries is growing quickly. Much of the food consumed in the United States, especially processed foods, derives from GM crops. GM seed companies and other advocates argue that GM crops are a natural extension of modifying plants that has been done since the First Agricultural Revolution. Companies are applying the knowledge of the day—genetic engineering—to plants and animals. They argue that the GM crops could produce higher yields and more food, have more resistance to pests—thus requiring less pesticide—and have desired traits, such as rice with more nutrition.

Criticisms of GM crops can be grouped into three categories: environmental, health, and political/economic. Critics worry that targeted pests will develop a resistance to Bt and that the genetic material will drift onto other plants, creating unintended "genetic pollution." The most common health concern is that the long-term consequences of consuming GM food is unknown. Labeling food with GM products is not required in the United States, but in Europe, where very little GM food is consumed, labeling is required. The political and economic concerns fit into a larger concern over corporate control over agriculture, and agricultural biodiversity. GM crops are increasingly common, but only a few corporations own the seed patents. The Monsanto Corporation, for example, owns the patents on most of the soybeans and much of the corn crop grown in the United States. Another political and economic concern is the U.S. government's interest in pushing markets for GM crops. Europe and many developing nations have resisted GM grain imports from the United States, prompting the United States to sue the European Union through the World Trade Organization on the grounds that the EU has no legitimate health reasons for rejecting the imports.

ENVIRONMENTAL IMPACTS

The environmental impacts of agriculture are substantial. Agriculture has replaced many biodiverse ecosystems with monocropping, reducing natural habitat. For example, the primary cause of deforestation in the Amazon forest in 2004 was the conversion of forests to monocropped soybean fields. Intensive cultivation practices have caused erosion, as well as clogging and degrading of rivers and other aquatic ecosystems with sediment. Agrochemicals have accompanied the sediment, polluting streams and aquifers. Fertilizer runoff creates fertile conditions for some plants and algae to thrive in lakes. Microorganisms consume the plants and lower the dissolved oxygen in the water, depriving fish and other aquatic life of dissolved oxygen. Although developed countries use most of the agrochemicals in the world, the use of these chemicals is most dangerous in developing countries, which still use some chemicals taken off the market in North America and Europe. Farmers unintentionally poison themselves, and an unhealthy chemical residue remains on many crops.

ALTERNATIVE AGRICULTURE

A number of alternative perspectives have developed in response to the perceived environmental and social effects of industrial agriculture. One such movement, agroecology, calls for the application of ecological principles to agriculture in order to create sustainable agricultural systems. Sustainable agriculture produces healthy food in a way that would not undermine the ability to do so in the future. It minimize the impact on the environment by not releasing toxic chemicals, and uses local resources and organic material to replenish soils and conserve biodiversity. Many of these practices—biological pest control, crop rotations, multi-year fallows, intercropping, minimal tilling, and raising livestock with cultivated crops—were common practices before the industrialization of agriculture. Other movements, such as buying organically grown products, are commonly based in similar principles as agroecology. Buying locally grown, organic food is touted as an important way to eat healthy, minimize damage to ecosystems, reduce energy costs, and be in touch with local environmental conditions and farmers.

CONCLUSION

More food will need to be produced to feed a growing population, but how much food will depend on yields, consumption, how efficiently food is used, and whether luxury crops (drugs, flowers, bananas) are replaced with staples. The environmental and social conditions of food production, and who benefits from it, are critical issues. Industrial agriculture has caused serious environmental problems, but has also produced an abundance of food in developed countries. Proponents of biotechnology see GMOs as a way to produce more food efficiently. Advocates of agroecology see GM crops, industrial agriculture, and corporate control of the food supply as problems, and advocate alternative agriculture as a way to produce healthy food without undermining the ability to produce in the future.

SEE ALSO: Agroecosystems; Agronomy; Cash Crop; Cattle; Crop Plants; Dryland Farming; Farmers' Markets; Farming Systems; Genetically Modified Organisms (GMOs); No-Till Agriculture; Organic Agriculture.

BIBLIOGRAPHY. J.W. Clay, *World Agriculture and the Environment: A Commodity-By-Commodity Guide to Impacts and Practices* (Island Press, 2004); G. Conway, *The Doubly Green Revolution: Food for All in the Twenty-First Century* (Comstock, 1998); Food and Agriculture Organization, www.fao.org (cited October 2006); S. Nottingham, *Eat Your Genes: How Genetically Modified Food is Entering Our Diet* (Zed Press, 2003); Michael M. Pollan, *The Omnivore's Dilemma: A Natural History of Four Meals* (Penguin Press, 2006); E. Schlosser, *Fast Food Nation: The Dark Side of the All-American Meal* (Perennial Press, 2001); O.T. and D.J. Solbrig, *So Shall You Reap: Farming and Crops in Human Affairs* (Island Press, 1994).

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Agroecosystems

AGROECOSYSTEMS ARE PLANTS and animals interacting within a shared physical environment that has been modified by human practices to produce food, fuel, and other products. In other words, agroecosystem analysis rests upon a holistic view of human–nature interactions.

Agroecology is the study of agroecosystems. Agroecology, the study of agroecosystems, draws from the fields of agronomy, genetics, and pest ecology to understand the entire system of food production. However, the social sciences, such as sociology, political science, and anthropology, have been helping to inform agroecosystem principles. This has caused the definition of agroecology to broaden to include social systems.

AGROECOSYSTEM MANAGEMENT

Agroecosystem management, in terms of its ecological components, rests upon the principles of sustainable yields, natural pest regulation through diverse rotations, and building biologically rich soils. The goal is to design farming systems that more closely mimic natural systems. Agroecologists seek to optimize the recycling of nutrients and organic matter, creating an energy loop that requires minimal (if any) synthetic inputs.

Special features of agroecosystems include crop rotations, which provide not only crop nutrients but also help to break up the life cycles of weeds, pests, and disease, reducing the need for herbicides, pesticides, and fungicides. Polyculture, where multiple crops inhabit a single field to enhance yields and biomass, is another important feature of agroecosystem management.

Agroforestry systems, in which trees and/or livestock cohabitate and compliment each other, are also gaining in popularity among agroecologists. Animal integration, in which livestock are integrated into a farming system, is yet another feature of ecosystem management. Livestock help to not only increase biomass output, but they also play an important role in recycling nutrients (such as the nitrogen-rich manure that can be applied on fields to fertilize crops). The ultimate goal is to integrate components in a manner that increases overall biodiversity, improves biological efficiency, and maintains the self-regulating capacity of the agroecosystem.

SOCIAL COMPONENTS

Agroecosystems also have a social component. Recent conceptions of agroecology draw as much from the social sciences as the biological sciences. Well-managed agroecosystems are designed to ensure that their development processes are locally controlled by indigenous knowledge, with the idea that in the end, no one knows the local natural systems better than the area farmers. Beyond this, agroecology seeks to strengthen communities by encouraging local partnerships between people and development groups by teaching principles of agroecology to community members.

The popularity of agroecology has increased in recent years with the rise of sustainable and organic farming. These alternative models of food production rest upon many of the principles of agroecology. As an indication of their growing relationship, a number of U.S. universities are offering degrees in the areas of agroecology and sustainable agriculture, such as the University of Illinois, Pennsylvania State University, and the University of California at Santa Cruz. Principles of agroecology are also being used around the globe under the guise of sustainable development, so as to increase the self-sufficiency of rural inhabitants in less developed countries as they work to build sustainable local food systems.

SEE ALSO: Agroforestry; Agronomy; Farming Systems; Integrated Pest Management; Knowledge; Organic Agriculture; Sustainable Development.

BIBLIOGRAPHY: Cornelia Flora, *Interactions Between Agroecosystems and Rural Communities* (CRC, 2001); Mario Giampietro, *Multi-Scale Integrated Analysis of Agroecosystems* (CRC, 2003); University of Illinois Web, www.uiuc.edu.

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Agroforestry

AGROFORESTRY IS A term used to designate land management systems that combine woody species (typically trees, palms, bamboos, and shrubs) with agricultural crops. The combination may be concurrent (both woody and crop species organized spatially, such as by intercropping), or occur in temporal succession (agricultural crops succeeded by woody species or vice versa); and in some cases it also may incorporate animal species. Various forms of agroforestry have long been practiced in diverse regions of the world; perhaps the best known examples come from studies in Asia, Latin America, and Africa.

Combining agriculture with the cultivation of tree species can have ecological, economic, and social benefits. Ecological benefits include the at least partial replacement of vegetative (tree) cover in agricultural areas to resemble the natural structure and diversity of the local forest. Restoration of vegetative cover can cause or be accompanied by improvements in soil organic matter, texture and moisture capacity; reduction in soil acidity and salinity; improved nutrient availability and cycling; and nitrogen fixation when involving leguminous species. Often, increased levels of biological (species) diversity are reported in agroforestry systems. Economic benefits include both efficiency and stability in production processes and the producton of a diversity of commodities, including food, medicines, construction materials, soil conservation, and protection.

Many proponents claim that agroforestry systems better utilize labor and tools and support a more diverse set of land management practices than either agricultural or forestry activities alone. Aside from various crop, fruit, and timber tree species, such activities may include aquaculture (fish farming), apiculture (beekeeping), or livestock farming. While some researchers consider swidden (slash-and-burn) agriculture to be one form of agroforestry for its temporal sequence of forest-crop-fallow-forest, others view agroforestry systems that incorporate the planting of leguminous species as a more sustainable production process that lessens the need for fallows. Agroforestry systems take diverse forms, and may include home gardens, enriched fallows, tree-crop combinations in fields, or mixed fruit trees in orchards.

SOCIAL BENEFITS

The social benefits of agroforestry are touted by several studies that note how most indigenous systems of agriculture involve various forms of agroforestry, often empowering otherwise marginalized social groups with access to resources and livelihoods, and preserving cultural and linguistic xtraditions. By the same token, findings caution how many development projects that promote agroforestry as a means of improving local economies while protecting the environment may introduce livelihood transformations that have inequitable effects on distinct economic classes, genders, and/or socio-cultural groups.

The designation of land tenure rights, whether formal or informal, statutory or customary, should be examined along with the effect of agroforestry systems on ecosystems, livelihoods, and living standards. For instance, tree or agricultural products that are cash crops, such as timber, coffee, and sugarcane, are typically planted in areas of secure land rights, while subsistence crops may not. However, it is important to recognize the complexity in land tenure, agroforestry systems, and their practitioners in analyzing their potential for conservation and economic development.

The International Center for Research in Agroforestry (ICRAF), headquartered in Nairobi, Kenya, is dedicated to promoting agroforestry research and development in order to stem tropical deforestation and land degradation, and improve the livelihoods of small, resource-limited farmers. ICRAF and other agroforestry-focused institutions recognize the benefits of locally evolved (indigenous) systems of cultivation, which in the tropics typically involve agroforestry systems of varying degrees of complexity. Native agroforestry systems are often distinguished from externally introduced, donor-funded, and top-down agroforestry projects for the formers' long history and particular adaptations to local ecological, economic, and social conditions.

BIBLIOGRAPHY. ICRAF, *The World Agroforestry Center,* http://www.worldagroforestry.org (cited May, 2006); R.P. Miller and P.K.R. Nair, "Indigenous Agroforestry Systems in Amazonia: From Prehistory to Today," *Agroforestry Systems* (v.66, 2006); P.K.R. Nair, "Agroforestry defined," in P.K.R. Nair (ed.) *Agroforestry Systems in the Tropics* (Academic Publishers, 1989); D.R. Rocheleau, "A Land User Perspective for Agroforestry Research and Action," In H. Gholtz (ed.) *Agroforestry: Realities, Possibilities and Potentials* (Martinus, 1989).

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Agronomy

AGRONOMY IS A branch of agricultural science concerning the study of soil types, crop types, and the maximization of agricultural production. Agronomists have become increasingly concerned with the issue of sustainable production. Consequently, topics studied include the relative balance of agricultural inputs and outputs, use of irrigation and fertilizer methods, selective breeding of agricultural plants and animals, and the understanding of specific local conditions and empowering local people to maintain healthy agricultural systems.

Generations of farmers have improved their production in a series of small steps; examples include soybeans, rice, and grapes. Further, farmers have developed their use of local knowledge to improve agricultural production. Such systems can prove fragile when faced with internationally sponsored, scientifically based production improvements that fail to take account of this local knowledge. The promotion of inland black tiger prawn raising in Thailand, for example, led to short-term income increases for many subsistence farmers who participated in the scheme. However, the negative impacts became clear as the lack of water inflows contributed to the buildup of pollutants, which led to the degradation of the surrounding land. Greater participation by local people might have revealed the knowledge that would have prevented this problem. Many multilateral donors, notably the World Bank, have made efforts to increase that participation.

Improvements in scientific knowledge and methodology have enabled agronomists to become increasingly effective in understanding global production methods. However, conditions are constantly changing as pollution and environmental degradation negatively affect many agricultural production systems. Consequently, much agronomy is devoted to maintaining existing production levels.

Major international agronomy organizations include the Food and Agriculture Organization (FAO), which was founded in 1945 as a specialized agency of the United Nations, and which provides technical expertise and capacity-building to countries around the world. Many universities offer agricultural departments that include agronomic interests. Private-sector organizations have also spiked their interest in agronomy, as profitable opportunities have become increasingly evident. The use of genetically modified organisms, for example, has offered considerable opportunity, and some corporations have rushed to capture those incomes. These ventures have often relied upon strict rationing of intellectual property rights, which has caused local people who fear they have lost control over their agricultural inputs. Consumer-led oppositions have also become influential and in many countries in western Europe, and the involvement of private-sector corporations in agricultural production has led to significant consumer boycotts.

SEE ALSO: Agriculture; Farming Systems; Food; Sustainability.

BIBLIOGRAPHY. D.G. Armstrong, et al., eds., *Feeding a World Population of More than Eight Million People: A Challenge to Science* (Oxford University Press, 1998); Anthony S.R. Juo and Kathrin Franzluebbers, *Tropical Soils: Properties and Management for Sustainable Agriculture* (Oxford University Press, 2003); John Passioura, "Increasing Crop Productivity When Water Is Scarce—From Breeding to Field Management," *Agricultural Water Management* (v.80/1–3, 2006).

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Air Conditioning

AIR CONDITIONING IS the mechanical control of the cooling, heating, circulation, cleaning, humidification, and dehumidification of air. Originally, air conditioning was designed to improve industrial or manufacturing processes, and providing human comfort was only a secondary purpose.

Cooling by conditioning the air is basically a form of refrigeration. The air is cooled by evaporating a liquid with a low boiling point, called a refrigerant. General Motors produced chlorofluorocarbon refrigerants for Frigidaire in 1928, and in 1930, Freon was introduced to the public. Freon was popular until the discovery that chlorofluorocarbons (CFCs) damage high-altitude ozone, and in 1990, The Clean Air Act in the United States banned deliberate venting of chlorofluorocarbons. Hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) are in use today and are safer for the environment.

A COOL HISTORY

Humanity's first trials to improve air condition were simple. Possibly the very first form of air conditioning was the use of a cave for shelter. In summer, the cave provided a cooler environment than the strong sun and heat of the outdoors. Forced cooling took longer to develop.

A primitive form of air conditioning was recorded as far back as when ancient Egyptians, Greeks, Romans, and eastern Indian peoples observed that hot, dry breezes became cool and moist when moved through damp mats or over porous containers of water. Roman emperors cooled their gardens with snow brought down from mountains. Snow was also used in Baghdad in the 8th century to cool the air in the Caliph's residence, where spaces between walls were packed with it. In the early part of the 8th century, Japan improved the fan with pleats.

The work of experimental scientists contributed to the many pieces of modern, mechanical air conditioning. From Galileo Galilei's air-and-water thermoscope invention in 1592, to thermodynamic discoveries continuing through the 1800s, inventions primarily led to work with mechanical heat. However, innovation efforts soon began to focus more on refrigeration.

In 1851, Dr. John Gorrie, a physician in Florida, patented his refrigerating machine that lowered the temperature and humidity of air. Gorrie believed that cooling and drying the excessively hot and humid air, typical of the climate of the southeastern United States in summer, would improve the health of local inhabitants.

By the 1880s, mechanical refrigeration, or "manufactured air," was used commercially by cold storage, ice-making, brewing, dairy, and meatpacking companies. Another key technology that played an important part in conditioning the air of large spaces was the power plant. In 1882, the first electric power plant in New York provided an inexpensive source of energy for commercial and residential customers. Air conditioning would remain a commercial commodity until the next century.

Air circulation was also improved with the electric fan. The first commercial electric fan was manufactured by Crocker and Curtis Electric Motor Company in 1882. In 1908, the first oscillating fan came on the market. Electric fans quickly became popular in office buildings. In 1902, Willis Carrier, a mechanical engineer with the Buffalo Forge Company of Buffalo, New York, developed a spray-type temperature and humidity control. This and other innovations and improvements he developed led to his title, “the father of air conditioning.”

In July of 1902, Carrier installed his first air conditioning system at a printing plant in Brooklyn, New York, where summer heat and humidity caused paper to dampen and curl. Carrier’s system helped control the heat and humidity in the building to prevent this problem. Another engineer in New York, Alfred Wolff, who had worked on developing a system to cool textile mills, helped adapt a system for the New York Stock Exchange. In 1902, their new building was equipped with a central heating and cooling system. In 1906, Carrier patented his “Apparatus for Treating Air,” and Stuart Cramer used the term “air conditioning” for a system to control the humidity in a southern U.S. textile mill. The term used today refers to the conditioning of moisture and ventilation, which changes the air. Regardless of temperature, humidity can greatly affect certain manufacturing processes.

Before becoming a household commodity, the public experienced conditioned air in public buildings such as theaters, department stores, and trains. In 1904 at the St. Louis World’s Fair, the Louisiana Purchase Exposition featured the comfort-cooled Missouri State Building with its 1,000-seat auditorium. The New Empire Theater in Montgomery, Alabama, in 1917 was the first documented theater to use refrigeration for cooling.

MODERN ADVANCES

Besides Frigidaire’s introduction of the first “room cooler” in 1929 and Freon in 1930, other refinements began to follow Carrier and others’ initial innovations. In the 1930s, the window unit air conditioner, a more efficient solution for smaller areas, was developed. Innovations from this machine were applied to central heating and cooling systems, improving their affordability.

It was not until after resources became more available after the end of World War II that air conditioning became common to residences. In the 1950s, an advertising slogan touting the practicality of air conditioning exclaimed, “for the millions, not just the millionaires.”

The influence of air conditioning can be seen in the change of architecture in America. Homes were once commonly designed with high ceilings, deep porches, and large windows and doors to allow cross-ventilation. Landscapes were more likely to include shade trees and fountains or small pools. After buildings and homes could be cooled mechanically, one-story homes with sliding doors, picture windows and no porches became popular. Landscapes had less shaded areas. Business buildings have evolved into towering glass skyscrapers defining city skylines.

Today it is estimated that about half of all homes and 80 percent of cars in the United States have air conditioning. Air conditioning can improve work productivity, industrial processes, medical and health needs, food preservation, and human comfort. Recent innovations consider the impacts air conditioning has on resource use and environmental effects of its mechanical process.

The demands for energy required by air conditioning, however, make these increases in efficiency seem like only marginal gains. Given that air conditioning accounts for roughly 16 percent of the average U.S. household electricity consumption, and that electricity demands are currently met almost entirely by fossil fuels, it is likely that air conditioning usage is a significant contributor to greenhouse gas emissions. Cooling the home, therefore, ironically may result in warming the planet, resulting in further demands for cooling, in a potentially accelerating feedback loop. Alternative approaches to cooling that use nonelectrical sources or rely less heavily on the broader energy grid seem unlikely in the near future, and breaking the cycle of warming and cooling may prove to be a difficult challenge.

SEE ALSO: Fossil Fuels; Global Warming; Landscape Architecture.

BIBILIOGRAPHY. R. Dickinson,"A Cool History: Celebrate a Century of Air Conditioning by Reading About What Life Was Like in Summers Past," *Christian Science Monitor* (August, 2002); B. Donaldson and B. Nagengast, *Heat & Cold: Mastering the Great Indoors* (American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1994); M. Jones, Jr., "Air Conditioning" *Newsweek* (v.130, 1998); B.C. Langley, *Fundamentals of Air Conditioning Systems* (Fairmont Press, 2000); B. Nagengast, "It's a Cool Story*!*" *Mechanical Engineering* (v.122, 2000).

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Constructed in 1977, The Trans Alaska Pipeline bisects the Kanuti River near the Dalton Highway.

Alaska Pipeline

OIL WAS DISCOVERED on Alaska's North Slope in 1967. Soon thereafter, the state of Alaska sold oil leases worth over $900 million, and established royalties that made Alaska one of the richest states in the nation. Before this could happen, oil companies needed an economical way to move the oil to market. Several ideas, such as rail transport and ice-breaking tankers, were rejected. A consortium of oil companies formed the Alyeska Pipeline Service Company to build the Trans Alaska Pipeline System (TAPS), which included both the pipeline starting in Prudhoe Bay, and the terminal facilities at Valdez, the northernmost ice-free port in Alaska. Two major interests opposed the pipeline. Alaska's native people pressed long-standing land claims and threatened to tie up the project in court unless their claims where honored. The Alaska Native Claims Settlement Act of 1971 sought to compensate the native peoples for their land, thereby eliminating this hurdle.

Many environmental groups, however, continued to oppose the pipeline, with particular concerns about the environmental impact on wildlife and habitat. Others raised concerns about potential leaks and oil spills along the pipeline at Port Valdez, and as oil traveled through Prince William Sound. Due to these concerns, engineers made several changes to the original pipeline design. Most of the pipeline north of the Yukon River was built above ground to minimize damage to tundra and permafrost. Designs were also incorporated to protect the pipeline in an earthquake, changes that proved their value when the pipeline successfully withstood the magnitude 7.9 Denali earthquake in 2002. Growing needs for domestic oil led Congress to enact the Trans Alaska Pipeline Authorization Act (TAPAA) of 1973. The vote on the bill was a tie in the Senate; Vice President Spiro Agnew broke the tie, which allowed TAPAA to go forward. The act exempted the pipeline system from provisions of the National Environmental Policy Act (NEPA), although environmental laws were followed. Construction began soon thereafter, and was completed in 1977, when the first oil tanker left Port Valdez.

Some of the environmental concerns were overstated, but the pipeline has still had an effect on the environment. The behavior of animals near construction camps was altered when people fed them, often through garbage dumps, although this did not seem to have had a major impact. Other effects have been controversial. There have been several small leaks of the pipeline. In March 2006 there was a 250,000-gallon leak in feeder pipes from British Petroleum's oil field to the pipeline, and the discovery of another leak in the same system in August 2006 shut down the Prudhoe Bay field for months while repairs were made. North Slope oil also spilled from the *Exxon Valdez* in 1989. Perhaps the most profound impact of the TAPS was socioeconomic—Alaska's population and treasury grew rapidly in the 1970s, and oil wealth and the drive to find more oil reserves to pump through the pipeline have had a profound effect on the life and culture of Alaskans.

SEE ALSO: Arctic National Wildlife Refuge; *Exxon Valdez*; United States, Alaska.

BIBLIOGRAPHY. "Alaska Pipeline: Back to Court Despite Interior's OK," *Congressional Quarterly Almanac* (v.28, 1972); Peter A. Coates, *The Trans-Alaska Pipeline Controversy: Technology, Conservation and the Frontier* (University of Alaska Press, 1993); Clifford Krauss and Jeremy W. Peters, "Biggest Oil Field in U.S. Is Forced to Stop Pumping," *New York Times* (August 8, 2006); National Research Council, Polar Research Board, *Cumulative Environmental Effects of Oil and Gas Activities on Alaska's North Slope* (National Academies Press, 2003).

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Albania

ALBANIA IS STILL in the process of political and economic transition after almost five decades of Communist rule that ended in the early 1990s. During that period, Albania's natural resources and raw materials were regularly exploited, and little was done to promote environmental awareness. Since the shift to a market economy, environmental problems have been further exacerbated as the country has become more urbanized and industrialized. Albania is still one of the poorest countries in Europe and is the least developed country on the continent. Because of its temperate climate, Albania experiences cool, wet winters and hot, dry summers. Destructive earthquakes often lead to major environmental damage, as do alternating floods and droughts.

Fluctuating weather conditions present great risks for the 57 percent of Albania's workforce who are engaged in the agricultural sector. Employing methods that protect the environment is difficult for Albanian farmers, who do not have the financial means to modernize equipment and who sometimes lack environmental knowledge. Almost 15 percent of the population is illiterate. Nevertheless, Albania has the potential for economic growth because of natural resources that include petroleum, natural gas, hydropower, coal, bauxite, chromite, copper, iron ore, nickel, salt, and timber. Environmentally, the Albanian government is struggling to deal with deforestation, soil erosion, and water polluted by industrial and domestic effluents, but progress has been made. In 2006, a study by scientists at Yale University ranked Albania 57 out of 132 countries on environmental performance. Approximately 97 percent of the population have access to safe drinking water, and 89 percent have access to improved sanitation. The Albanian government has been relatively successful in promoting biodiversity. Of the 68 mammal species endemic to Albania, only three are threatened. Likewise, only three species of the 193 endemic bird species are threatened.

ENVIRONMENTAL ADVANCES, SETBACKS

In 1993, using financing from the World Bank, the Albanian government established the National Plan of the Action on Environment with the goals of strengthening institutions, protecting natural resources, and dealing with industrial pollution. Golemi Beach was identified as a model for maintaining clean coastal areas, and a pilot project for preserving resources and wildlife was launched at Dajti National Park. Sewage treatment facilities were erected in Vlore and Pogradec, and solid waste treatment facilities were set up in seven large cities. A major environmental study was undertaken at the Patos-Marinzes oil field of Karavasta Lagoon.

Despite major gains in promoting environmental awareness, a U.S. study in 2001 identified five major "hot spots" of environmental contamination in Albania. One is situated near a chemical plant in Durres, where about 20,000 tons of lindane are covered only by a thin layer of soil. The 80 families that live in an abandoned pesticide plant on the land face enormous health risks from constant exposure to the lindane that is present at 500 times an acceptable level in the air and water, as well as in the soil where vegetables are grown. Contamination from this and other infected sites in Albania have been spread to others by using the contaminated soil in the construction of other homes and buildings.

Although Albania has laws in place to check environmental damage, implementation continues to be difficult because of funding and personnel shortages, ignorance of existing laws, and judicial corruption. Without enforcement of fines, laws fail to serve as deterrents to polluting the environment. In 1998, Albania strengthened the powers of the National Environmental Agency, placing it under the Council of Ministers. Priorities of the agency include intensive environmental training at the national and local levels. Albania also promotes greater environmental responsibility through participation in the following international agreements: Biosafety, Climate Change, Kyoto Protocol, and Biological Diversity. International agreements that have been signed but not ratified include: Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Deforestation; Drought; Kyoto Protocol; Sewage and Sewer Systems; Tsunamis.

BIBLIOGRAPHY: Paul Brown, "Children Play with Death in Toxic Wasteland," *Guardian*, 27 April 2001; CIA, "Albania," *The World Factbook*, www.cia.gov/cia/publications/factbook/geos/al.html (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); "Phare Program in Albania's Environment," www.keshilliministrave.al/english/info/english/page10.htm (cited March 2006); Regional Environmental Center for Central and Eastern Europe, "Country Report: Albania" (Tirania: REC, 2000); Republic of Albania, *State of the Environment Report, 1997–1998* (Tirania: National Environmental Agency, 1999); UNDP, "Human Development Report: Albania," http://hdr.undp.org/statistics/data/cty/cty_f_ALB.html (cited March 2006); World Bank, "Albania," *Little Green Data Book*, www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Algeria

ALGERIA WON ITS independence from France in 1962 after years of struggle. Subsequent internal conflicts erupted into open battle in 1992. Over the next six years, at least 100,000 Algerians were killed when conflict between extremists and army forces led to the annihilation of whole villages. Even though the fighting has tapered off, the Algerian government has been accused of widespread inefficiency and corruption. As a result, there is a serious housing shortage in Algeria, and water and electrical supplies are unstable. The undiversified Algerian economy is heavily dependent on petroleum, which has generated a large cash reserve that may eventually be used to deal with social problems and improve the weak infrastructure. Other natural resources include iron ore, phosphates, uranium, lead, and zinc. The Algerian government owns 91 percent of the forests and formally manages 28 percent.

Algeria has the world's seventh-largest reserves of natural gas and the 14th largest oil reserves, and is the second-largest exporter of gas in the world. The hydrocarbons sectors furnish 60 percent of budget revenues, 95 percent of export earnings, and roughly a third of the Gross Domestic Product.

Algeria's per capita income of $7,200 ranks 108th in the world. One-fourth of the population lives below the national poverty level, and 22.5 percent of the work force are unemployed. Although only 3.17 percent of the land area is arable, 14 percent of the population are engaged in agriculture. The United Nations Development Program (UNDP) Human Development Reports rank Algeria 103rd in the world in overall quality-of-life issues.

Eight percent of Algerians lack access to improved sanitation, and 13 percent lack sustained access to safe drinking water. As a result, the Algerian population of over 32 million faces an intermediate risk of food and waterborne diseases. Some areas are also at high risk for cutaneous leishmaniasis, a vector-borne disease. The literacy rate of 61 percent for adult females (78.8 percent for males) hampers government efforts to disseminate written health and environmental information.

Bordering on the Mediterranean Sea in northern Africa, Algeria has a coastline of 998 kilometers. Much of the land is high plateau and desert interspersed with mountains. Of all North African countries, Algeria is the most vulnerable to seismic activity, with 90 percent of the population and infrastructure at risk. Along the narrow, discontinuous coastal plain, winters are generally wet, and summers are hot and dry. In the high plateau, the climate is arid. The sirocco, a hot wind that transports dust and sand, appears in the summer. The rainy season often produces mudslides and floods, such as the flood that claimed 800 lives in November 2001. Algeria also experiences drought, locust infestation, and fires.

Living in the Kasbah

The Kasbah (or Casbah or Qasbah) in Algiers is the central citadel of the city and was largely built during the period of Ottoman rule from the 16th century, initially by the Turkish corsair Arroudj. The Kasbah, which overlooks the harbor, was the residence of the Bey of Algiers, the city's Turkish administrator.

In 1830 the French captured the city, massively enlarging it, but doing little to alter the Kasbah. By this time the term "Kasbah" came to refer to the entire old city, more properly known as Medina. It occupied 18 hectares, with architects coming from Granada, Constantinople (Istanbul), and even Venice. In spite of these diverse styles, because of the building materials available—mainly stone—there was a significant architectural unity about the place. With the buildings close to each other and narrow shaded streets, the temperature remains much the same year round. Originally, the area was divided into "quarters," similar to European church parishes, each having its own mosque, fountain, or tomb of a holy man.

During the Algerian War of Independence, the French were constantly attacked by Algerians who then fled into the Kasbah where, with narrow windy streets, pursuit was impossible. From January until September 1957 there was constant fighting around the Kasbah involving the highly controversial French General Massu.

ENVIRONMENTAL CONSEQUENCES

Irresponsible agricultural management has led to serious soil erosion in Algeria, and desertification has resulted from human activity as well as climatic conditions. Algeria's waters are heavily polluted because of raw sewage dumped directly into freshwater resources, and from waste products released by refineries and other industries. The ecology of the Mediterranean Sea has been seriously threatened by oil wastes, soil erosion, and agricultural runoff. Algeria also suffers from a lack of potable water.

Carbon dioxide emissions measured by per capita metric tons declined in Algeria from 3.5 in 1980 to 2.9 in 2002. Algeria produces 0.4 percent of the world's total carbon dioxide emissions. Waste management has been of particular concern in Algeria because of the age-old practice of dumping raw sewage into wadis (dry riverbeds that fill up during times of heavy rain), which transport the waste directly into the sea. Even though 30 water treatment facilities were set up in Algeria in the 1980s to deal with this problem, two decades later only two were still in operation. The contamination led to outbreaks of typhoid and cholera. The lack of solid waste treatment facilities has further damaged the Algerian environment.

In 2006, a study by scientists at Yale University ranked Algeria 63 of 132 countries in environmental performance, in line with the comparable income and geographic groups. The lowest scores were assigned in the categories of air quality and biodiversity and habitat. Of 92 endemic mammal species, 13 are endangered. Likewise, six of 183 endemic bird species are threatened.

With nearly 60 percent of the population living in urban areas and producing increasing amounts of pollution, the Algerian government launched the National Environment Plan in 2002 under the leadership of the Ministry of Regional Planning and Environment. The plan is designed to increase access to safe drinking water, improve waste management, and preserve biodiversity. The Tassili N'Adjjer and the Ahaggar have been set aside as national parks. The overall goal of sustainable development guides environmental policy in Algeria, and the government is working with international agencies to achieve this goal. Algeria has ratified the

The Hosalis

In 1921 Frances Kate Hosali, the widow of an Indian barrister, Moti Hosali, and her daughter Nina Hosali went on a holiday to Algeria, planning to spend eight months in North Africa. When they were at the Algerian port of Mostaganem, they were distressed to see the ill-treatment of domestic animals, in particular donkeys. After their return to London, they established the Society for the Protection of Animals in North Africa (S.P. A.N.A.) in 1923 to look after animals, especially donkeys, in North Africa. It always remained heavily centered in French Algeria. They had support from the Royal Society for the Prevention of Cruelty to Animals (R.S.P. C.A.) in London, and from then on, Kate Hosali spent most of her time in Tunisia, Algeria, and Morocco, with her daughter running the office in London. By the outbreak of World War II in 1939, the society had free treatment centers in twenty places in Algeria and Tunisia. Kate Hosali died in 1944 in Marrakech, Morocco, and her daughter, who continued running the main office in London, also took over overseeing the field work. In 1953 the charity was treating 100,000 animals each year; by 1984, the society had 250,000 members. Nina Hosali died in January 1987. She had been made a Member of the British Empire in 1976 for services to animal welfare, particularly in North Africa. The society continues to this day.

following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Desertification; Floods and Flood Control; Kyoto Protocol; Sewage and Sewer Systems; Waste, Solid.

BIBLIOGRAPHY: CIA, "Algeria," *World Factbook*, http://www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Human Development Report: Algeria," http://hdr.undp.org/statistics/data/countries.cfm?c=DZA (cited May 2006); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); World Bank, "Algeria," www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Allergen

AN ALLERGEN IS any substance that, if ingested, can cause an allergic reaction—a hypersensitive state that stimulates the production of reaginic antibodies, and which may have sometimes severely negative medical impacts upon the individual. Allergens include viruses and bacteria, dust, pollen and smoke particles that may be inhaled, foodstuffs, and chemicals. The allergic reaction varies from individual to individual and from place to place, since the environmental quality of the air varies according to location and time.

The huge increase of chemical substances used in foodstuffs and other consumer products mean there are many more possibilities for allergic reactions. Consequently, advice on how to avoid allergens has become increasingly prevalent in modern society. This includes warnings on consumer products, public health warnings and, rather less reliably, a whole new set of urban myths about possible contaminants and threats. Nevertheless, it is true that a small number of people can suffer severe allergic reactions to specific food items such as nuts, which can be so severe as to lead to death. The proportion of people, especially young children, suffering from asthma and other respiratory diseases triggered from allergens is sharply and significantly increasing.

As the variety and importance of allergens in modern Western society in particular has increased, along with the ability to diagnose their presence and impact, several product sectors have become increasingly important. These include advice about supposedly healthy living and eating and avoidance of possible allergens. Another is the threat of consumer boycott of products believed to contribute to allergic reaction, as well as the possibility of litigation against companies alleged to be contributing to the presence of allergens. This represents an uncertain future for a number of companies, which face future liability for their products based on allergic reactions that are just emerging or have not yet emerged. Genetically modified organisms have been cited as a particular problem in this respect because of the unknown future interaction with other complex chemicals in the environment.

Methods of preventing allergens from triggering a reaction include enhanced control over living environments, including cleanliness in kitchen and household environments; control of household pets; and greater knowledge of the constituents of newly employed consumer products. However, it may be impossible to eliminate the risk of exposure, and it may be necessary in the future for everyone to accept a potential threat of allergic reaction.

SEE ALSO: Chemical Additives (in Foods); Food; Genetically Modified Organisms (GMOs).

BIBLIOGRAPHY. Felicity Goodyear-Smith, "Health and Safety Issues Pertaining to Genetically Modified Foods," *Australia and New Zealand Journal of Public Health* (v.25/4, 2001); Stef J. Koppelman and Sue L. Hefle, eds., *Detecting Allergens in Food* (Woodhead Publishing, 2006); Richard Lockey, *Allergens and Allergen Immunotherapy* (Marcel Dekker, 2004).

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Alliance of Small Island States (AOSIS)

IN JANUARY 2005, the representatives of several small island states gathered in Mauritius to recommit themselves to a program of action for sustainable development, first adopted in Barbados 10 years previously. This meeting, attended by the United Nations (UN) Secretary General, 13 heads of state, 19 member representatives, and 11 observers, affirmed the need to focus international attention on this issue, particularly in the area of climate change. The motivation to convene was fortified by the dramatic demonstrations of the scale of natural disasters in 2004, paired with significant cuts of funding from major international bodies.

The delegates in Mauritius represented an organization created in 1990 under the aegis of the UN, the Alliance of Small Island States (AOSIS). This group acts as the lobbying voice for small island developing states (SIDS). The group currently has 39 member states, ranging in size from large islands like Cuba and Cyprus to tiny nations like Tuvalu, Nauru, and the Seychelles, plus observers from U.S. territories (Guam, American Samoa, and the U.S. Virgin Islands) and the Netherlands. Other member states such as Belize and Guinea-Bissau are not islands, but share similar coastal and economic concerns. These states share a common threat from climate change, as predicted rising sea levels threaten to displace coastal populations, damage freshwater reserves, and even completely submerge the low-lying coral atolls of several Pacific states.

PARTNERSHIPS FOR CONSERVATION

Since its founding, AOSIS has held a number of international conferences on climate change and related issues, issuing statements on vulnerability and adaptation, renewable energy development, and restrictions on greenhouse gas emissions in partnership with the leading developed states of the world. In 1996, a public hearing was held in Luxembourg on climate change and small island states, which aimed to stimulate partnership in specific commitments for carbon dioxide reductions with the European Union and the ACP (African, Caribbean, and Pacific Group of States). This was followed in 1999 by a workshop on the implementation of the Kyoto Protocol and the Clean Development Mechanism (CDM), held in the Marshall Islands with invited guests from larger states with similar coastal concerns, including the United States, the United Kingdom, Australia, New Zealand, and Norway.

EARLY WARNING SYSTEM

Since the early 1990s, ecologist and biologists have warned of the increasing danger of climate change to small island states, particularly those with limited highland areas, and those with few resources to combat meteorological disasters. These states have been viewed as a sort of early warning system for global environmental problems. By their very nature as islands, the ecosystems of these island states are isolated and vulnerable to change. AOSIS hopes to draw the attention of the world's larger states to a number of related issues, from support of tourism to wildlife conservation.

In biogeography, *island theory* focuses on the importance of equilibrium in these delicate environments, both for human and animal populations—the greater the isolation, the higher the risk. Moreover, conservation goals in such underdeveloped island states are often at odds with sustainable development goals.

AOSIS is run through the diplomatic missions of its UN members. Every three years one of these representatives takes on the role of chairman, but there is no formal charter, nor any regular budget. Collectively representing about 20 percent of UN total membership and 5 percent of global population, AOSIS is emerging as a leader in the global effort to control climate change.

SEE ALSO: Coral Reefs; Equilibrium; Greenhouse Effect; Kyoto Protocol.

BIBLIOGRAPHY: International Institute for Sustainable Development, www.iisd.ca/sd/aosis (cited December 2005); Niels Kristoffersen, "Public Hearing on Climate Change and Small Island States," Luxembourg, September 25, 1996 (Working Document, European Parliament, Directorate General for Research, External Economic Relations Series: W-15.2-1997); Small Island Developing States Network, www.sidsnet.org/aosis (cited December 2005); UN Economic and Social Commission for Asia and the Pacific: www.unescap.org; Robert J. Whittaker, *Island Biogeography: Ecology, Evolution, and Conservation* (Oxford, 1998).

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Alternative Energy

ALTERNATIVE ENERGY IS the generation of power from nontraditional sources as opposed to sources such as coal and oil. The main sources of alternative energy are hydropower, wind, solar, hydrogen, bioenergy, geothermal, and hybrid technology. Currently, the most prodigious source of alternative energy is produced by large-scale hydroelectricity schemes, which account for 16 percent of the world supply of energy. By comparison, the other sources combined generate approximately 4 percent.

HYDROPOWER

Hydropower is produced by constructing a dam wall across a river to create a reservoir. The stored water is then released through turbines built into the dam wall, generating electricity. Although the generation of hydroelectricity does not produce any climate-changing emissions, the construction of large dams does cause significant environmental and social problems. When completed in 2009, the Three Gorges Dam in China will be the world's largest hydroelectricity scheme and able to generate 18,200 megawatts of power. However, the project will create a reservoir that is 412 miles (159 kilometers) long and will inundate 13 cities, submerge ancient archaeological and tourist sites, and make up to 1.2 million people homeless.

At an environmental level, a hydro-dam drastically changes the landscape and local hydrological processes. A dam hinders the movement of fish upstream, preventing them from spawning; downstream, less silt moves through the river system, starving the land of valuable nutrients. In heavily degraded landscapes, this loss of silt can be beneficial in reducing the need for dredging river estuaries. Another environmental impact of hydro technology is cold water pollution, in which the water in the deeper parts of the reservoir, normally at the dam wall, is significantly colder than at the surface. This temperature change has caused fish kills.

WIND POWER

Wind power is generated by the force of the wind, which spins rotor blades attached to a turbine.

The clean, efficient nature of wind energy has seen a rapid expansion in the development of wind farms.

Modern wind turbines can be up to 305 feet (93 meters) tall with rotor diameters larger than the wingspan of a jumbo jet (210 feet [64 meters]), and which at full power can generate enough energy to power more than 500 homes. It is a very clean and efficient method of generating power, producing zero emissions of climate-changing gases, and it competes relatively well on price with other sources of traditional sources of power.

The clean, efficient nature of wind energy has seen a rapid expansion in the development of wind farms. Energy generated by wind grew by 28 percent in 2004, and is the second-fastest growing source of alternative energy in the world. Consequently, major companies including General Electric and Siemens are now investing in the wind industry, ensuring that the cost of production becomes even more competitive with traditional forms of energy.

Wind energy is not without its critics. Due to the many social and political issues raised by the prospect of wind farming, including the availability of suitable sites, visual impacts, competing land pressures, and noise pollution fears, wind farms are increasingly being built offshore. Energy outputs can also be 50 percent higher offshore than onshore. The largest offshore wind farm in the world is the Horns Rev development in Denmark, a central plank in Danish government plans to cut carbon dioxide emissions by 50 percent, to 1988 levels, by 2030.

SOLAR ENERGY

Solar energy is created by harnessing the power produced by the sun, and can be generated in three ways. First, passive solar power manages natural light entering a building. Through the application of a combination of strategies, including correct building orientation and insulation, the temperature inside a structure can be maintained at a more comfortable level. This reduces the need for energy hungry air-conditioners and heaters.

Second, active solar power absorbs the sun's heat through solar-thermal concentration systems. The most common concentration system is a solar hot water heater. Unfortunately, these systems are not highly efficient, and during winter in many parts of the northern hemisphere, a backup supply of electricity may be required.

A third, more efficient form of solar energy is generated in photovoltaic (PV) cells, which convert the energy captured from the sun into electricity. Until recently, PV cells had not made a large contribution to the alternative energy market because of their low conversion efficiency and relatively high cost. However, recent technological advances in PV efficiency have resulted in staggering improvements and growth in its use. Between 2000 and 2004, grid-connected solar PV energy generation grew by 60 percent, and is now the fastest-growing alternative energy industry in the world.

Developments, including "thin-film" PV technology, allow any surface, such as the roof of a house, to be converted into a solar-electric power source. As of 2004, over 400,000 rooftops in Japan, Germany, and the United States were generating power in this way.

HYDROGEN

Hydrogen has been described by Royal Dutch Shell as the ultimate fuel source with the potential to revolutionize society's use of energy. Hydrogen is the most common element in the universe, and is found in water and all living things. It can be produced in many ways, including through partial oxidation from fossil fuels such as gas and from renewable sources such as wind or the sun.

When hydrogen is used in a fuel cell, the only emissions are water. As an energy carrier, meaning it can be stored, hydrogen can be used in portable devices such as cars or buses. Shell suggests that vehicles powered by hydrogen fuel cells are 40–60 percent energy-efficient compared to internal combustion engines, which only use 30 percent of their fuel energy.

Iceland is pioneering the use of hydrogen as an alternative energy and plans to have the world's first "hydrogen economy" by 2050. In Iceland, there is strong political support, a relatively small population, and a well-developed alternative energy sector (principally hydro and geothermal), which have collectively primed the conditions for the government to make significant energy changes. Iceland plans to convert all of Reykjavik's buses to hydrogen by 2013 and begin conversion programs of its entire fishing fleet in 2015. In Regina, Canada, a trial to extract hydrogen from landfill gases by solar energy has begun, and is designed to reduce greenhouse gas emissions by 2,205 pounds (1 tonne) per household per year.

The fundamental challenge in the transition to a hydrogen-based energy system is that although hydrogen is ubiquitous, releasing it and storing it in a usable form requires energy inputs, which must come from other sources. As long as these are conventional sources (oil and gas), the switch to hydrogen represents only a modest change in the overall structure and environmental impact of the energy economy. Accompanied by a switch to a set of alternative sources, however, hydrogen offers a high potential source. And while new infrastructure is also required in order to make hydrogen readily available to the public, the Tyndall Centre for Climate Change Research, a British think-tank, argues that such problems can be overcome—and that with the right levels of investment in infrastructure, high numbers of vehicles could be potentially powered by hydrogen by mid-century.

From a social perspective the introduction of a hydrogen economy has the potential to have a profound impact. With the right infrastructure, any country can produce hydrogen. This would allow the world to operate on a more energy even footing and give poorer countries access to power currently denied them.

BIOENERGY

Bioenergy fuels are an alternative source that can also greatly reduce climate-changing emissions from vehicle use. There are two key types of bio-fuels: ethanol and bio-diesel, and both can be produced from a number of food stocks including sugar, soybeans, corn, and wheat. Brazil is the largest producer of ethanol products and operates over 300 distilleries, accounting for 50 percent of global exports.

Ethanol is generally used as a 10 percent blend with gasoline (petrol) and can be used in most vehicles without the need for engine modifications. Specially designed "flex-fuel" vehicles operate with 85 percent ethanol; there are currently 4 million such vehicles in North America. Cellulose ethanol is made from nonfood stock such as straw, and as such does not compete with the food industry.

The increased use of bio-fuels by the developed world is having significant environmental and social impacts on developing countries such as Brazil. Large swathes of tropical rainforest in the Amazon Basin are being cleared to grow soybeans and sugarcane for ethanol production. This is causing significant biodiversity loss, degrading water quality, and having a negative impact upon the region's indigenous peoples, who rely on healthy, intact forests. Moral debates are also discussing the ethics of burning an edible food source for fuel while millions of people around the world face famine.

Bio-diesel is produced from a chemical reaction between vegetables and oil. Bio-diesel has similar properties to petroleum diesel fuel, but has 85 percent fewer cancer-causing agents. It is most commonly used as a 20 percent blend with petro-diesel. France is the largest user of bio-diesel, where it is commonly used for heating and mixed as a 50 percent blend with petro-diesel to power vehicles.

Biomass energy refers to the generation of power resulting from the burning of organic materials, such as agricultural and household waste in an energy-for-waste energy power station. While the use of biomass greatly reduces the amount of waste deposited at landfill sites, there is concern at the levels of carbon dioxide and methane released as a consequence of burning organic materials.

HYBRID TECHNOLOGY

Hybrid technology can significantly reduce carbon dioxide emissions from vehicle use. A hybrid vehicle is one that is powered using a mixture of gasoline and electric sources. There are several different types of hybrid vehicles, including the full-hybrid, which can be powered by gasoline or battery power alone; an assist-hybrid, which uses an electrical source when the car requires extra power; and a plug-in-hybrid, which is attached to the main power for recharging. Like the full-hybrid vehicle, the plug-in-hybrid is powered solely from an electrical source.

GEOTHERMAL ENERGY

Geothermal, or hot rock energy, generates electricity by the injection of water into a borehole in rocks with temperatures of at least 200 degrees C. The water is heated upon contact with the rock and is returned to the surface via a second borehole in the form of steam, which is then used to turn turbines that generate electricity. The cooled steam is then reinjected back into the first borehole where the process begins again. Geothermal energy can also be used to heat buildings by pumping heated water from the ground into pipes that feed internal radiators.

Researchers at the Australian National University argue that hot rock energy is a vast, environmentally friendly, and economically attractive energy source. The geothermal industry is dominated by several major companies including Ansaldo, Fuji, and Mitsubishi and is generated in many countries around the world. Use is highest in the Philippines, with geothermal energy providing approximately 27 percent of power needs. In Iceland, 85 percent of all the nation's space-heating needs are met by direct geothermal energy.

NUCLEAR POWER

Although the nuclear power industry describes itself as an alternative energy, uranium is nonrenewable and the amount to be found naturally is finite. The European Commission estimates that with current levels of uranium consumption, known uranium resources, will last just 42 years. Further, energy use during plant construction and the storage of radioactive waste makes the adoption of nuclear energy in many parts of the world environmentally, politically, and socially problematic. However, due to the overwhelming evidence of climate change and a rapid rise in carbon dioxide emissions from the burning of fossil fuels, governments and scientists, including Sir James Lovelock, the originator of the Gaia Hypothesis, are advocating an increased use of nuclear power as a means of reducing and limiting the impact of global warming.

ALTERNATIVE ENERGY INDUSTRY

The alternative energy industry is enhancing many lives through the creation of over 1.7 million well-paid jobs. Over half a billion dollars is invested each year in developing countries for renewable energy projects. No single alternative energy source can provide the world with all its energy needs, but together, the various sources can greatly reduce the reliance on fossil fuels, thus conserving valuable resources and reducing the chance of catastrophic climate change. As the global supply of fossil fuels become scarcer and their environmental consequences become more apparent and unacceptable by society, alternative energy sources will play an increasing role in meeting the power needs of the world.

SEE ALSO: Bioenergy; Dams; Deforestation; Geothermal Energy; Global Warming; Greenhouse Gases; Hydrogen Fuel; Hydropower; Indigenous Peoples; Solar Energy, Think Tanks; Three Gorges Dam; Wind Power.

BIBLIOGRAPHY. Australian National University, "Hot Rock Energy—The Concept," http://hotrock.anu.edu.au/index.htm (cited April 2006); P. Berinstein, *Alternative Energy, Facts, Statistics and Issu*es (Orxy Press, 2001); B. Sorensen, *Renewable Energy: Its Physics, Engineering Use, Environmental Impacts, Economy and Planning Aspects* (Roskilde University, 2001); M. Dresselhaus and I. Thomas, "Alternative Energy Technologies," *Nature* (v.414, 2001); Norsk Hydro, "Hydrogen-Fuel of the Future," www.hydro.com (cited April 2006); Iogen Corporation (homepage), www.iogen.ca, (cited April

2006); A. Jameson, "Uranium Shortage Poses Threat," *The Times* (2005); J. Pelley, "Sunlight Turns Landfill Gas into Hydrogen," *Environment, Science and Technology* (v.39, 2005); Pew Centre on Global Climate Change, *Global Warming Basics,* www.pewclimate.org/global-warming-basics/ (cited April 2006); Renewable Energy Policy Network, *Renewables 2005 Global Status Report* (Worldwatch Institute, 2005); Royal Dutch Shell, "The Ultimate Fuel," www.shell.com/home/Framework?siteId=hydrogen-en&FC2=/hydrogen-en/html/iwgen/leftnavs/zzz_lhn3_0_0.html&FC3=/hydrogen-en/html/iwgen/ultimate/ultimate_fuel_0111.html (cited April 2006); A. Sigfusson, "Iceland Pioneering the Hydrogen Economy," *Foreign Service Journal* (2003); Tyndall Centre for Climate Change Research, *Decarbonising the UK: Energy for a Climate Conscious Future* (Tyndall, 2005).

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Amazon River Basin

AS A DRAINAGE basin, the Amazon covers more than 7 million square kilometers in South America, making it the largest in the world. The Amazon basin encompasses portions of Bolivia, Brazil, Colombia, Ecuador, Suriname, Peru, and Venezuela, and roughly two thirds of this area fall within Brazil. Many of the main rivers of the basin are more than 2 kilometers wide, and the Amazon itself discharges roughly 175,000 m^3 of water per second into the Atlantic.

Climate in the Amazon is eminently tropical with limited variation in temperatures and more seasonal variability in rainfall, which is generally greater from November to May. Soils in the Amazon were once believed to be very fertile, but most of the basin has relatively old, weathered soils that are nutrient-poor and unsuitable for sustained agriculture. The Amazon watershed consists of different kinds of rivers. Whitewater rivers, such as the Amazon itself, are very turbid because they carry greater sediment loads, transported from clay soils by heavy rainfall during the wet season. By contrast, clearwater rivers are more transparent, but sediment-poor, and blackwater rivers have the color of tea due to plant tannins in the water. During the rainy season, river levels rise, inundating lowland forests; many fish then come into the flooded forests to feed and reproduce. Whitewater rivers deposit considerable sediments in lowland soils, and due to these nutrients, whitewater rivers have particularly abundant fish populations. The nutrient deposits also raise lowland soil fertility, and when river levels decline in the dry season, the exposed lowlands are farmed due to their relatively high productivity.

The Amazon has very high biodiversity, and as a result, the countries sharing the basin are among the most biodiverse in the world. Brazil alone holds between 10% and 20% of the 1.5 million species catalogued thus far. These numbers are low, however, since new species in the Amazon are regularly being discovered and described.

HUMAN OCCUPATION

Understanding of the initial human occupation in the Amazon is changing. It now appears that humans arrived in the Amazon at least 11,500 years ago, judging from pottery shards. Debate continues concerning Amazon's pre-Columbian populations, which informs estimates of the basin's human carrying capacity. Scholars who emphasize lower numbers call attention to the basin's limited protein sources, and note evidence of higher population concentrations near whitewater rivers.

However, archaeological evidence of sizeable pre-Columbian earthworks, roads, and centralized settlement designs in the uplands suggests larger populations than previously estimated. Similarly, ethnobotanical evidence indicates that many areas of "pristine" forest in the Amazon were modified by human use over long periods. And patches of "Black Indian soils," which resulted from disposal of large quantities of organic waste by indigenous groups, have been found in many places across the basin.

Indigenous peoples in the Amazon largely resided along rivers, which they intensively exploited. In the uplands, indigenous groups cut and burned vegetation to form small clearings, where they cultivated food crops. Such clearings were only temporarily used, as tribal groups subsequently moved on, allowing the forest to reclaim cleared patches.

European colonization of the Amazon began in the 16th century with Portuguese incursions westward from the Atlantic, and Spanish expeditions eastward from the Andes. Impressed with the luxuriant vegetation and considerable indigenous populations along the rivers, Europeans went in search of exotic commodities. This led to river-based trade in dyes, seeds, animal hides, and numerous other products, which were exported to Europe. This system was based in part on indigenous labor, often in missionary settlements. As a result, indigenous populations declined, and the Amazon economy became increasingly focused on specific commodities, leading to boom-bust economic cycles.

The most noteworthy such cycle in the Amazon involved rubber. Industrial demand for rubber in North Atlantic economies in the 19th century drove increasing extraction of raw latex from the Amazonian rubber tree. Drought in the Brazilian Northeast and propaganda by rubber estate owners prompted considerable migration into the Amazon. Rubber exports rose steadily from 1850 to 1910, and the wealth flowing into trading centers such as Rio Branco, Manaus, and Belém prompted rapid urban growth. However, English botanists smuggled rubber seeds out to Malaysia, where rubber plantations were established. Lacking the endemic pests that prevented such plantations in the Amazon, Malaysian producers soon undersold their Amazon counterparts, turning the boom to a bust.

In the 1960s and 1970s, national governments of the countries sharing the Amazon embarked on ambitious frontier development projects involving highway construction, colonization programs, and fiscal incentives for capital investment. As a result, populations in and around towns along the new roads expanded rapidly, and as colonists and ranchers arrived, they cleared large areas of forest in order to establish land claims. The new populations also encountered indigenous peoples and rubber tappers, resulting in conflicts over whether to leave the forest standing for traditional uses or to cut it down for agriculture. By the 1980s, there were violent conflicts over natural resources in many parts of the Amazon, including around large mining and oil extraction projects.

The global economic recession of the early 1980s prompted many governments to withdraw support from Amazon development. In the vacuum left by the state, social movements emerged in the Amazon, calling attention to various concerns ranging from indigenous rights to support for small farmers to loss of biodiversity.

In 1988, the murder of rubber tapper Chico Mendes transpired in the context of record levels of deforestation and burning. This called international attention to the linkage between the Amazon's social problem of human rights violations and its ecological problem of forest destruction. As a result, monitoring of deforestation has become a priority, facilitated by improving remote sensing technologies. According to Brazil's National Institute for Space Research, more than 600,000 square kilometers of forest in the Brazilian Amazon (15%) had been cleared as of 2005. In addition, Brazil and other countries accelerated designation of national parks, state forests, and biological and indigenous reserves to protect portions of the Amazon basin.

GLOBALIZATION

In the context of globalization, the Amazon has become the target of a new generation of infrastructure projects. Paving of the BR-163 highway from Cuiabá to Santarém, a north-south corridor through the heart of the Amazon, has become the topic of much policy debate in Brazil. Other infrastructure initiatives, such as paving of the Interoceanic highway through the exceptionally biodiverse southwestern Amazon, and the Madeira river dam complex, stand to bring enormous changes to the watershed.

Other worrisome changes are also evident in the Amazon. Of particular concern has been the expansion of illegal logging operations, which are impoverishing forests by removing certain tree species. Logging also degrades ecosystems by opening numerous canopy gaps that facilitate the entry of fires, which further alter rainforest ecology. Along with such alterations, low rainfall during 2005 facilitated the entry of fires into previously moist forests. Similarly, the growth of large-scale agricultural operations, especially extensive cattle ranches and mechanized agricultural enterprises, is pushing out rural populations and forming large blocs of deforested land. Governments sharing the Amazon basin see large-scale agricultural operations as efficient generators of foreign exchange to pay down national debts, but many social movement leaders view them as threats to communities who depend on small-scale forest resource extraction. The future of the Amazon is consequently very uncertain, for it is increasingly exposed to global market forces, and may be greatly affected by climate change.

SEE ALSO: Brazil; Climate, Tropical; Colonialism; Deforestation; Rubber; Rivers

BIBLIOGRAPHY. James Barter, *Rivers of the World—The Amazon* (Lucent Books, 2002); Andrew Revkin, *The Burning Season: The Murder of Chico Mendes and the Fight for the Amazon Rain Forest* (Island Press, 2004); Nigel J. H. Smith, *The Amazon River Forest: A Natural History of Plants, Animals, and People* (Oxford University Press, USA, 1999)

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Amphibians

AMPHIBIANS (GREEK, "DOUBLE LIFE") are a class of animals with vertebrae or backbones. They live part of their lives in water and part on dry land. There are over 3,000 kinds of amphibians known to scientists, most of which have smooth skin without scales. They are the least numerous of all classes of vertebrates. Amphibians first appeared during the Mississippian and Pennsylvanian Periods as land vertebrates. By the Mesozoic Era, the ancestors of present day amphibians appeared probably from the lobe-lunged fish. These ancient fish had lungs and fins with enough muscle and bone to support them on land for a brief period. The prehistoric *Labyrinthodontia* was one of the first amphibians.

There are three orders of amphibians: legless caecilians (*Cymnophiona* or *Gymnophonia*); salamanders, including newts (*Caudata*); and frogs and toads (*Salientia*). All are cold-blooded and lay their eggs in water, and most eat insects. The amphibians that live in cold climates hibernate during the winter.

Amphibians have declined in number in recent decades, partly due to human activities such as draining wetlands.

Most amphibians that live in warm climates aestivate (become dormant) during summer dry seasons. Most amphibians mate at night during rainy seasons. The eggs are laid in a jelly-like mass outside of the body and are fertilized by the male. Most frogs and toads leave the eggs unguarded, but some carry the eggs until they hatch as larvae. Frog larvae are born with gills and are called tadpoles or polliwogs. They live in water during the early stages, but undergo a metamorphosis in which the tail eventually disappears, legs grow, and the gills become lungs as well as eyes and a digestive system.

Caecilian (a legless, wormlike, tropical amphibian) males fertilize the female's eggs inside of her body. She then lays eggs that are guarded by the female of some species of caecilians. Salamanders also fertilize eggs in the female's body. In some species, such as the Japanese giant salamander, the male will guard the eggs until they are hatched.

The larvae of amphibians feed on algae, plant material, the larvae of insects, and even small animals. In turn, amphibians are the food of numerous birds, mammals, reptiles, and even other amphibians. Amphibians defend themselves against enemies with camouflage, hiding, and in the case of some species of frogs, with poison glands. All amphibians have a lateral line system of sensory organs along the sides of their bodies. The sensitive organs enable them to detect movement in water and to respond accordingly. The croaking of frogs and toads is a mating call. In contrast, salamanders and caecilians are voiceless. All amphibians have a digestive system for utilizing food that is taken in through the mouth. The Jacobson's organ, at the back of the mouth, is for smelling or tasting. The size of amphibians varies. Some are very tiny even as adults. The largest is the Japanese giant salamander, which grows to five feet (1.5 meters) in length.

Amphibians have declined in number in recent decades, partly due to human activities such as draining or polluting wetlands. A few species have become extinct. Other amphibian populations are endangered in remote areas because of climate change. The Golden Toad (*Bufo periglenes*), which is found in the cloud forests of Costa Rica, is being hurt by reduced moisture in the Costa Rican cloud forests. Other species of frogs and toads, as many as 55 in Costa Rica and Panama, are endangered. The reduction in the amount of waters has pushed adults into smaller pools, where they are more vulnerable to parasitic flies and fungi. The cloud forests in the Andes are also seeing reductions in amphibian populations.

The Japanese giant salamander is also an endangered amphibian. It lives in clear mountain streams of fast-flowing water at altitudes between roughly 980 to 3,300 thousand feet (300–1000 meters) on the islands of Honshu and Kyushu. Along with the Chinese giant salamander, these large salamanders have declined because of deforestation and damming of streams.

SEE ALSO: Cloud Forests; Wetland Mitigation; Wetlands.

BIBLIOGRAPHY. Doris M Cochran, *Living Amphibians of the World* (Doubleday, 1961); William Edward Duellman and Linda Trueb, *Biology of Amphibians* (McGraw Hill, 1986); Robert Hofrichter, *Amphibians: The World of Frogs, Toads, Salamanders and Newts* (Firefly Books, 2000); William Souder, *A Plague of Frogs: The Horrifying True Story* (Hyperion, 2000).

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Analytical Chemistry

ANALYTICAL CHEMISTRY IS the branch of chemistry that uses specialized techniques to identify and understand the structure and function of chemical substances. These techniques include crystallography, spectroscopy, electrochemistry, and chromatography. Analysis depends on sound laboratory practices and the application of the scientific method for obtaining data from repeated, robustly designed experiments and then using statistical methods to determine probability to the distributions of results. Various competencies are required, therefore, and the cost of not only training suitable personnel but providing appropriate premises and equipment can be high. The practitioners of forensics, for example, have made great strides in identifying such issues as causes and times of death, evidence of poisoning, and locating microscopic scraps of evidence to tie to perpetrators. However, these activities are both labor- and capital-intensive, and so there is considerable pressure on the limited funds possible to disburse on them.

New, or comparatively new, techniques used in analytical chemistry include the consideration of the substance's interaction with gravity (gravimetric analysis), heat (calorimetry), electrical fields (electrochemical analysis), or electric and magnetic fields (mass spectrometry). Physical methods of analysis include separation processes such as chromatography, which passes liquid substances through a suitable medium with the aid of which individual components of a mixture may be identified. The enormous increases in computational power have been of great assistance in facilitating many forms of analysis. New generations of chemistry are likely to focus on biochemical substances and the processes of life and how to improve it. Researchers who can materially contribute to improving life chances and who are able to benefit from capturing intellectual property rights may obtain large profits.

Analytical chemistry and its various techniques have become increasingly important in identifying particular substances in the environment and in determining the interaction between naturally occurring substances and those introduced into the environment. Innovative techniques allied with robotics and related technologies make it possible for accurate analysis in circumstances hostile to human life to a much greater degree than in the past. This form of chemistry has helped to determine safe tolerance levels of chemical substances in the ground or atmosphere, safety of new additives in foodstuffs and drugs, culpability for dumping pollutants, and so forth. However, many of these areas are very complex and subject to lobbying from commercial interests, who may have powerful incentives for attempting to influence regulations or testing criteria.

SEE ALSO: Food and Drug Administration (U.S.); Green Chemistry; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Kris Christen, "Robot Chemists Push Aside Decades-Old Water Quality Analysis Tool," *Environmental Science and Technology* (v.40, February 2006); Gary D. Christian, *Analytical Chemistry* (John Wiley & Sons, 2003).

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Andes Mountains

THE ANDES MOUNTAINS are one of the greatest mountain ranges on earth, superseded in height only by the Himalayas. They form an enormous meteorological barrier along the spine of South America, running along the western side of the continent from Columbia south to Chile for over 4,000 miles (over 7,000 kilometers).

The Andres have over 50 mountains that exceed 20,000 feet (6,1000 meters) in height; only the Himalayas are taller. Mount Aconcagua, Argentina, only 65 miles west of Santiago, Chile at 22,831 feet (6,959 meters), is the tallest mountain in the Western Hemisphere.

Passes across the Andres usually are very high. At its widest in the Bolivian section it is over 300 miles (500 kilometers) across from east to west.

From the peaks of the Andes flow the Amazon, Orinoco, and Parana-La Plata Rivers. The Pacific side is arid in the central section range. However, the eastern side quickly descends into jungles or swamps.

There are volcanoes in three areas, which have contributed to the formation of the range. Much of the range is composed of faulted and folded rock.

Throughout much of the Andes, glaciation has shaped the mountains and valleys. There many fiords and several active glaciers in the south on the Pacific side. Glaciers were once active in other areas, even in the high elevations at the equator.

The Andes do not form a single mountain chain, but are made up of a number of ranges that are loosely joined together. In the northern section in Columbia, the Cordillera Occidental, Cordillera Central, and the Cordillera Oriental are the major ranges of the Andes.

The Cordillera Oriental runs northward as the Sierra de Perija y Motilones and the Sierra Nevade de Merida, which extend into Venezuela and on to Trinidad. Geologists disagree whether the highlands of Venezuela and Trinidad are part of the Andes. The Cordillera Central and Occidental extend into Ecuador, where a rift valley bordered by volcanoes forms a series of high basins.

The central section of the Andes extends through southern Ecuador to northern Chile and Argentina. The area is a vast highland region with many plateaus and basins formed by separate mountain ranges and volcanoes. There are eastern and western cordilleras that rim the basins and plateaus in between. The Cordillera de los Angles on the west is a chain of volcanoes, most of which are extinct.

In Bolivia lies Lake Titicaca in the Altiplano. Its high basins are above 12,000 feet (3,700 meters), and is the home of numerous Indians. Southward is the Puna de Atacma, much of which is in Argentina. The area is arid, cold, and windswept.

The southern section of the Andes runs from 27 degrees south to Tierra del Fuego. This section has some of the highest peaks, with passes at the 10,000- to 15,000-foot level (3,000 to 4,600 meters). South of 39 degrees south is a vast lake district divided between Argentina and Chile. Shaped by glacial action, the Chilean area has twelve major lakes and many smaller ones with volcanoes and primeval forests. The Argentina lake district is actively used for recreation.

The climate of the Andes is naturally cold in the higher elevations. However, it also varies in response to geographic location and moisture brought by the winds. The eastern side quickly descends into jungles in the north and the Grand Chaco in the central region, but into the arid Patagonian region in the south.

Minerals abound in the Andes. Gold and silver have long been mined in the central areas of Peru and Bolivia. Copper is a major resource in the deserts of northern Chile, while Ecuador and Columbia have produced many of the world's most beautiful emeralds.

The Spanish brought a number of new crops along with cattle. However, the llama, alpaca, vicuña, and chinchillas have been major wool producers that can handle the cold altitudes. The potato was extensively cultivated in the central Andes before the rise of the Inca empire. Vegetation is varied with many alpine plants. Coca leaf, now an illegal resource for the international drug market in cocaine, has long been used by the Indians for relief from the cold and altitude.

BIBIOGRAPHY. Thomas Harper Goodspeed, *Plant Hunters in the Andes* (University of California Press, 1961); Stefan Hastenrath, *Glaciation of the Ecuadorian Andes* (Taylor & Frances 1981); Simon Lamb, *Devil in the Mountain: A Search for the Origins of the Andes* (Princeton University Press, 2006); Tony Morrison, *The Andes* (Time-Life Books, 1975).

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Angola

BETWEEN 1975 AND 2002, the Republic of Angola was involved in a civil war that began immediately after independence from Portugal. Estimates place the human cost of the war at 1.5 million lives, and an additional 4 million people were displaced. Much of the infrastructure was destroyed during the war, and Angola's attempts to rebuild it with the assistance of a $2 billion line of credit from China have been hampered by pervasive government corruption. Angola is rich in natural resources that include petroleum, diamonds, iron ore, phosphates, copper, feldspar, gold, bauxite, and uranium. The oil industry contributes around 45 percent of the Gross Domestic Product and over 50 percent of export revenue.

With a per capita income of $3,200, Angola ranks 158th in income among nations of the world. Despite a real growth rate of 19.1 percent, 70 percent of Angolans live in poverty, and 40 percent are undernourished. Approximately 85 percent of the workforce is engaged in agriculture, chiefly at the subsistence level. Unemployment and underemployment may affect as many as 50 percent of Angolans. Most social indicators point to a threatened population: a population growth rate of 1.9 percent, an annual death rate of 25.9 deaths per 1,000/population, a life expectancy of 38.43 years, an infant mortality rate of 191.19 deaths per 1,000 live births, a fertility rate of 6.8 children per female, and a literacy rate of 66.8 percent (53.8 percent for females). The United Nations Development Program's Human Development Reports rank Angola 160 of 232 countries on overall quality-of-life issues.

The excessive HIV/AIDS rate of 3.9 percent is largly responsible for high death rates. At least 21,000 people have died from this disease, and an estimated 240,000 are living with it. Because only half the population have access to safe drinking water, and less than one-third have access to improved sanitation, Angolans have a very high risk of contracting food and waterborne diseases, which include typhoid fever and hepatitis A. Angolans are also at high risk for other severe and potentially deadly diseases, including meningococcal meningitis, a bacterial infection; and schistosomiasis, which is contracted from infected water. Some locations carry additional high risks of contracting vector-borne diseases, including malaria and African sleeping sickness (trypanosomiasis).

ENVIRONMENTAL CHALLENGES

Bordering on the South Atlantic Ocean in southern Africa, Angola has 1,600 kilometers of coastline but no inland sources of water. The narrow coastal plain of Angola gives way to the vast interior plateau. Elevations vary from sea level at the Atlantic to 2,620 meters at Morro de Moco. Along the coast, the climate is semiarid. However, northern Angola's dry season, which lasts from May to October, is followed by a five-month hot, rainy season that produces periodic flooding on the plateau.

Environmental problems in Angola are caused both by demands of a large population (over 11 million) coupled with historic underdevelopment, exploitation of natural resources by both domestic and foreign firms, and long periods of war. Overuse of pasture land has caused soil erosion. The rain forest is being depleted at a rate of 124,800 hectares annually in response to the demand for tropical lumber and the use of valuable wood for fuel and cooking. In turn, deforestation and hunting have led to great loss of biodiversity. Desertification and soil erosion contribute to water pollution and the siltation of rivers and dams. A study by Yale scientists in 2006 ranked Angola fifth from the bottom among 132 countries in environmental performance, well below the comparable income and geographic groups. The lowest ranking was predictably assigned in the category of environmental health.

Over half of Angola's land area is forested, but the government has protected only 6.8 percent of lands, chiefly due to a lack of funds. Angola's rainforest is home to 1,546 species of amphibians, birds, mammals, and reptiles. Over 4 percent of these are endemic to Angola. Of 276 known mammal species, 19 are endangered, as are 15 of 265 known bird species. During the civil war in Angola, the National Union for the Total Independence of Angola (UNITA) forces purchased arms from South Africa with ivory and teak and used many large animals for bush meat. By 1990, 90 percent of the large mammal population had vanished.

The Angolan government created the Ministry for Urbanization and Environment and charged it with promoting sustainable development and conservation as established by the General Environment Law of 1998. The chief priorities of Angolan environmental policy are limiting deforestation, decreasing levels of soil erosion and desertification, developing alternative energy sources, preventing further loss of ecosystems and habitats, and improving access to safe drinking water and sanitation. The government is also dealing with the aftermath of oil spills, including one in the Cabinda province in June 2002 that led to a fine of $2 million. Angola has ratified the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Law of the Sea, Ozone Layer Protection, and Ship Pollution.

SEE ALSO: Deforestation; Poverty; Soil Erosion; Subsistence.

BIBLIOGRAPHY. CIA, "Angola," *World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); UNDP, "Human Development Report: Angola," http://hdr.undp.org (cited May 2006); World Bank, "Angola," www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Animal Rights

IN 1789, JEREMY Bentham famously asked, in relation to animals: "The question is not, can they reason, nor, can they talk, but, can they suffer?" Ovid proclaimed in the Metamorphoses, "Oh, what a wicked thing it is … to fatten on the body of another, for one live creature to continue living, through one live creature's death." John Salt, a philosopher of the early 20th century, first used the term *animal rights* and propounded many of its core contemporary ideological arguments.

It was not until the 1970s that animal rights crystallized as a political movement based around an ideological belief that animals have moral rights. Animal rights proponents differ from animal welfare advocates, such as the Royal Society for the Prevention of Cruelty to Animals, which address animal suffering and cruelty, but does not ascribe moral rights to animals.

Animal rights advocates essentially reject the idea that animals are capital goods or property that exist simply for the benefit of humans. Rather, animal rights advocates argue that no ethical basis exists for elevating membership of one particular species over another. Animal rights proponents argue that issues surrounding animal cruelty, animal experimentation, and animal rights to life deserve moral consideration. This must not to be confused with the assumption that animal rights advocates argue that animals are all equal, such as a biocentrist would; rather, that the moral rights of animals must be factored into decision making.

For proponents of animal rights, the capacity of animals to suffer is an essential factor in determining whether animals have interests. Animal rights advocate Peter Singer notes, "Pain is bad…humans are not the only creatures to feel pain or suffering, therefore, when humans take life, the rights of the creature being killed to decide its own fate needs consideration." Some philosophers, such as Arthur Schopenhauer, argue that compassion for animals is in fact related to goodness in human beings, and thus cruelty toward animals indicates a correlative lack of goodness and compassion in humans.

Similarly, the notion of sentience is used as a further basis by some animals rights thinkers to argue for animal liberation or moral consideration in relation to human use of that species. In this case, only species that are considered to possess sentience also possess rights and interests. The notion of sentience is a major factor in ethical debates over whale or seal hunting. Embracing humanity's responsibilities toward animals is sometimes called specieism.

Animal rights arguments are used to justify opposition to animal vivisection, cruelty, sport hunting, medical experimentation, and the use of animal products in cosmetics and clothing, resulting in the proliferation of animal-rights organizations.

ORGANIZATIONS AND LAWS

Some organizations target the ethical treatment and welfare of animals, including the People for Ethical Treatment of Animals (PETA), International Fund for Animal Welfare, Citizens to End Animal Suffering and Exploitation, and the Animal Liberation Network (ALN).

The environmental organization Greenpeace focuses on specific animal groups, such as marine life preservation, while organizations such as the National Alliance for Animal Legislation focus on achieving animal rights through legislative reform.

The International Association against Painful Experiments on Animals and the International League of Doctors for the Abolition of Vivisection focus on the experimentation of animals in the pharmaceutical industry. Often, organizations focus on specific species, including Bat Conservation International and the Beaver Defenders.

The animal rights movement is often subject to strong criticism. Those with a more utilitarian approach argue that the benefits derived from the use of animals, whether for medical experimentation or food, outweigh the negatives. Moreover, it is often difficult for proponents of animal rights to present clear-cut and straightforward positions on which to base their ethical and philosophical decisions.

The notion of animal rights per se has also been critiqued as primarily Eurocentric and thus a culturally biased notion. Indigenous peoples often take a very different view of their relationship to animals. While Western cultural mores may deem that hunting species such as green turtles, dugongs, whales, seals, and polar bears is cruel and unnecessary, even if conducted for subsistence purposes, indigenous peoples see hunting as a manifestation of an important cultural relationship to the species being hunted. The Inuit conceptualize the killing of whales as an essential manifestation of the respect and trust relationship between themselves and the animals. Similarly, indigenous peoples of Australia argue that their traditional butchering techniques of green turtles and dugongs is essential to maintaining the sacredness and spirituality of the hunt.

Today, many countries have laws against animal cruelty. However, some animal rights groups, such as those active in the United Kingdom and the United States, continue to lobby governments to obtain stronger legislative protection for animals. In 1992, the Swiss government legislated to recognize animals as beings, not things; as did Germany in 2002, when the Bundestag made specific alterations to the constitution to enshrine protection for animals.

SEE ALSO: Animals; Anthropocentrism; Biocentrism; Greenpeace; Hunting; Indigenous Peoples; Meat; Vegetarianism.

BIBLIOGRAPHY. J. Bentham, *The Principles of Morals and Legislation* (1798); Melissa Nursey-Bray, "Fishing for Answers; The Incorporation of Indigenous Fisheries Knowledge in Northern Australia, Developing Cross Cultural Literacy," in *Putting Fishers' Knowledge to Work: Conference Proceedings August 27–30, Fisheries* (University of British Columbia, 2003); H. Salt, *Animals' Rights: Considered in Relation to Social Progress,* (Macmillan, 1894); P. Singer, ed. *In Defense of Animals* (Basil Blackwell, 1985).

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Animals

FROM A BIOLOGICAL point of view, animals are living entities that are equipped with nervous systems and sensory organs that render them capable of detecting and rapidly responding to stimuli. They also differ from plants in that animals require organic matter as nourishment, whereas plants have the ability to transform inorganic molecules directly into food. While biology provides insight into the physiology and behavior of animals, social scientists study the many meanings that animals have in different societies as well as the role that animals play in human social relations. There isn't a single society in the world in which animals do not occupy a critically important place. Although in many societies—including those of the Western world—the conventional use of the word *animal* normally refers to nonhuman animals, it is important to remember that humans, too, are animals from a biological point of view. One of the social sciences' most enthralling contributions has been to study how different societies define such categories and the effects that they produce.

Often, pets enter highly important human social relations, even attaining the status of family member.

SOCIOLOGY AND ANIMAL STUDIES

Nonhuman animals, as most of nature, did not become a main research interest for social scientists until the second half of the 20th century for many reasons. First, in an effort toward emancipation, early social scientists in the 19th century attempted to distance themselves from other existing sciences—especially from biology and from psychology. One way to achieve this distance was to focus on studying phenomena that were not already being studied. Thus, the founders of the first social science—the sociologists—focused on "social facts" directly pertaining to human societies and cultures.

A second reason social scientists avoided the study of nonhuman animals and nature is that when sociology was founded, certain biological theories had been wrongfully used to explain human behavior, societies, and cultures. These theories had attempted to explain variability between societies, cultures, and ethnic groups as resulting from fundamental biological differences between humans. They proposed that general biological conditions determined human behavior and even the historical development of societies. The problem is that these apparent differences between peoples were the outcome of socially preconceived ideas rather than a reflection of actual biological facts. This bias is now known as biological determinism. It was one of the main sources of the numerous forms of racism that dominated many European and North American circles well into the 20th century. Given this historical legacy, sociologists for many generations were weary of studying topics that might seem to entail the risk of fallaciously incorporating knowledge from the natural sciences. This includes the study of animals, which was formerly the object of zoology and biology.

The third reason why most sociologists in particular ignored animals and nature in their studies pertains to how sociology conceptualized its main area of enquiry in regards to its closely related discipline of anthropology. Both disciplines were created to study societies and cultures. However, although the following division of labor no longer holds true, sociologists turned their attention to Western urban societies and anthropologists focused primarily non-Western and/or rural and maritime cultures. Therefore, anthropologists often studied societies in which people had close relations with animals and nature.

Sociologists, on the other hand, were more interested in studying human relations within urban settings, in which a smaller number of people interacted directly with nonhuman animals or in which animals did not seem to play an important role in people's lives. This assumption was incorrect. Animals do occupy a crucial space in urban industrial societies as companion pets, lifeguards, or psychological therapists; in research laboratories, where medical and cosmetic products for humans are tested; and as the food that people consume. Sociologists are now interested in studying all of these roles that animals have.

Finally, sociologists have traditionally been reluctant to study animals because one of the main premises in sociology has been that only humans are capable of verbally articulating abstract ideas and achieving self-conscious understanding of one another. More recently, some social scientists have argued that even though animals are not capable of speaking, they can still communicate with humans at different levels. These sociologists are working toward developing a theoretical and methodological framework that will allow them to account for the peculiarities of human–animal communication.

Social scientists do not study animals in and of themselves. They investigate animals only insofar as animals enter the world of human societies and thus acquire social and cultural significance. There are many criteria used to categorize and describe social scientific approaches to animals. For the sake of simplicity, it is possible to divide the sociology and anthropology of animals into the following themes.

First, there is the study of animals as social constructs, whereby social scientists explore how different societies attribute symbolic or cultural meanings to animals. This includes research on how animals are represented, how animals become part-and-parcel of human relations, and how humans define themselves in connection to animals. Second, there is the study of animals as social products and as participants in societies. This entails, for example, research on the social history of animals, as well as the role of discourses and ideology in the establishment of power relations between humans and animals. Third, there is an emerging area of sociological enquiry that focuses on the new ethical and philosophical issues that recent developments in science bring forth. It is definitely worth looking at these approaches in greater detail in order to understand how they shed light on societal-animal relations.

ANIMALS AS SOCIAL CONSTRUCTS

Social scientists have repeatedly proven that at least for human beings, the meaning of things emerges as an outcome of social interaction, that is, as things acquire a social life. This approach is known as symbolic interactionalism. For example, an cup used in one society for holding a drink may be seen in another society as a sacred object.

The same is true of animals. Depending on social or historical context, the same animal can be seen as food, as a pet, as taboo, or even as a source of prestige. Such is the case of the pig. For example, suckling pigs are best known in Portugal as a culinary delicacy, while in German urban centers, keeping pigs as household pets has become a trend. In Jewish societies, there are strict taboos prohibiting the ingestion of pork, while in Papua New Guinea, pigs are collected and traded as a sign of prestige. The approach to dogs is another way to understand this point. In most Western societies, dogs are seen as pets. Often, they enter highly important human social relations and are even attributed the status of family member. Many psychological studies have shown that grieving the death of a pet dog can be as painful and stressful as grieving the loss of a human family member. On the other hand, there are many societies where dogs are perceived as working animals and live in completely separate quarters from their owner, such as hunting dogs in the United Kingdom or sheepdogs in the Swiss Alps.

All of the above means that in addition to being living biological entities, when animals are brought into human societies, they also become socially constructed beings. Animals must be understood not only from a biological and behavioral perspective, but also in terms of how they are conceptualized in a culture. The meanings that are attributed to animals are often ambiguous; not only can the same animal vary from one society to another, it frequently falls between categories within one society.

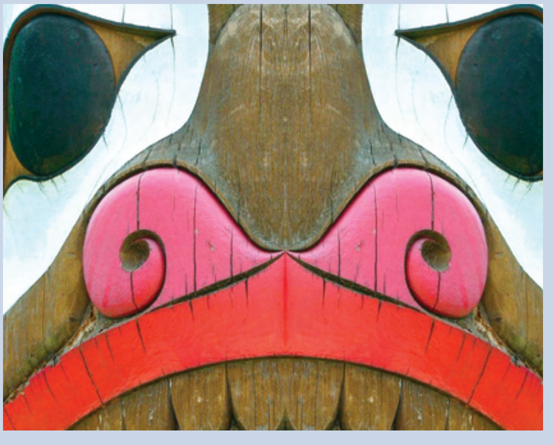
The distinction between wild and domesticated animals is a case in point, especially when it comes to zoo animals. When animals like leopards and African elephants are displayed in a zoo, they are usually presented as wild animals. Still, zoo leopards do not hunt for their food as they would in their original habitat, nor do elephants migrate across vast territories as they would in Africa. In fact, zoo animals are managed on a carefully studied schedule and environment. Usually, they even require human intervention to mate and reproduce. These animals are certainly not wild, but they are hardly domesticated, either. They are somewhere in between.

On another level, this example also entails an ambiguous definition of the relation between the notion of natural and nonnatural animal environments. It is assumed that the animal's native environments was a natural environment, which contrasts starkly with the human-made environment of the zoo. However, these distinctions are also the result of socially constructed assumptions. In many cases the so-called natural environments had been transformed long ago by other human beings who historically occupied those spaces. In turn, most contemporary zoos try to mimic the ecosystems from which the zoo animals were brought; in some cases, zoos are the closest thing to animal ecosystems that have been destroyed.

Totemic Relationships

Anthropologists have studied many cultures where a person's identity is acquired through their special relation to an animal. For instance, in clan societies, each is identified as having a unique relation to a particular animal species. These relations between humans and animals are known as totemic relations, and they are often represented symbolically in objects that are called totems. In the case where humans develop totemic relations with animals, people are believed to carry within them the spiritual characteristics of these animals. Examples include the intelligence that is attributed to coyotes, the ingenuity of foxes, and the nobility and wisdom of elks.

From a cultural point of view, non-Western societies are generally less prone to conceptualize human identity and human nature in opposition to that of animals. Examples are societies where people hunt, such as the Cree of northern Canada, who argue that unless a hunter can be partly like a deer and communicate with the deer on its own terms, killing the animal is immoral and very likely to fail. Although this way of thinking is more predominant in non-Western societies, it is not exclusive to them. Sports teams, such as the Toronto-based Raptors basketball team and the Chicago Bulls, brandish images of their mascot to indicate the teams' identification with their mascot animals' extreme agility and aggressiveness.



Finally, animals in Western societies are sometimes considered the opposite of what it means to be human. In other words, animals are portrayed as humanity's symmetrical "other"—as if humans were not animals themselves. Humans thus develop their own sense of identity by establishing contrasts that they attribute to animals. There are abundant examples: "You're an animal," "You eat like a pig," "You're chicken," "You dog!" As harmless as they may seem, these distinctions produce serious effects in terms of how humans treat animals, turn them into commercial goods, or legitimize their position of power and control over animals. It is important to understand how these distinctions developed in the Western world, and to know the role that these contrasts play in the development of social and cultural notions of identity among humans.

With the Renaissance and the Enlightenment periods, scientific thinking increasingly began to substitute for religious thought as the means to understand the world. In this context, rationality and objectivity became the two central tenets of the new emerging order. The most important scholars of this period thought in dualistic terms, or "either/or" through mutually exclusive categories. Consequently, they believed that in order to be rational one must reject all emotions, and that in order to be objective, scientists must rely on special tools and instruments that explain the world as it is beyond our senses. The French philosopher René Descartes was a major proponent of this new line of reasoning. He proposed that the interference of the human senses and emotions distort humans' view of the world and impede them from knowing the truth. In time, modern science's primary mandates became the removal of emotion and sensory information from scientific endeavor so that it would not interfere with the full development of human rationality and objectivity.

Descartes and many of his contemporaries believed that the capability for rationality and objectivity was uniquely human, and that this capability meant that humans were unquestionably superior to all other animals. As feminists have pointed out, this prejudice also carried over into arbitrarily defined categories used to create a hierarchy among human beings. Western white males were seen as the most rational of all human beings, and thus superior to women and other humans—with animals at the very bottom of this scale. Recent work by philosophers, critical theorists, biologists, and neurologists has shown that these Cartesian premises are not only unfounded, but they promote serious injustices and abuses. A prime example of these contributions is the work of Antonio Damasio, an American neurologist, who has proven that rational thought is actually not possible if a person's brain is affected in areas allotted to emotion. In fact, he discovered that emotion enables rational thought.

Within the framework of Cartesian thinking, animals came to symbolize all that humans were not supposed to be. Animals were said to operate on the basis of instinct, when humans were trying to achieve unprecedented levels of rationality. Controlling animal-like urges and needs became a central preoccupation in most European societies. Linked to this way of thinking, the Bible was successively interpreted toward reinforcing the notion that there is a great divide separating humans from nature, and from animals.

The curriculum taught in schools during the past few centuries has also strengthened this worldview. Slowly, these ideas permeated almost all areas of Western thought and action. It has been only in the late 20th century and early 21st century that Western societies have begun to again recognize that humans need to rethink their existential links to all other animals. Some scholars criticize previously dualistic assumptions that separate humans from all other animals. Consequently, they also critique the notion that humans are superior to other animals and nature, and that humans have the legitimate right to control the lives of animals without any ethical considerations. The word *specieism* is now entering the vocabulary of many people who are critical of these resulting prejudices.

Humanity has inherited a complex legacy of ideas and assumptions about the relationship between humans and animals. A plethora of concepts circulating in most contemporary societies simultaneously presumes that humans are completely separate and superior in relation to all other animals, *and* that animals and humans are ontologically linked at the same existential level, thus mutually affecting one another. This seeming contradiction reflects ancient philosophical debates. At least since the time of the first Greek philosophers—Socrates, Plato, Aristotle—Western thinkers have been faced with the philosophical challenges that animals pose to humans. This is because while humans are animals like any other, at the same time, they are the only animal known to articulate thoughts in an abstract, symbolic language that can be written and communicated through generations. The Western world's most famous philosophers have produced numerous text on the meaning of being human in relation to being animal. Other participants in these discussions include Martin Heidegger, Ludwig Wittgenstein, Friedrich Nietzsche, Edmund Husserl, Jürgen Habermas, Maurice Merleau-Ponty, Jacques Derrida, and Gregory Bateson. They have pondered the moral status of animals, the extent to which human language truly separates humans from all other types of animals, the ethical basis and legitimacy for human dominance over animals, and also—in the case of Bateson—whether our failure to recognize that we are part of an interconnected, living system will eventually lead to our demise.

One of the current challenges in the social sciences is to understand and represent animals in a way that is closer to their own perceived realities. This is sometimes called an eco-centric or animal-centric perspective. The anthropologist Annabelle Sabloff has proposed that one possible strategy is for humans to develop a new language of metaphors for revealing values and logics that are not human. This would entail a search for new metaphors that would reflect the changing nature of human–animal relations from one of domination to one of simultaneous acknowledgement and mutual respect. Other authors, such as Erica Fudge, argue that before this can happen, humans will have to realize the many contradictory—and often cruel—ways in which humans perceive and relate to animals.

Research on the social history of animals, as well as discourses and ideology on animals, will play a key role in shedding light on these debates.

ANIMALS AS SOCIAL PRODUCTS

Animals also enter human societies as commodities. From this perspective, animals are studied as material objects in the form of goods that are produced, bought, and sold within societies. There are social, scientific approaches that study the relationship between transforming animals into material commercial products and the histories of the ideologies and practices of different societies. Their proponents

Anthroprocentrism

The fact that animals are imbued with many layers of social meaning raises interesting philosophical challenges in regards to humans representing animals. While the tendency to create a dualistic divide between humans and animals can lead to "specieism" and its related abuses, sometimes an excessive effort to focus on human-animal similarities can be equally unproductive. Such is the case when people project human qualities onto animals, which portrays animals as possessing characteristics and motivations that are typically human. The process of understanding animals through the projection of human qualities, emotions, and motivations onto animals is called anthropocentrism.

An example occurs in the context of whale watching. Tourists are delighted when dolphins approach their boat and seemingly engage with humans in play. Dolphins jump beside the boat, moving close enough at times to stare into the eyes of the humans. Assuming that this behavior is motivated by a desire to play—or even to communicate—with human beings is a projection of human-centered motivations onto these cetaceans. Marine biologists have noted that people are arriving at these conclusions without much information about what is actually going on. In a great number of cases identifying this type of cetacean behavior, it was alpha male dolphins who swam near the boats, getting close enough to "check things out." Normally, there is a much larger pod of juvenile dolphins as well as pregnant, nursing and junior dolphins nearby, and the alpha males are engaging with the boats to determine any threat as well as warn the people on the boat that they are there to defend their pod if necessary.

argue that the varied range of past and present societies is a direct reflection of different social arrangements between human beings to produce the goods they need. Since these theories explain societies as the result of the relation between such material arrangements and these societies' worldviews, the analytical model that they propose is called historical materialism. It is heavily influenced by the work of Karl Marx and Friedrich Engels.

Basically, followers of Marx contend that the basis of the social structure of any given society derives from what is produced, how it is produced, and how this is exchanged. For instance, the structure of a hunter-gatherer society is directly related to the acquisition and exchange of goods that are openly available to all members of the society. No one owns the land where the society's members hunt, and no one owns the tree from which fruits are collected. Within these settings, when there is a concept of ownership, it refers to community ownership. Such areas are known as commons. Having access to the goods is dependent on one's hunting skills and ecological knowledge rather than on owning the resources. However, hunting is a very demanding and precarious activity; according to a historical materialist perspective, members of hunter-gatherer societies tend to cooperate in order to cope with these challenges. Some of its members focus on gathering fruits and greens, which they share with hunters who, in turn, reciprocate when their hunting efforts are successful. Some historical materialists also argue that males and females cooperate in taking on different tasks so that the women can stay in the community and take care of children while men travel the long distances required by hunting. The major point of historical materialism is that there is a relation between the social arrangements that develop toward the satisfaction of material needs and the worldview of societies.

In addition, historical materialists have shown that social class relations emerge from the distinction between owning animals and having access to them. When applied to different societies, this analytical model shows how even more complex divisions of labor lead to the structuring of societies and to the development of related ideologies. More complex forms of divisions of labor often lead to the emergence of classes when certain groups of individuals gain control over resources or means of production. For example, when animals were domesticated and land was turned into private property, the new class of landowners could decide who had access or not to the animals and means to produce agricultural foods, as well as for what price. Obviously, those in control of the means of production are in a much more powerful position to make decisions about their communities' histories.

As with the hunter-gatherers, the class structure of agrarian societies was also reflected in worldviews and cultural values. For example, in medieval Europe aristocrats promoted the idea that they had inherited a God-given right to own land as a way to maintain the extremely unequal distribution of land between aristocrats and peasants. In controlling most of the land—peasants normally only possessed miniscule marginal gardens for basic crops—the aristocrats also controlled access to animal husbandry. In so doing, they ultimately determined who could consume animal proteins and, again, at what cost.

Even though Karl Marx attributed an important space in his work to discussions of nature and of animals, his interest is not in these subjects *per se*, but on how humans come together to use them as resources. It is humans who are at the center of his writings. For Marx, human beings are very different from all other animals because humans possess creativity and consciousness and are capable of transforming themselves in ways that they envision—thus making their own histories and destinies. Insofar as humans are capable of imagining a future and of taking the actions that make this future come to fruition, they are imbued with agency. Marx argues that even though people are often subjugated and exploited by other more powerful humans, they possess the capability to become aware of their condition of being oppressed and engage in revolutionary action to overcome this state of affairs. For a long time the pervasiveness of Marx's arguments led many scholars to assume that because animals are not capable of conscious awareness, and not capable of planning actions toward an idealized future, they lacked agency.

More recently, sociologists and philosophers have been rethinking this premise. They search for ways to show that even though animals do not display signs of being capable of the high levels of conscious awareness displayed by humans, they too can potentially exercise their will to produce the outcomes that they desire. Animal agency may be different from that of humans, but it this does not mean that it does not exist. What is missing is a better sociological and philosophical approach to the investigation of animal agency.

Many scholars have been tackling this issue since the emergence of postmodernism in the 1960s. They began by critically questioning and challenging the dichotomous thinking, which presents humans and animals as dual opposites, that marked Western though since the times of Descartes. Postmodern thinkers were the first to point out that these distinctions are socially constructed, and that they produce major effects. They are directly related to how animals are treated in any given society and the extent to which they are abused and exploited. Societies that see animals as bearing absolutely no common ground with humans tend to legitimize the most extreme forms of inhumane treatment of animals. In turn, societies that conceptualize humans as also being animals tend to be more engaged in practices that secure a minimal level of respect and proper conduct towards nonhuman animals. The most current debates center on cultural ideas and discourses about animals, the status of animals in relation to human beings, and issues of ethics in human–animal interaction.

NEW ANIMALS, NEW ETHICAL ISSUES

Finally, a new kind of animal may soon live among us as the result of the most advanced human technological innovations. These are new animals that are created in laboratories out of the transferal of genes from one species to another. These are animals that have been genetically modified such that they contain genes from species they could never reproduce with outside the lab context. In particular, there are now animals who carry a certain percentage of human genes. These are normally created so that their organs can be harvested for human use without the danger that the receiver of these organs will reject them upon transplant. These new animals will certainly play a very important role in future human societies and may potentially save many human lives. Their existence raises many philosophical, ontological, and ethical issues that have yet to be fully understood.

An examples of a totemic relationship includes the mix of intelligence and playfulness attributed to coyotes.

SEE ALSO: Animal Rights; Lab Animals; Vegetarianism; Zoos.

BIBLIOGRAPHY. Steve Baker, *Picturing the Beast: Animals, Identity, and Representations* (University of Illinois Press, 2001); Erica Fudge, *Animal* (Cromwell Press, 2002); Donna Haraway, *The Companion Species Manifesto: Dogs, People, and Significant Others* (Prickly Paradigm Press, 2003); Nigel Rothfelds, ed., *Representing Animals* (Indiana University Press, 2002); Annabelle Sabloff, *Reordering the Natural World: Humans and Animals in the City* (Toronto University Press, 2001); James Serpell, *In the Company of Animals: A Study of Human–Animal Relationships* (Cambridge University Press, 1986); Paul Shepard, *The Others: How Animals Made Us Human* (Island Press, 1996); Peter Singer, ed., *In Defense of Animals: The Second Wave* (Blackwell Press, 2006); H. Peter Steeves, ed., *Animal Others: On Ethics, Ontology, and Animal Life* (State of New York University Press, 1999); James Turner, *Reckoning with the Beast: Animals, Pain, and Humanity in the Victorian Mind* (John Hopkins University Press, 1980); Cary Wolfe, *Animal Rite: American Culture, the Discourse of Species* *and Posthumanist Theory* (Chicago University Press, 2003); Cary Wolfe, ed., *Zoontologies: The Question of the Animal* (University of Minnesota Press, 2003).

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Animism

THE WELL-KNOWN BRITISH anthropologist Edward B. Tylor defined *animism* in his classic 1871 book *Primitive Culture* as a belief in spiritual beings. He theorized that this was the ultimate basis of all of the religions of humankind. Animism derives from the Latin *anima,* which refers to spirit, soul, or life-force.

Animists believe that supernatural forces permeate and animate nature, including animals, plants, waters, rocks, and other environmental phenomena. Whether these forces are envisioned as personal or impersonal, they are thought to influence humans. Shamans and priests, part- and full-time ritual specialists, respectively, attempt to communicate with and thereby influence the spiritual realm.

Animism is by far the oldest religion of humanity as evidenced by Neanderthal burials and associated artifacts at Shanidar cave in northern Iraq, which archaeologists have dated to around 60,000 years ago. Pollen analysis of the plant remains over the graves indicates that these were from flowers of species known to currently grow in the region to have medicinal properties. The antiquity of other ancient religions, by contrast, extends back only a few thousand years.

By far the most widespread of all religions, animism is common in hunter-gatherer, fishing, farming, and pastoral societies throughout the world. Furthermore, it forms a substratum in the religion of many people who would identify themselves primarily with Buddhism, Christianity, Hinduism, Islam, or another so-called world religion. Moreover, not only does animism survive and thrive in the religious beliefs of a multitude of diverse cultures, it has also been revitalized in areas where it was long suppressed, such as Europe and North America, where it may be referred to as neopaganism.

Australian Aborigines believe that their kinship is directly connected to ancestral spirits in the biotic species and land forms of their environment, a phenomenon referred to as totemism. Uluru (Ayres Rock) is one of the most famous, sacred places in nature in Australia. Many people in Southeast Asia believe that spirits dwell in rice, trees, caves, and rivers as well as in various small shrines constructed near their community, home, or business. Traditional Hawaiians recognized supernatural power or *mana* in sharks, forest plants, rocks, volcanoes, tides, streams, wind, rainbows, and numerous other natural phenomena. Many related taboos, rituals, institutions, and practices helped manage and conserve their environment. In modern America, some individuals suspect that if a black cat crosses their path, it may cause bad luck. In short, the majority of the some 7,000 cultures in the world today believe in some kind of supernatural forces in nature.

In addition to its antiquity, universality, ubiquity, and vitality, animism is also significant because it is the original nature religion. Most indigenous societies that pursue animism are relatively sustainable ecologically. Indeed, many have flourished for centuries or even millennia in the same general area without causing irreversible resource depletion and environmental degradation to the ecosystems in their habitat. In such societies, nature is not merely a reality that provides economic and recreational resources, but it has inherent spirituality. Accordingly, nature deserves special respect and care, and, in some cases, reverence. Animists recognize the unity of nature, spirits, and humans as integral components of the web of life. The interrelationships and interdependencies within environmental systems are elemental principles of animism as well as of the Western science of ecology. The ecological resonance of animism is probably part of the reason for its persistence. It may also contribute toward the diminution or resolution of environmental problems and crises. Indeed, some environmentalists consider themselves to be neo-animists or eco-pagans.

SEE ALSO: Anthropology; Biocentrism; Indigenous Peoples; Sustainability.

BIBLIOGRAPHY. Edward Clodd, *Animism, the Seed of Religion* (Read Books, 2006); George William

Gilmore, *Animism or Thought Currents of Primitive Peoples* (Kessinger Publishing, 2004); Graham Harvey, *Animism: Respecting the Living World* (Columbia University Press, 2005).

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Antarctica

ANTARCTICA IS THE fifth largest of the world's seven continents. Its land mass is located at the South Pole and lies almost entirely inside of the Antarctic Circle. The South Pole, near the Queen Maud Mountains, at 90 degrees south, is also about the geographic center of the continent. Most of the Antarctic continent extends to the Antarctic Circle at 66 degrees 30 minutes north of the South Pole. The size of the continent of Antarctica is 5,400,000 million square miles (13,985,936 square kilometers.). Its land area combined with its ice cap makes it larger than either Australia or Europe. The ice cap that covers almost all of Antarctica is more than two miles (3.2 km.) thick in most places. The Atlantic, Pacific, and Indian Oceans surround the island continent of Antarctica. Some have called the ocean waters around the continent the Antarctic or Southern Ocean; however, the general scholarly opinion is that it does not have a true ocean. The Transantarctic Mountains separate the continent into the larger region of East Antarctica and the smaller region of West Antarctica. The Indian and South Atlantic Oceans surround the East Antarctica area. West Antarctica faces the Pacific Ocean.

The land in West Antarctica between the Transantarctic Mountains and the Marie Mountains is covered with a thick sheet of ice. If the ice cap were to melt, much of West Antarctica would turn into islands because the area is mostly below sea level. West Antarctica is part of the Pacific "ring of fire" and contains several active volcanoes. It was formed later than East Antarctica. Geological studies of East Antarctica have revealed that this area is composed of Precambrian shield. Other geological surveys have found small deposits of copper in the Antarctic Peninsula, coal beds in the Transantarctic Mountains, and traces of other minerals including gold, zinc, lead, iron, and manganese. The mountain ranges and volcanoes of West Antarctica contain the continent's highest elevation, reaching to a height of 16,864 feet (5,141 meters), on the Vinson Massif in the Ellsworth Mountains near the Antarctic Peninsula. The Antarctic Peninsula is an S-shaped range of mountains that is really an extension of the Andean Mountains. Islands in proximity to the peninsula include the South Shetland Island and Deception Island, which is also an active volcano.

The area of East Antarctica has a mountainous coastline with a rift

Mawson's Huts

Mawson's Huts are a collection of buildings located at Cape Denison, Commonwealth Bay in the Australian Antarctic Territory. They were built and then occupied by the Australasian Antarctic Expedition (A.A.E.) in 1911–14, which was led by the Australian geologist and explorer Sir Douglas Mawson (1882–1958) who had been the first person to reach the summit of Mt. Erebus.

The most famous building at this site, known as Mawson's Hut, was where the eighteen men of the A.A.E. main base party stayed. It had been prefabricated in Sydney and then shipped to Antarctica by the A.A.E. in 1912. Other huts include the magnetograph hut, which was used to calibrate variations in the south magnetic pole; and the transit hut, which was used as a makeshift astronomical observatory.

Mawson's huts are one of only six surviving collections of buildings from the early 1900s, and the Mawson's Huts Foundation was established to look after them. Between 1997 and 2005 it has carried out some repair work on these huts, in which there are still many relics of Mawson's time, including books and even tins of food from his expedition.

valley that cuts deep into the continent from the Indian Ocean to the Prince Charles Mountains. Glaciers move down the mountain valleys in Antarctica to the oceans. In the summertime, they drop or "calve" icebergs. Many of these will later be blown up into ice packs against the Antarctica landmass. Most of East Antarctica is a plateau covered with ice with a depth of greater than two miles. The average height of the plateau is 10,000 feet (3,000 meters). Sastrugi, which are ridges of ice and snow, are formed on the plateau by strong winds that can exceed 100 miles per hour. The climate of Antarctica is extremely cold and dry. The South Pole and its surrounding environment is a cold desert that receives only about two inches (five centimeters) of snow each year. The coasts of the continent are moist and receive up to 24 inches (61 centimeters) of snowfall each year. There are a few places in the Transantarctic Mountains and elsewhere where valleys are free of ice and snow. The winds sweep these valleys so fiercely that snow cannot accumulate.

Despite the fact that Antarctica has a cold desert climate, it contains so much ice that about 70 percent of the freshwater on earth is to be found there. Some engineers have explored the possibility of towing icebergs from Antarctica to desert regions of the world where they would be used for fresh water.

LIFE IN THE ICE

There are very few plants in Antarctica. In some lakes and on the continental edge, algae grow on snow at times, turning the areas into pink or green tinged snowfields. In other places, mosses and lichens cling to rocks despite the harsh environment. A tiny wingless midge (fly) survives on the Antarctic mainland. However, most insects are parasites such as lice, fleas, mites, and ticks found on seals or birds. While the Antarctic continent is a cold, virtually sterile desert, the waters surrounding the continent are teeming with life. Plankton and krill abound in the nutrient rich waters off the continent. Other sea animals include squid and various kinds of fish. These smaller life forms provide a rich diet for many species of whales, seals, and penguins.

Antarctica has several kinds of seals. In the 19th century, they were hunted for their fur. The southern elephant seal is the largest kind of seal in the world. Other seals include the Ross seal, Weddell seals, Crabeater seals, Antarctic fur seals, and Leopard seals. There are four kinds of penguins found in Antarctica. Unable to fly, penguins are excellent swimmers. The Emperor penguin is probably the most famous of all Antarctic wildlife. About four feet (1.2 meters) tall, they are known for their mutual care of the egg produced by a breeding pair. After laying the egg, the male Emperor penguin puts it onto his feet, where it is incubated. The most common penguin is the Adelie, which builds nests of pebbles on the beaches. Chinstrap penguins and Gentoo penguins inhabit the Antarctic islands and the Antarctic Peninsula. King penguins, macaroni penguins, and Rockhopper penguins nest in the islands north of Antarctica. In addition, there are over 40 species of flying birds that spend the summer in Antarctica, including cormorants, gulls, pirons, albatrosses, and terns.

Krill is the food of Blue whales, Fin whales, Humpback whales, Minke whales, Right whales and Sei whales. The Blue whale is rare, but is the largest animal that has ever lived. Other whales in Antarctic waters include Sperm, Southern Bottlenose, Southern Fourtooth, and Orcas (Killer). These whales eat fish and squid, while Orcas prey on seals, penguins, and other smaller whales. There are over 100 species of fish found in Antarctic waters. These include Antarctic cod, icefish, and plunderfish. In the 1800s, whalers and seal hunters killed great numbers of whales and seals, but they have since been protected by international agreements.

The only human settlements in Antarctica are scientific research stations. Some are used only in the summertime, while a few are occupied in the winter. No country exercises sovereignty over Antarctica. The United States has rejected a claim to the continent, but has reserved the right to do so because seven other countries have made claims. These are Argentina, Australia, Chile, France, Great Britain, New Zealand, and Norway. In 1959, 12 countries signed the Antarctica Treaty. The agreement and additional later agreements form the Antarctica Treaty System.

SEE ALSO: Climate, Arctic and Subarctic; Global Warming; Ice Core; Whales and Whaling.

BIBLIOGRAPHY. David G. Campbell, *Crystal Desert: Summers in Antarctica* (Houghton Mifflin Co., 2002); Scovazzi Francioni, *International Law for Antarctica* (Brill Academic Publishers, 1997); Mike Lucas, *Antarctica* (Artabras Publishers, 1999); David McGonigal, *Antarctica: The Blue Continent* (Firefly Books, Ltd., 2003); Tony Soper, *Antarctica: A Guide to the Wildlife* (Bradt Publications, 2005).

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Anthropocentrism

ANTHROPOCENTRISM, OR "human centeredness," has been a much-debated concept in environmental ethics and philosophy over the last few decades. It describes the belief that human concerns outweigh the needs of other species or that environmental preservation and conservation possess only instrumental value, meaning that no inherent demand for environmental protection exists beyond its potential to benefit human society. In opposition to such anthropocentric attitudes, early environmentalists such as John Muir and Aldo Leopold believed nature had intrinsic value, and they alternatively envisioned a biocentric ethics that would value the planetary biodiversity of flora and fauna equally with human civilization. Others have described the transition from anthropocentrism to a holistic ecocentrism, in which the totality of the ecosphere would have greater moral status than the part played by human society.

Elements of anthropocentrism can be discovered in many cultures. The philosophic origins of the idea in the West can be traced to Aristotle, who wrote in *Politics,* "Nature has made all things specifically for the sake of man." However, many place the origins of anthropocentric thinking in Judaeo-Christian biblical scripture that emphasizes the divine role given to human existence, as well as the importance of human dominion and stewardship over all other life on earth.

In a modern scientific context, the proto-ecologist Ernst Haeckel was one of the first to inveigh against theological anthropocentrism during the 19th century, critiquing it along with anthropomorphism and anthropolatrism, as an antiscientific form of anthropism that fallaciously opposes humanity to the natural order. In his view, which accords with scientific beliefs today, humanity should not be understood as either divinely created or the end product of a directed evolutionary lineage, but rather as a contingent member of ongoing biological and ecological processes that share similar evolutionary promises and risks with many other species.

Yet, it has been claimed that modern science itself is anthropocentric. Environmentalists such as those involved in the Deep Ecology and Ecofeminist movements have argued that the scientific revolution developed out of the anthropocentric ideas of Early Modern figures such as Francis Bacon and Rene Descartes and Enlightenment thinkers, who were concerned with the mastery and instrumentality of nature as well as with the perfectibility of nature by human intervention, respectively.

The historian Lynn White made a more radical critique that linked the environmental destructiveness of modern science and technology to a Western ideology rooted in Judaeo-Christian anthropocentrism in his highly influential 1960s essay, "The Historical Roots of Our Ecological Crisis." White felt that Christianity should be described as the most anthropocentric of any religion, and that it negatively affected Westerner's views of nature by ideologically legitimating exploitation of the environment and nonhuman animals. This provided the necessary conditions for the emergence of rapacious forms of science and technology that has resulted in the domination of the natural world.

White engendered a firestorm of criticism, however, and many have since argued that the Judeo-Christian tradition, when properly interpreted, offers a sound environmental ethic of stewardship. Ideas outlining human stewardship, it is claimed, are undeniably anthropocentric but do not result in granting moral license to be irresponsible with the environment. Rather, when humans act as stewards over divine creation, they are charged with its proper care and protection.

Types of anthropocentrism, then, may be outlined as "strong" and "weak." Strong anthropocentrism believes that humanity can rightfully do with nature as it wishes, while weak anthropocentrism believes that human control of nature comes with additional responsibilities to ensure that environmental uses are sustainable over the long term. In this respect, some environmental ethicists now point out that, whether based in religious or scientific views, anthropocentrism is not a major cause of environmental destruction per se, but rather its sweepingly strong and absolute forms are the most problematic.

As ecological crises continue to mount in the present day, however, the biocentric and ecocentric challenges to anthropomorphic attitudes and values have been widely adopted by a variety of environmental groups and Green political organizations. Those supporting biocentrism and ecocentrism argue that weak anthropocentrism amounts to a reformist position that is incapable of mounting a significant critique of mainstream practices, and that new ethics are required to defend nonhuman species, the environment, and society from the catastrophic overuse of nature as a resource. Anthropocentric philosophies are therefore controversial; while they have defenders within the environmental community, those who seek to radically transform Western tradition toward environmental sustainability often target them for blame.

SEE ALSO: Anthropology; Anthropomorphism; Deep Ecology; Ecofeminism; Human Nature.

BIBLIOGRAPHY. James Connelly and Graham Smith, *Politics and the Environment* (Routledge, 2002); Bill Devall and George Sessions, *Deep Ecology* (Peregrine Smith, 1985); Tim Hayward, *Political Theory and Ecological Values* (Palgrave, 1999); Val Plumwood, *Environmental Culture: The Ecological Crisis of Reason* (Routledge, 2002); Lynn White, "The Historical Roots of Our Ecological Crisis," *Science* (v.155, 1967).

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Anthropology

DERIVED FROM THE Greek *anthropos* (human) and *logia* (study), anthropology is the study of humans, past and present. Ideally, the perspective of anthropology is expansive, comparative, and holistic, tackling questions such as why people behave as they do and what accounts for human diversity. Two basic foci—cultural and biological variation—have preoccupied proto-anthropologists for millennia and continue to drive the discipline today. Anthropologist Eric Wolf described anthropology as "both the most scientific of the humanities and the most humanistic of the sciences."

DEVELOPMENT OF THE DISCIPLINE

During the 15th century, Europeans set sail in search of additional trade routes, and they encountered peoples and places, flora and fauna previously unknown to them. Developments in maritime technologies and the invention of the rifle aided European influence and imperial expansion, facilitating in myriad ways greater intercultural interactions as well as processes of acculturation (forcible culture change).

By the start of the 19th century, Europeans had traveled and collected vast amounts of information regarding different peoples and their environs, feeding speculations about "human nature" and "human society" on a global scale. Around this time, the word anthropologist came into use in the English language. Formalization of anthropology as an academic profession occurred in 1884, as Sir Edward Burnett Tylor accepted the first university position in anthropology as a University Reader at Oxford.

Ethnography, which refers to the written, photographic, and/or motion picture account of cultural anthropological fieldwork, and anthropology in general, were linked to imperialism and colonialism. The same European countries expanding their spheres of influence requested ethnographic data about colonized people in order to figure out how to manage them.

Some colonial era ethnographers, such as Evans-Pritchard, were renowned for their defense of indigenous ways of life, and still others actively critiqued the colonial enterprise (e.g., Franz Boas). However, not all of the so-called great colonial powers developed a discipline of anthropology—Portugal and Spain did not—and not only colonials collected anthropological data. Colonial administrators also relied heavily on accounts from missionaries, merchants, and other travelers.

The three major homes of academic anthropology today derived from 19th- and 20th-century hubs of imperial expansion. They are continental Europe, Britain, and the United States. Although of similar roots and some convergence, there have been differences in approaches among them. There are many and varied thinkers and movements that have contributed to the discipline of anthropology. For example, proto-anthropology can be traced back to Herodotus (5th century B.C.E.) and his detailed cultural descriptions; and contemporary anthropology can also be described as an outcome of the Age of Enlightenment and its varied attempts to methodically examine human beings through empirical research. Heavily influenced by natural history and the theory of evolution through natural selection, 19th-century anthropologists adopted the notion of "progress" to describe changes in human cultural practices over time.

Lewis Henry Morgan of the United States, fascinated with American Indians and cultural change, provided great contributions to kinship studies in the late 19th century. Drawing on his own fieldwork, other ethnographic accounts, and responses to questionnaires he had distributed to missionaries and travelers, Morgan embraced ethnology, the comparative study of human societies. Morgan's book *Ancient Society* (1877) codified the cultural evolutionist position in anthropology, proposing that some human societies had progressed more than others. This universalist and unilineal theory of human development drew from French philosopher Montesquieu and included three stages: savagery, barbarism, and civilization. The first two stages included subdivisions of lower, upper, and middle; new inventions marked transitions from one stage to the next, such as the use of fire, pottery, and so on. These stages of development tracked differences and changes in technology, political organization, and kinship systems. Karl Marx and Friedrich Engels viewed Morgan's work as validating historical materialism and also providing comparative data from nonindustrial societies. Engels would later write *Origin of the Family, Private Property, and the State* (1884), paralleling Morgan's *Ancient Society* and tying their materialist strategies together.

Another ethnologist, Edward Burnett Tylor of Great Britain, published *Primitive Culture* in 1871 and employed the same three stages of development as Morgan, but added that civilization included an advance in happiness and certain moral qualities. Tylor drew his conclusions from comparative research on religions, which he suggested were universal responses to universal experiences, and he traced religious evolution from animism to polytheism to enlightened monotheism. Like Morgan, Tylor's comparative method considered living "tribal" peoples as examples of prehistoric societies that had yet to evolve into the higher stages of development. Significantly, Tylor defined culture as "that complex whole which includes knowledge, belief, arts, morals, custom, and any other capabilities and habits acquired by man as a member of society." As it turns out, Tylor the Englishman gave American anthropology "culture," its basic unifying concept, and Morgan, an American, founded detailed kinship studies, which has since become the forte of the British.

EARLY 20TH CENTURY

By the end of the 19th century, some anthropologists openly rejected the unilineal evolutionist paradigm, and the 20th century opened with wide-ranging support of some combination of diffusionism, historicism and, eventually, structuralism and functionalism. For example, Austro-German anthropology, rooted in geographic and linguistic studies, analyzed culture complexes, their ecological constraints, and how they developed historically.

As Morgan's work indicates, anthropology in the United States arose in part from concerns for the cultures and histories of populations native to North America. This line of anthropology was furthered via the Bureau of Indian Affairs and the Smithsonian's Bureau of American Ethnology. The honorific title of "Father of American Anthropology" belongs to German-born and educated Franz Boas, also known as Papa Franz. Boas founded the first major department of anthropology at Columbia University in 1899. A proponent of what became known as historical particularism, Boas advocated participant observation and "total recovery"—a holistic approach in collecting data to understand the historical events that may have led to the development of particular cultural facts. Among Boas's more famous students were Ruth Benedict, Margaret Mead, Alfred Kroeber, and Robert Lowie.

Due in large part to Boas's influence, American anthropology has typically been divided into four fields: 1) archaeology—the study of material remains of human societies, usually from the past, to describe and explain human behaviors; 2) biological/physical anthropology—the study of humans and nonhuman primates as biological organisms through primatology, biological evolution, forensics, osteology, population genetics, and so on; 3) linguistics—the study of human language, its variations, social uses, relationship to culture, and changes over time; and 4) cultural/sociocultural anthropology—the study of human beliefs, values, and behaviors, such as ideology, production and consumption patterns, kinship, gender roles, exchange, politics, religion, and art.

While Boas was shaping American anthropology, A.R. Radcliffe-Brown and Polish-born Bronislaw Malinowski were busily shaping British social anthropology. Malinowski and Radcliffe-Brown proposed functionalist paradigms, which were far less interested in reconstructing a society's history than Boasnian historical particularism. Rather, functionalists focused on analyses of how societies operated and held together in the present. Based on his extensive participant-observation fieldwork in the Trobriand Islands, Malinowski developed psychological functionalism to describe how cultural institutions meet basic physical and psychological needs of individuals within a society. Malinowski's students included E.E. Evans-Pritchard, renowned for his work among Nuer and Azande peoples in Sudan, and Raymond Firth, a key economic anthropologist.

Radcliffe-Brown created structural functionalism, which studied various aspects of society in terms of how they functioned to maintain the society as a whole. Drawing on French sociologist Emile Durkheim, Radcliffe-Brown subscribed to the notion that society was somehow distinct from its members and as such molds individuals' behaviors. These functionalist theories were conceived by European anthropologists and applied through studies of peoples in European-held territories.

POST–WORLD WAR II TO THE PRESENT

Because of the discipline's growth, post-World War II anthropology has become a collection of more specialized subfields that cut across the four fields outlined previously. Three of the fastest-growing examples include development anthropology, medical anthropology, and environmental anthropology. Medical anthropologists study meanings of and relationships among health, disease or illness, healing practices, and social systems. Development anthropologists may also examine human health and nutrition as they look at global, economic contexts within which "development" takes place, with a focus on implications of international trade, investment, international lending institutions, and debt. Environmental anthropology focuses on the relations between humans and their environments. Contemporary environmental anthropology has grown out of and/or co-evolved with cultural ecology, founded by Julian Steward; ecological anthropology, for example, Roy Rappaport's work on ecosystemic homeostasis; human ecology; and ethnoecology, which refers to how people name, classify, and otherwise conceptualize flora, fauna, and human activity within the environment.

Founded in 1902, the American Anthropological Association (AAA) now has over 10,000 members and is the world's largest organization of individuals interested in anthropology. Completion of a doctorate is necessary to achieve full professional status as an anthropologist. Directly linked to the academy, one could also work as a field archaeologist, or within museums, research institutions, physical anthropology labs, area studies, or ethnic/multicultural centers.

Outside of academic institutions, cultural and linguistic anthropologists may work as research directors; science analysts; and program officers in federal, state and local government, international agencies, nonprofit organizations, health care institutions, marketing firms and research institutes. Biological anthropologists may work in biomedical research, forensics, genetics laboratories, and pharmaceutical firms.

SEE ALSO: Animism; Colonialism; Human Ecology; Indigenous Peoples; Rappaport, Roy.

BIBLIOGRAPHY. American Anthropological Association (homepage), www.aaanet.org (cited April 2006); Franz Boas and George Stocking Jr., ed., *A Franz Boas Reader: The Shaping of American Anthropology, 1883–1911* (University of Chicago Press, 1989); Merwyn Garbarino, *Sociocultural Theory in Anthropology* (Waveland Press, 1983); R. Jon McGee and Richard Warms, *Anthropological Theory: An Introductory History* (McGraw-Hill, 2003).

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Anthropomorphism

ANTHROPOMORPHISM IS THE attribution of human qualities—specifically, complex emotions, reasoning, and motives—to anything that is not human. Most religions describe the divine in human terms, even though divinity is defined as something inherently beyond the human. The tendency to put a human face on celestial bodies and on features of the topography dates to religious beliefs that deities had assumed those forms. Other deities were said to have assumed animal forms, and myths have reinforced totemic associations of certain animals with particular characteristics—for instance, owls with wisdom, foxes with cunning, and swans with elegance.

In popular culture, the sun and the moon are still often represented not only as having features, but also as being capable of emotive expressions. Enduring features of the topography such as mountains and rivers are often described as old men. Some pet owners may believe that their dogs and cats enjoy being dressed in hats, sweaters, and booties. Other pet owners may believe that a dog or cat is capable of smiling or frowning in response to events. Some plant owners may truly believe that their plants not only are responsive to soothing or harsh sounds, but also are capable of feeling happy or sad. This sort of anthropomorphism occurs even when natural phenomena are destructive—for instance, Atlantic hurricanes that are given human names such as Katrina and Rita.

Anthropomorphism has become a point of contention when it has been used to heighten the impact of arguments about environmental choices or about what constitutes humane treatment of other creatures. For instance, describing a logging or mining practice as the "rape" of the environment stigmatizes that practice. Likewise, describing orphaned animals as being overwhelmed by sorrow or grief following the deaths of their mothers transforms natural selection into a heart-rending melodrama. However, the survival of adult bears (or any adult carnivore) often depends on their being able to find easy kills among orphaned animals. Even the use of the term "orphaned" illustrates the pervasiveness of anthropomorphism that prevents many from thinking clearly about how other species may be very different from humans.

This lack of clarity has muddied issues such as what constitutes the humane treatment of wild and domesticated animals harvested for food or clothing, of animals used in the testing of medical treatments and cosmetics, and of animals kept in zoos and other exhibitions. Traditionally, the sense of the urgency of these issues has intensified the more closely related the species has been to man. Primates are most likely to be described in anthropomorphic terms, as are almost all other mammals. At the other end of the spectrum are insects, fish, and reptiles—none of which provoke much sympathy. Interesting exceptions are amphibians and birds, which, despite having eyes with the flat, inhuman aspect associated with fish and reptiles, are capable of producing sounds that appeal to the impulse to anthropomorphize.

Knowledge of the ways in which other species perceive the world is very limited, and it may always be limited by the inability to completely transcend human perceptions. Some investigators who have been especially concerned about human mistreatment of other species have argued that other species do not respond to experiences in a manner comparable to human emotions, but they may still be capable of feeling. The newest type of anthropomorphism involves the attribution of human qualities to machines, in particular to thinking machines such as computers that may someday be capable of artificial intelligence.

SEE ALSO: Animal Rights; Animals; Animism; Anthrpocentrism.

BIBLIOGRAPHY. Eileen Crist, *Images of Animals: Anthropomorphism and Animal Mind* (Temple University Press, 1999); R.W. Mitchell, N.S. Thompson, and H.L. Miles, eds., *Anthropomorphism, Anecdotes, and Animals* (State University of New York Press, 1997); Margot Norris, *Beasts of the Modern Imagination: Darwin, Nietzsche, Kafka, Ernst, and Lawrence* (Johns Hopkins University Press, 1985).

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Antibiotics

ANTIBIOTICS ARE CHEMICALS used to fight diseases caused by pathogens such as bacteria, fungi, or protozoa. Only a few antibiotics are effective against just a few viruses. Antibiotics can be used to fight infections because they are toxic to specific microbes. They may be prescribed to prevent infection when the immune system is impaired, or when there is a risk of endocarditis (inflammation of the lining of the heart). Before the advent of modern antibiotics, many patients experienced a uniform progression of the disease to the death. Antibiotics were originally produced from selected mold and fungi found in the earth, air, or water.

Since the 1930s, thousands of antibiotics have been found in nature; however, only a few (over 60) have been found to be safe for use as medicines. Most modern antibiotics are made synthetically by chemical means. Millions of tons of antibiotics are manufactured every year in a process that brews a culture of the microbe that produces the chemical that is the active agent in fighting a disease. After the antibiotic broth is filtered, the antibiotic molecules are combined with a resin that is washed to collect the pure antibiotic crystals.

In the late 1800s, a Danish bacteriologist, Hans Gram, classified bacterial infections as either gram positive (G+) or as gram negative (G-). Bacteria in these categories are sensitive to some drugs, and not to others. If an antibiotic fights only a few bacteria infections, it is called a limited-spectrum drug. If it fights a wide variety of bacteria that are both G+ and G-, it is called a broad-spectrum antibiotic.

Antibiotics are manufactured by "brewing" a culture of the microbe that produces the active disease-fighting agent.

Bactericidal antibiotics are drugs that kill bacteria by causing a disruption in its cell walls, causing the bacterial cell wall to turn into water and allowing water to flood the cell. It then explodes, killing the bacteria. They do not have any affect upon human tissue. Other antibiotics are bacteriostatic drugs, which work by disrupting the growth of bacteria. This allows the immune system to have time for fighting successfully the infection. The most common forms of antibiotics include aminoglycosides, macrolides, penicillins, tetracyclines, and cephalosporins. Each works in a different way.

The aminoglycosides include drugs such as gentamicin, anikacin, and tobramycin, which prevent bacteria from producing protein; however, they can damage internal ear nerves and the kidneys. Macrolides also disrupt protein production by bacteria. Erythromycin, a macrolide, can cause bowel discomfort.

Sir Alexander Fleming discovered penicillin in 1928. Many kinds of bacteria are destroyed with penicillin drugs, which destroy bacteria cell walls. However, it can cause side effects ranging from a rash or fever, to life-threatening allergic reactions (anaphylaxis). Tetracyclines can destroy both bacteria and other organisms, and prevent the production of protein in many germs. However, side effects such as gastric discomfort, sensitivity of skin to sunlight, liver damage, or kidney damage may occur. The cephalosporins, which disrupt bacteria cell wall formation, are antibiotics that are effective against a wide range of bacteria. Cefaclor is a commonly prescribed cephalosporin. At times, physicians will prescribe a combination of antibiotics in order to ensure the destruction of the infectious bacteria and to reduce the risk of drug resistance. This can happens if a bacteria simply mutates, or if it is able to develop a growth mechanism that allows it to grow unaffected by the drug. Or, the bacteria may produce an enzyme that neutralizes the drug.

Antimicrobial resistance to antibiotics drugs is a growing, global problem that has alarmed some health care professionals, because diseases once "conquered" are returning in the form of strains that are resistant to older antibiotics. It has arisen because bacteria not killed by a specific antibiotic were able to reproduce, carrying that characteristic that resisted the drug. If a patient fails to take a full course of medicine or take it as directed, resistance may develop. Resistance has been found in strains of tuberculosis, sexually transmitted diseases (STDs), and other diseases that now pose a renewed threat to human and animal health.

While powerful antibiotics are available, serious questions have been raised about the wisdom of administering these drugs to patients with lifestyles that suggest they may not follow proper treatment procedures and may increase the likelihood of new strains of resistant bacteria developing and transmitting to others. The consequences could be the spread of diseases for which there are few, if any, treatments available.

The overuse of antibiotics has exacerbated this problem, with widespread prescription of antibiotics by physicians for conditions that rarely respond to the treatment, such as childhood ear infections. Antimicrobial soaps and other commercial consumer products may also accelerate the evolution and adaptation of various microbes toward immunity. Antibiotics have been used as a food preservative by the food industry, and ranchers and farmers also use antibiotics in order to stimulate animal growth. The degree to which this widespread use may further influence the resistance of microbes remains a controversy, especially as the livestock industry has rapidly industrialized.

Besides side effects, antibiotics can have other negative consequences. For instance, some antibiotic drugs may become toxic if they are taken after their effective date. Since 1900, the world's population has grown enormously. Antibiotics have played a major role in that growth. However, the emergence of resistant microbes poses a grave threat to the future of human life and health.

SEE ALSO: Drugs; Mold; Pasteur, Louis; Vaccination; Viruses.

BIBLIOGRAPHY. Harry F. Dowling, *Fighting Infection: Conquests of the Twentieth Century* (iUniverse, Inc. 2000); Norbert Gualde, *Resistance: The Human Struggle against Infection* (Dana Press, 2006); Milton Wainwright, *The Story of Antibiotics and the Golden Age of Antibiotics* (Oxford-Blackwell, 1990).

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Antiquities Act

THE ANTIQUITIES ACT of 1906 was the first law in the United States to designate and protect archaeological sites and artifacts. It gave the president the right to declare by public proclamation the creation of "national monuments, historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest" based on archaeological significance. In addition, looting of related artifacts was made illegal on federal lands.

The Antiquities Act has three primary parts. First, it calls for the prosecution of persons who excavate, appropriate, injure, or destroy any historic or prehistoric ruin or monument or any artifact on federal lands, and specifies penalties for those convicted of these offenses. The act specifies that any person convicted of appropriating, excavating, injuring, modifying, or destroying any historic or prehistoric ruin or monument, or any artifact, is to be fined no more than $500, be imprisoned for a period not to exceed 90 days, or be both fined and imprisoned at the discretion of the court.

Second, the act empowers the president to declare areas of public lands as U.S. National Monuments, reserving, modifying, or accepting private lands for this purpose of conversion to monument status as well. Since its passage in 1906, the act has been used by 14 out of 18 presidents (the four nonusers being Richard Nixon, Ronald Reagan, George H.W. Bush, and George W. Bush). Congress also has the power to declare national monuments, having done so in 29 cases. Of the 105 national monuments proclaimed under the Antiquities Act, 46 are larger than 5,000 acres and 28 are larger than 50,000 acres. Hunting and grazing are often allowed within the boundaries of U.S. National Monuments, because they are usually managed less stringently than U.S. National Parks. In addition, it is not uncommon for a national monument to ultimately be redesignated as a national park. In fact, 25 percent of America's national parks were originally designated as monuments under the Antiquities Act and include such wonders as the Grand Canyon, Arches, and Bryce Canyon. Noteworthy implementation of the act has included Theodore Roosevelt declaring 18 national monuments in nine states, Jimmy Carter declaring 56 million acres in Alaska, and Bill Clinton designation of 1.7 million acres for Grand Staircase–Escalante National Monument in 1996.

Finally, the Antiquities Act permits the examination and assessment of ruins, excavation of archeological sites, and the collection of objects of antiquity on lands owned or controlled by the United States, including federal marine environments on which submerged cultural resources are located. The act permits and/or regulates related salvage procedures. The act establishes that such permissions are under the jurisdiction of the appropriate secretary of the land being investigated (i.e., Departments of Interior, Agriculture, and Defense). The secretary may authorize the institutions deemed qualified to conduct such examination, excavation, or gathering.

The act requires that "examinations, excavations, and gatherings" are conducted for the benefit of museums, universities, and colleges, and/or other recognized scientific or educational institutions, for the purpose of increasing the knowledge of such artifacts, and that the collections from such "gatherings" be made a part of public museum displays and collections.

SEE ALSO: Carter Administration; Clinton Administration; National Monuments; National Parks; National Park Service; Roosevelt (Theodore) Administration.

BIBLIOGRAPHY. David Harmon, *The Antiquities Act: A Century of American Archaeology, Historic Preservation, And Nature Conservation* (University of Arizona Press, 2006); U.S. Department of the Interior/National Park Service Web, http://www.cr.nps.gov (cited February 2007).

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Appalachian Mountains

THE APPALACHIAN MOUNTAINS, a prominent mountain range in the eastern North America, extend from central Alabama northeastward into Newfoundland and Labrador. The Appalachians are geologically an old range. Several mountain-building episodes in geologic history have resulted in a complex system of ranges and valleys and the presence of significant deposits of anthracite and bituminous coal, which have provided the basis for economic development in the region. The Appalachians represent the physical dividing line separating the vast central basin and the eastern seaboard.

During the colonial era, the Appalachians were a barrier to the inviting agricultural regions to the west. Prior to the end of French and Indian War in 1763, the regions immediately to the west of the Appalachians were considered hostile territory. The region remained essentially inaccessible following 1763 by virtue of a British proclamation in that year limiting colonial settlement eastward from a line marked by the mountain summits. This restriction was eliminated following the Revolutionary War, and people on the eastern seaboard began a migration to the west through the Cumberland Gap and the Hudson-Mohawk Corridor in New York, a transportation route that remains important.

The term Appalachia has been used generally in reference to the entire mountain system and more specifically in identifying the central and southern sections of the Appalachians prominent for high levels of poverty, economic exploitation, and environmental degradation. The Appalachian Regional Commission (ARC), an organization representing both federal and state governments, is devoted to improving conditions in the region. The ARC has created taxonomy of economic development categories to identify counties within the region. The categories include distressed, transitional, competitive, and attainment. Distressed counties have per capita incomes not exceeding two-thirds of the national average. Transitional counties rank somewhat higher than the distressed category, but are still lower than national averages. The competitive grouping ranks below the national average in unemployment and poverty, but income levels remain at least 10 percent below the national average. Finally, counties at the attainment level are on a par with the remainder of the country in income level, poverty rate, and level of unemployment. Appalachia has been the recipient of federal assistance for poverty alleviation and economic revitalization for decades. In recent years the region has benefited economically from a rise in tourism.

The widespread forest cover in the Appalachians became the basis for a flourishing forestry industry early in the region's settlement history. However, within the past several decades the forest cover has suffered from the deposition of acid rain and high ozone levels. The primary sources of air pollution are coal-fired electrical generating plants in the midwest and the Gulf states. The general pattern of airflow in this region of North America is west to east and the particulates emanating from the power plant smoke stacks mix with moisture in the atmosphere and fall as acid rain over the forested areas of Appalachia.

SEE ALSO: Acid Rain; Coal; Forests.

BIBLIOGRAPHY. Mary Anglin, "Lessons from Appalachia in the 20th Century: Poverty, Progress, Power, and the 'Grassroots,'" *American Anthropologist* (v.104, 2002); Marilyn Evans, Holly George-Warren, and Robert Santelli, *The Appalachians: America's First and Last Frontier* (Random House, 2004); Kevin M. Pollard, *A "New Diversity": Race and Ethnicity in the Appalachian Region* (Population Reference Bureau, 2004).

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Foxfire Books

The first of the Foxfire books was published in 1972 and was compiled by B. Eliot Wigginton (b. 1942), a high school teacher in Rabun County, Georgia, who had persuaded his students from Southern Appalachia to collect local stories and write about legends and customs. Many of these were first published in magazine form.

Eliot Wigginton started the project partially out of curiosity, but also to empower his students and give them confidence. He felt he had access to much local folklore that would otherwise go unrecorded. In 1966, these vignettes appeared in *Foxfire Magazine,* named after a type of local fungi. Demand was so great that these appeared in book form six years later.

The topics covered details on preserving fruit, recipes such as apple butter, burial customs, stories about local witches, animal care, the handling of snakes, faith healing, and information on how to make fiddles and soap; there were also accounts of beekeeping, spinning, tanning hides and carving wood. Wigginton edited the first nine volumes: *Foxfire 9* was published in 1986. He was awarded the MacArthur Foundation fellowship three years later. *Foxfire 12* was published in 2004.

Appropriate Technology (AT)

DEFINING APPROPRIATE TECHNOLOGY (AT) is difficult; it means many things to many people, and what may be understood as appropriate to one community may not be consistent with another. In broad terms, the National Center for Appropriate Technology (NCAT) describes AT as a technology that is simple to apply, is not capital- or energy-intensive, uses local resources and labor, and protects environmental resources and human health. Practical Action, a nongovernmental organization (NGO), suggests that AT takes advantage of local resources, uses and employs recyclable materials, is affordable, and generates local employment in its application.

AT emerged as a movement during the 1960s in the context of economic theory that argued that Western models of development were unsustainable, environmentally degrading and would not provide benefit to the world's poor. Ernst Schumacher is regarded as the founder of the AT movement and is best known for his seminal work, *Small Is Beautiful: Economics as if People Mattered*. Schumacher, an economist, argued that the world's poor did not benefit from modern technological advancement because it wasn't affordable, accessible, or appropriate to their circumstances. Therefore, he suggested that an intermediate or appropriate form of technology should be developed, at a small scale that built upon the existing skills and knowledge base of local communities. The use of such technology would ensure all people, including the poor, maintain improved standards of living and that natural resources are managed sustainably for future generations.

In 1966, Schumacher founded the Intermediate Technology Development Group, designed to reduce poverty around the world by the application of AT principals. Now known as Practical Action, the group coordinates projects in Latin America, East Africa, Southern Africa, and South Asia. Their projects are established to assist communities to develop AT in the areas of food production, agroprocessing, energy, transport, small enterprise development, shelter development, small-scale mining, and disaster mitigation. For example, projects aimed at encouraging the use of indigenous food crops and the sustainable harvest of wildlife have been trialed in order to facilitate increased food production without degradation of the natural environment.

Unlike Practical Action, NCAT was founded to improve the living standards of poor Americans, not those in developing countries. During the 1973 energy crisis, the cost of fuel rose dramatically because the Organization of Petroleum Exporting Countries (OPEC) stopped supplying the United States and Western Europe with oil due to their support for Israel during the Israeli war with Egypt and Syria. Consequently, many poor Americans could not afford to heat their homes. To help conserve and reduce the amount of energy required to heat a building, NCAT devised AT solutions, such as super insulation, and designed technological solutions that were appropriate for poorer households. NCAT now primarily focuses on sustainable farming techniques, such as reducing chemical use.

In Australia, the Centre for Appropriate Technology (CAT) manages projects designed to improve the lives of Aboriginal peoples living in remote areas where access to modern technology is limited, unaffordable, or not appropriate in environmental or cultural contexts. Like indigenous peoples all over the world, Australian Aborigines face severe socioeconomic challenges. CAT provides AT that is not only cheap and easy to maintain, but also helps build the skills capacity within a local communities through the provision of training and information sessions in appropriate formats (such as brochures and training guides in local languages).

APPROPRIATE TECHNOLOGY ADVOCACY

The AT movement also performs a significant advocacy role. For example, CAT advocates funding for capacity-building programs and for the adoption of the Sustainable Livelihoods model into Australian policy design and decision-making processes for remote aboriginal communities. The Sustainable Livelihoods model is an international program that evolved from a research paper by Robert Chambers and Gordon Conway in 1991, called "Sustainable Rural Livelihoods: Practical Concepts for the 21st Century." This model, which has since been championed by government and NGOs, aims to reduce poverty. It is based on ensuring that when development decisions are made in poor countries, the decisions are designed to be appropriate and will ensure benefits accrue to the whole community, not just the ruling elite. Practical Action advocates for the development of policies and practices within the United Kingdom and European Union (EU) that will benefit the world's poor.

It is important to note that AT does not advocate abandoning modern technology. Rather, modern technology should be delivered on a small, localized scale, such as a Remote Area Power System (RAPS) that will generate electricity for remote communities where it is not technically or economically feasible to be connected to a main power supply.

As the pace of technological advancement increases, developing nations are being left farther behind and the gap between the technologically rich and poor is growing ever wider. Increasingly, developed countries are defending their economic interests more aggressively and only countries with strong institutional arrangements are able to take part and benefit from globalized markets. Therefore, AT will increasingly play a significant role in providing the world's poor, isolated, and rural communities with access to technology that enhances and provides benefit to their lives.

SEE ALSO: Indigenous Peoples; Justice; Poverty; Sustainable Development; Sustainablility.

BIBLIOGRAPHY. R. Chambers and G. Conway, *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century* (Institute of Development Studies, 1991); Development Center for Appropriate Technology, "Current Work Status," www.dcat.net/about_dcat/current.php (cited April 2006); Gaia Trust, "Ecovillage Movement," www.gaia.org/ecovillage/index.asp (cited April 2006); R. Grieve, "Appropriate Technology in a Globalizing World," *International Journal of Technology* (2004); S. Lall, "Industrial Success and Failure in a Globalizing World," *International Journal of Technology Management and Sustainable Development* (v.3 2004); National Center for Appropriate Technology, "History," www.ncat.org/about_history.html, (cited April 2006); National Center for Appropriate Technology, "Web Sites for a Sustainable World," www.ncat.org/website.html (cited April 2006); Practical Action, "Food Production," www.itdg.org/index.php?id=food_production (cited April 2006).

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Aquaculture

AQUACULTURE IS THE controlled cultivation of aquatic organisms, such as fish, mollusks, crustaceans, and plants. Aquaculture may take place in oceans, rivers, lakes, ponds, or manufactured tanks. The first known records of aquaculture are from China, circa 889–904 C.E., where carp was farmed in flooded rice fields. This system took advantage of excess water, while at the same time fertilizing the earth and clearing the land of weeds. Thirty percent of the marine products consumed today come from aquaculture, which is currently the world's fastest-growing food producing sector.

Aquaculture has experienced rapid growth and expansion on a global scale since the 1980s, while most wild-capture fisheries are in decline. International development agencies and state and local governments herald aquaculture as a means of economic development, resource diversification, and food security. Some scientists argue that it can be a strategy for taking the pressure off of wild fish stocks in order for them to recover. On average, seafood accounts for 16 percent of all animal protein in the human diet, making it the most important single source of high-quality protein.

Aquaculture is a global phenomenon, with a diversity of scale and levels of market integration. In some countries, aquaculture is practiced at a subsistence level, while other countries are internationally engaged in an industrialized process of fish production and export. Asia is the world leader in aquaculture production, due to its historical foundation in the process. Latin America has experienced a sharp rise in aquaculture production, with an average growth rate of 18 percent per year during the 1990s. The market is expanding most rapidly in North America, growing by approximately 13 percent per year in recent years.

The primary increase in aquaculture products has occurred in Low Income Food Deficit Countries, further reinforcing the view that the practice is a nutritional and economic resource. Many countries, including the United States, have encouraged aquaculture research and development as a means to meet the growing demand for seafood products in the face of a significant decline in wild populations. If environmental and social needs can be met, aquaculture might help alleviate poverty and hunger, while generating employment, though the actual effects of its rapid promulgation on local populations remain controversial.

Aquaculture at the industrial scale is relatively new and is still in the process of adaptation. Some concerns have emerged that the cultivation of certain species on intensive scales is ecologically harmful. Although aquaculture occurs in a controlled environment, cases of escapes, contamination, and spread of disease have been documented, all of which may harm the natural ecosystem in the surrounding area. For example, studies in Chile have shown that escaped salmonids can colonize their new, nonnative environment, resulting in resource competition and potentially altering local ecosystem processes. Shrimp production in Asia and other parts of the world has resulted in the deforestation of mangroves and wetlands in order to create space for shrimp ponds. The cultivation of carnivorous fish depends on the extraction of wild fin-fish that are converted to meal for fish food. In some parts of the world, this has meant depleted stocks for local fishermen, who still depend on these species for a supplement to their diet or for income. Experts have recently recommended that endemic herbivorous or filter feeders be farmed, rather than nonnative carnivorous species, in order to avoid some of these potential problems. Another suggested solution is to farm exclusively in terrestrial, man-made tanks where all stages of production could be managed, including the disposal of waste.

The future of aquaculture depends on cooperation between stakeholders, including regulatory agencies, industry, scientists, and fishermen in order to achieve responsible and sustainable aquaculture operations. Improving technology and species diversification can promote sustainable marine resource consumption, and may benefit a wider range of consumers. The diverse ecological, sociocultural, and political interests make this a challenge, though one that has the potential to be met. Global cooperation is paramount for the diffusion of successful information and technology to establish and maintain sustainable practices. Under the right conditions, aquaculture may help to meet demands for this important resource while establishing socioecological improvements that can benefit human and biophysical ecosystems. The positive and negative economic, political, and ecological impacts of the rapid transition toward aquaculture, however, are still being assessed.

SEE ALSO: Farming Systems; Fisheries; Food; Invasive Species; Proteins.

BIBLIOGRAPHY. Connor Bailey et al., eds., *Aquacultural Development: Social Dimensions of an Emerging Industry* (Westview Press, 1996); Food and Agriculture Organization of the United Nations, "Fisheries Global Information System," www.fao.org/figis (cited September 2005); National Oceanic and Atmospheric Administration, "NOAA Aquaculture," www.nmfs.noaa.gov/mediacenter/aquaculture (cited October 2005); Doris Soto et al., "Escaped Salmon in the Inner Seas, Southern Chile: Facing Ecological and Social Conflicts," *Ecological Applications* (v.11/6, 2001); World Fish Center, "Publications," www.worldfishcenter.org (cited September 2005).

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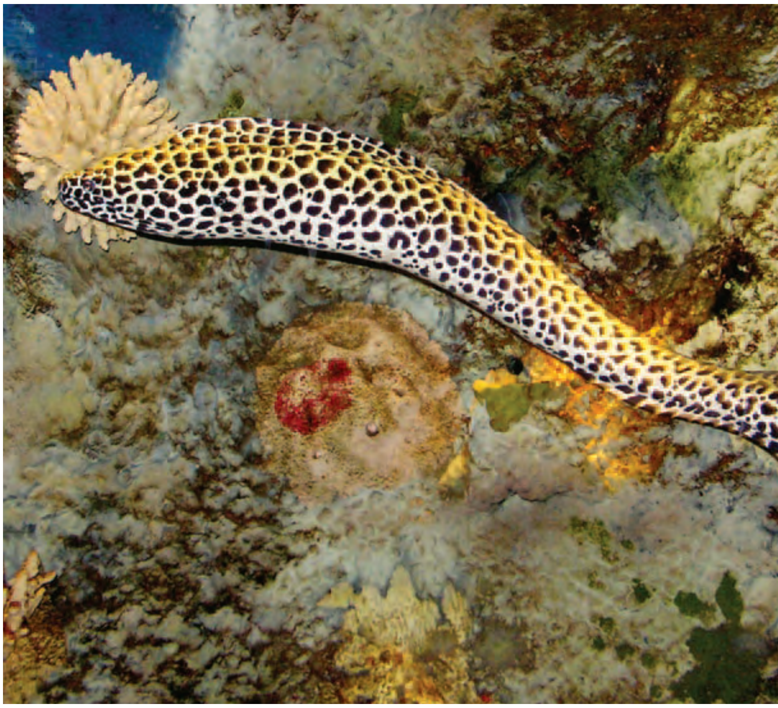
Aquariums

FISH HAVE BEEN raised in captivity since at least 2300 B.C.E., when people raised them for entertainment and to satisfy their intellectual interests. In addition, animals, shellfish, and plants have been kept as part of aquariums. In the 1800s, home aquariums became very popular in England. As interest spread, many people journeyed to the nearby English coasts in order to gather fish, plants, and other creatures. These were then kept in the available containers that constituted the aquariums of the day. Soon, attention turned to the fresh waters for aquarium specimens. Many homes became supplied with a lake in a glass bowl with specimens taken from local streams and lakes. Businesses began selling aquariums and aquarium supplies, aiding the growth of aquarium keeping. By the end of the 1800s, merchant ships were carrying tropical or other exotic species of fish and aquarium species from all over the world to supply home aquariums. Books were written on species of sea and fresh water fish, plants, and other living organisms. By the 2000s, large producers of goldfish, tropical fish, snails, and other aquatic creatures were marketing the creatures in specialty aquarium supply outlets.

Successfully keeping a healthy home aquarium requires equipment—an aquarium tank, tank cover, water filter, lighting, heater, and thermometer. A home aquarium should approximate the aquatic environment of the fish that will live in the tank, with rocks, gravel, sand, wood, and plants. Tropical fish, saltwater fish, or temperate-climate fish have different habitat requirements. Water chemistry is crucial if the fish and other aquatic creatures are to flourish. The filter supplies air to oxygenate the water. The heater maintains a constant water temperature that reduces stress on the aquarium's inhabitants. Proper feeding and cleaning is also crucial to maintaining a healthy aquarium.



With the decline of wild marine life, public aquariums are promoting good resource stewardship.

PUBLIC AQUARIUMS

As interest in home aquariums grew in the 1800s, large public aquariums were opened in the Gardens in Boston, Massachusetts, Germany, Austria, and elsewhere. Public exhibitions of the watery world of lakes, rivers, and oceans generated enormous interest. Many of these original aquariums, as well as some operating today, were built as places of entertainment for the public and as commercial enterprises for their owners. There are now several hundred great public aquariums around the world. Most, such as the Georgia Aquarium (Atlanta) and the Long Beach Aquarium (California), are places of entertainment, education, and research. They require millions of dollars to build and to maintain. They are usually a cooperative effort between foundations, civic boosters, state and local governments, universities, schools systems, and marine or aquatic research bodies.

Some of the great aquariums are organized around a theme. The Monterey Bay Aquarium and the Osaka (Japan) Kaiyukan Aquarium are focused on Pacific Ocean creatures and plants. Both have been built on the edge of the Pacific Ocean. The Monterey Bay Aquarium pumps in ocean water from the Pacific and circulates it through their display tanks in order to keep the water chemistry and the environment as natural as possible. The water is filtered in the daytime to remove impurities, so aquarium patrons can clearly see the octopus, sharks, stingrays, sea otters, aquatic plants, and fish. At night they use unfiltered seawater to nourish the exhibits in a manner similar to the wild. Other public aquariums have been built around a different theme. The Tennessee Aquarium in Chattanooga is a freshwater aquarium, organized around the theme of aquatic creatures in the Tennessee River. As patrons walk down a four-story ramp, they pass exhibits that trace the course of the Tennessee River from its origin high in the Appalachian Mountains until it meets the Gulf of Mexico, where its saltwater exhibits are displayed.

Many factors contribute to the continued success of public aquariums. Crucial to success are its volunteers, who supply an eager, unpaid workforce. Dedicated volunteers serve as docents, teaching visiting school children about the creatures and plants on display. Other volunteers, wearing scuba equipment, enter the tanks to clean them. Without the vast number of volunteer hours, the educational and research services of their aquarium could not exist. One of the favorite exhibits in the public aquariums is the seals, sea otters, or other mammals at feeding time. The animals seem to be trained to do tricks by their handlers, when in reality the "tricks" are used to measure their responses, or to prepare them for detailed physical exams by a veterinarian as needed. The modern aquariums conduct research on oceanic problems such as sterility in whales. They also have programs for breeding the specimens on exhibit, which enhances the survival of some species and provides a way for restocking exhibits. Surpluses can also be traded or shared. With the decline of marine life caused by overfishing or pollution, the public aquariums are promoting good resource stewardship. They are also educating the youth in ways to care for the waters of the planet.

ECOLOGICAL CONCERNS

Home aquariums can create ecological problems if unwanted specimens are dumped into local fresh water bodies and become invasive species. Critics of aquariums also suggest that many ocean-roving species (including great white sharks, for example, and many sea mammals) should not be kept in captivity, and that the central purpose of aquariums, like zoos, is generating revenue, rather than meaningful conservation or education. Most major breakthroughs in understanding aquatic species, they point out, are not made through observation in captivity, but instead in situ, seeing species in the context of their larger environment. Despite these criticisms, the number and distribution of aquariums is expected to increase greatly in the next century.

SEE ALSO: Aquaculture; Fisheries; Oceans; Zoos.

BIBLIOGRAPHY. Bernd Brunner, *The Ocean at Home: An Illustrated History of the Aquarium,* trans. by Ashley Marc Slapp (Princeton Architectural Press, 2005); Nora L. Deans, *Monterey Bay Aquarium: The Insider's Guide* (Monterey Bay Aquarium Foundation, 2005); Peter W. Scott, *The Complete Aquarium: A Practical Guide to Building, Stocking, and Maintaining Freshwater and Marine Aquariums* (DK Publishing, 1995).

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Arbor Day

ARBOR DAY IS a nationally celebrated observance that encourages tree planting. It officially takes place in the United States on the last Friday in April, although each state may have its own Arbor Day based on the planting season. Globally, many other countries have created their own Arbor Day based on the U.S. model. The day began in 1872 when journalist J. Sterling Morton, the editor of Nebraska's first newspaper, proclaimed the holiday in Nebraska. It has been widely cited that one million trees were planted on the first Arbor Day, in part due to prizes offered to individuals and counties for planting the most trees.

Tree planting in the United States was not new in 1872. Euro-Americans planted trees for windbreaks and ceremonial purposes for the previous four centuries. In addition, tree-planters such as John Chapman (Johnny Appleseed) preceded Morton, but unlike Chapman, who planted trees as a religious mission, Morton promoted tree planting as a catalysis to environmental change. He claimed that tree planting in the semi-arid plains would induce rainfall needed for agriculture and hence framed tree-planting as patriotic. By 1907, Theodore Roosevelt was speaking of Arbor Day in patriotic terms as well, "Arbor Day… [will give you] a day or part of a day to special exercises and perhaps to actual tree planting, in recognition of the importance of trees to us as a Nation." By 1882, Arbor Day traditions were brought to schools around the country, teaching children about the duty of planting trees.

Currently, the biggest promoter of Arbor Day is the National Arbor Day Foundation, a nonprofit organization that promotes the planting of trees and the celebration of Arbor Day. With each $10 membership, the foundation sends the member 10 trees. On a larger scale, the foundation organizes educational programs and the Tree City program. Cities must meet requirements such as tree care ordinances, a community forestry budget of at least $2 per capita, and an official Arbor Day celebration to be officially declared a Tree City.

Arbor Day, and those who promote the celebration, have not been without critics. Some point out that Arbor Day was founded in Nebraska, a treeless plain, under the notion that the land would be better with trees, even though the landscape prior to the arrival of the European Americans did not contain trees. The Environmental Protection Agency (EPA) has also been criticized for publishing a list of how many trees one must plant to offset environmental damage done with other activities. In this case, tree planting is seen as a way to make up for environmentally damaging behavior instead of promoting a change in behavior. In addition, the forestry industry often heralds its achievement by publicizing the number of trees planted; however, the vast monoculture tree plantations are often planted with the fastest-growing species, not with the most ecologically appropriate. Although these critiques are not against the concept of planting trees, they disagree with the rhetoric of these organizations, which tout tree planting as a panacea instead of seeing it as an act with political outcomes.

SEE ALSO: Forests; Roosevelt (Theodore) Administration; Timber Industry.

BIBLIOGRAPHY. Shaul E. Cohen. *Planting Nature: Trees and the Manipulation of Environmental Stewardship in America* (University of California Press, 2004); *National Arbor Day Foundation,* (homepage), www.arborday.org (cited March 2006).

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Arctic

COMPOSED OF THE northernmost residents of Alaska, Canada, Greenland, Scandinavia, and Russia, the arctic's population of 4 million is a heterogeneous blend of indigenous groups and immigrants, both utilizing the region's natural resources in mixed subsistence and cash-based economies. Together they sparsely populate an extreme environment characterized by tundra vegetation or boreal forests bordered by oceans teeming with wildlife. Indigenous arctic peoples such as the Aleut (Unangan), Yupik, Athabascan, and Inupiaq of Alaska; the Inuit of Canada and Greenland; the Saami of Scandinavia; and the Yakut, Yukagirs, Chukchi, and Evenks of Siberia were traditionally small nomadic groups who moved seasonally in pursuit of wildlife resources such as sea mammals, fish, and birds, as well as land mammals such as caribou, moose, and bear. These groups have always been renowned for their remarkable adaptive abilities in a challenging environment to which they are both economically and culturally connected.

Today, arctic residents live in diverse settings ranging from small villages of less than 100 people to large cities such as Murmansk in Siberia, which has a population of over 300,000. All communities are tied in some way, however, to the region's rich natural resources and industries based upon the exploitation of minerals, fish, and timber. Indigenous arctic populations are increasingly feeling the pressure of industrial expansion and resource extraction in their territories, as well as an influx of both migrant labor and tourists. All arctic residents of the 21st century now face dual concerns in the large-scale industrial extraction of their natural resources to meet the needs of a burgeoning global economy and in the spectre of the warming trends currently indicative of climate change predictions.

COLD FACTS ON CONSERVATION

Mining of nonrenewable resources such as gold, copper, iron, oil, coal, and natural gas provides the majority of revenue generated from arctic industries. Oil and gas extraction and refining in particular are vitally important industries in the arctic, but also stimulate debate over conservation concerns of some of the most environmentally pristine areas of the world, such as in the dispute over oil drilling in Alaska's Arctic National Wildlife Refuge. Overfishing of both the North Pacific and North Atlantic is also a contested issue for the arctic region, because not only does it put wildlife populations at risk, it also endangers traditional lifestyles based upon both subsistence and commercial fishing. Corporate fishing enterprises have been rapidly replacing small boat fisheries on the arctic coast since the 1970s, and challenge the existence of some coastal communities that are precluded from participation by restrictive access legislation. Large-scale deforestation of Siberia's boreal forests since the disintegration of the Soviet Union is also at issue in not only changing the arctic landscape, but also in the more global concern of contributing to atmospheric warming by eliminating carbon sinks.

According to the Arctic Climate Impact Assessment organization, climate change in the arctic will subject arctic residents in the future to changing weather patterns, melting of sea ice, rising sea levels and coastal erosion, thawing of permafrost, and changes in vegetation, as well as the appearance of new wildlife species or disappearance of others. Changing weather patterns make traditional methods of weather prediction more difficult as the frequency of storms increases, in addition to the potential for disasters caused by both slides and avalanches. Melting sea ice directly impacts the viability of marine mammal populations that use it for a habitat.

However, while climate change places some constraints on arctic peoples, it might also engender opportunities such as the opening of northerly trade routes with a reduction in sea ice. In addition, in some areas, the introduction of new species such as more northerly runs of Pacific salmon would be welcomed changes for some arctic peoples and industries. Traditional livelihoods would alter in other ways, however, such as with a northward shift of the boreal forest, which could result in an expansion of the timber industry. However, this would also entail a reduction in tundra, which would in turn affect traditional pasturelands of arctic reindeer and caribou herds. Despite the environmental challenges arctic residents face from both industrial exploitation of resources and climate change, governance of the region is characterized by a high level of international cooperation for environmental protection. The establishment of the Arctic Council in 1999, for example, brings together members from all eight nations with arctic lands and considerable indigenous participation providing opportunities for comanagement of resources.

SEE ALSO: Arctic National Wildlife Refuge; Boreal Forests; Climate, Arctic and Subarctic; Deforestation; Global Warming; Subsistence; Tundra.

BIBLIOGRAPHY. Fikret Berkes and Dyanna Jolly, "Adapting to Climate Change: Social-Ecological Resilience in a Canadian Arctic Western Community," *Ecology and Society* (v.5/2, 2001), www.consecol.org/vol5/iss2/art18/ (cited May 2006); Robert W. Corell, "ACIA Arctic Climate Impact Assessment," presented to the Committed for Science, Commerce and Transportation of the U.S. Senate (March 2004); Nelson H.H. Graburn and B. Stephen Strong, *Circumpolar Peoples: An Anthropological Perspective* (Goodyear Publishing Company, 1973); Richard Vaughan, *The Arctic: A History* (Sutton Publishing, 1994).

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Arctic National Wildlife Refuge

THE ARCTIC NATIONAL Wildlife Refuge (ANWR) is located along the Arctic Ocean in Alaska, east of the main North Slope oil fields, and bordering on the U.S.-Canadian (Alaska-Yukon Territory) border. It encompasses over 19 million acres of land. It is home to a great deal of wildlife, and may also contain oil. The federal government created the refuge in 1960, after a campaign by nationally known conservationists and scientists, as the Arctic National Wildlife Range. The range was somewhat smaller than the current refuge; in 1980, the Alaska National Interest Lands Conservation Act (ANILCA) expanded the "range" and made it a "refuge." According to the U.S. Fish and Wildlife Service, which manages ANWR, the refuge contains 45 species of land and marine mammals, perhaps the most famous (and controversial) of which is the vast porcupine caribou herd, the largest of several herds that inhabit the region. The three wild rivers in the refuge also contain 36 species of fish, and at least 180 species of birds.

In enlarging ANWR, the ANILCA created three basic parts of the refuge. Two of them, the refuge and the wilderness area, encompass 17.5 million acres. The remaining 1.5 million acres is the coastal plain, where oil is likely to be available, but which is also the natural habitat of caribou and other species. The coastal plain, known as the "1002 area" after that section of the ANILCA that mandated a study of the wildlife and petroleum resources in the refuge, is the focus of debate over oil exploration in the refuge. Proponents argue that there are between 600,000 and 9.2 million bbl (billions of barrels) of economically recoverable oil in the coastal plain. Opponents argue that production would not exceed 0.8 percent of world production annually, and, would be unlikely to reduce the world price of oil. Natural gas may also be abundant, and plans are underway to build a gas pipeline from the North Slope through Alaska and Canada to southern markets.

ANILCA section 1003 prohibits oil exploration and production in the 1002 area. Congress has the power, however, to repeal section 1003, and has attempted to do so. In 1989 it seemed likely that such an attempt would succeed, but the effort was stopped in its tracks by the *Exxon Valdez* oil spill, which raised questions about the oil industry's ability to responsibly produce and ship oil. In late 2005, congress again attempted to open ANWR, but it failed in the face of a threatened senate filibuster. In 2006 the House of Representatives voted to open up the area in the wake of rapidly escalating oil prices; once again, the senate failed to pass similar legislation. British Petroleum's partial shutdown of its nearby Prudhoe Bay field due to a pipeline leak illustrated the need for more oil production, and the continued environmental problems caused by oil.

SEE ALSO: Arctic; *Exxon Valdez*; Oil Spills; United States, Alaska.

BIBLIOGRAPHY. Arctic Power, "Arctic National Wildlife Refuge," www.anwar.org (cited August 2006); "The Battle in the Arctic," *Economist* (July 8, 2000); Defenders of Wildlife, "Help Save the Arctic National Wildlife Refuge," www.savearcticrefuge.org (cited August 2006); Jim Doherty, "The Arctic National Wildlife Refuge: The Best of the Last Wild Places," *Smithsonian* (v.26/12, 1996); Clifford Krauss and Jeremy W. Peters, "Biggest Oil Field in U.S. Is Forced to Stop Pumping," *New York Times* (August 8, 2006); U.S. Fish and Wildlife Service, www.fws.gov (cited August 2006); Todd Wilkinson, "Oil Industry's Biggest Obstacle to Drilling: Public Resistance," *Christian Science Monitor* (October 9, 1997).

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Argentina

WITH A LAND area of 2,780,092 square kilometers, Argentina is the second largest country of South America with an estimated population in 2006 of 40 million people. Two main units constitute the physical environment: the Andes in the west, and the much older and eroded Eastern massifs, now reduced to plains. The Andean region can be divided into two mountain ranges. The northern Andes, where the highest elevations are to be found (including the highest peak in the western hemisphere, Aconcagua, at 6,959 meters), are characterized by an arid climate and sparse herbaceous vegetation. The southern Andes, with smaller heights but more rainfall, offer a landscape that is a mosaic of forests, lakes, and glaciers. Eastern Argentina is formed mostly by undulating plains replenished by the alluvial materials of the large Paraná and Paraguay rivers in the so-called Mesopotamia region of the north, and the endless grassy plains of El Chaco and La Pampa toward the center and the south. The fluvial network is dominated by the large Rio de la Plata in the north (formed by the Paraná and the Uruguay rivers), the drainage basin of which exceeds 3.1 million square kilometers.

The recent environmental challenges faced by Argentina are closely related to the country's path since the early 1990s of specializing in the production of raw commodities (especially agricultural and mining products) for the growing demand of the global markets. The expansion of the agricultural frontier (wheat, maize, and increasingly, soybeans, to provide for European and Asian demand) toward the west, as well as the detriment of extensive grazing, has exacerbated traditional problems of soil erosion (about 25 million hectares of cropland and pastures were affected to some degree at the end of the 1990s) and desertification, as well as creating new problems, such as the proliferation of pesticides (between 1992 and 1996, sales of pesticides went from $400 million to almost $800 million). Moreover, Argentina is second in the world (after the United States) in the use of genetically modified crops.

Mining is rapidly expanding in the foothills of the Andean region. The exploitation of copper and gold ores has been facilitated by the substantial incentives given by the Argentine government to foreign companies (especially American, British, Spanish, and French). In 1993, the sector was freed from regulatory hurdles, and exports rose from $200 million in 1996 to $1.2 billion in 2004. Many local communities, however, have complained about the increasing levels of cyanide and other heavy metals found in the streams close to gold and silver operations.

Potential pollution by raw commodity production is also the source of international conflict. In 2006, Argentina requested the intervention of the International Court of The Hague to halt the construction of two polluting pulp and paper factories on the Uruguayan side of the fluvial border between the two countries.

Heavy flooding, especially of the northern rivers, has become a recurrent problem in the last decades of the late 1990s and early 2000s. Uncontrolled urbanization of flood-prone land (above all by poor populations) has contributed to an increased death toll from flooding in the Buenos Aires area and in other cities in the same time period. Some evidence indicates that the flooding may be due to an increase in precipitation and river flows (including a 30 to 40 percent increase in the Paraná and Uruguay Rivers) during the period 1950–2000. Furthermore, the water levels of the Rio de la Plata rose about 17 centimeters during the 20th century. For example, in May 2003, flooding by the Salado River resulted in 900 dead or missing and forced the evacuation of 36,000 in the city of Santa Fe. In 2005, the World Bank approved a substantial credit to finance the construction of flood control works in the capital.

Argentina is home to the oldest protected area in South America (1903) and also the oldest National Park Service (1932). In 2003, about 6.3 percent of the total area of the country was held under some kind of protection. The country has 11 Ramsar sites (wetlands of international importance designated under the Ramsar Convention) and 10 Biosphere Reserves, including spectacular areas such as the Perito Moreno Glacier in the south. Although not forced to do so by the Kyoto Protocol, Argentina has signed a voluntary program to reduce greenhouse gas emissions to combat climate change.

SEE ALSO: Biosphere Reserves; Desertification; Floods and Flood Control; Genetically Modified Organisms; Glaciers; Mining; Soil Erosion.

Opening of Patagonia

Humans lived in the southern part of Argentina, and also of Chile, known as Patagonia, from at least the 13th millennium B.C.E. It was first noted by Europeans when Ferdinand Magellan's expedition passed by in 1520. Later, Charles V of Spain (reigned 1516-1556 as "Charles I") conferred western Patagonia on Simón de Alcazaba Sotomayor, who sent Rodrigo de Isla to cross the region. However, his men mutinied and they never explored the whole of Patagonia.

Gradually, during the latter years of the sixteenth century, many more Europeans reached Patagonia, including Francis Drake, who sailed past in 1577 in the first part of his voyage around the world. However, it was not until the late eighteenth century that concerted attempts opened up the region for settlement and for agriculture. The founder of Chile, Bernardo O'Higgins, sent an expedition that formally established the city of Punta Arenas in 1848, six years after O'Higgins had died. It grew quickly, serving as a stopping-off point for the ships taking prospectors to the 1849 Californian Gold Rush. The nearby Argentine city Río Gallegos was founded in 1885.

In the late nineteenth and early twentieth centuries Patagonia—both Chilean and Argentine—were opened up for agriculture with many large sheep farms established. A number of the families there have close connections with those in the Falkland Islands (Islas Malvinas).

In 1921 there was a massive series of strikes in Argentina Patagonia, which were exploited by Anarchists who tried to take power. These were savagely put down by the local landowners, including the well-known Menendez family. Patagonia is now well-known through two books: *The Uttermost Part of the Earth* (1948) by E. Lucas Bridges (1874-1949), and *In Patagonia* (1977) by Bruce Chatwin.

BIBLIOGRAPHY. James Brennan, *Region and Nation: Politics, Economy, and Society in Twentieth-Century Argentina* (Palgrave Macmillan, 2000); "Argentina Warns of Climate Crisis," *BBC News*, http://news.bbc.co.uk/1/hi/sci/tech/4073933.stm (cited February 2007); Energy Information Administration website, http://www.eia.doe.gov/emeu/cabs/argenv.html (cited February 2007).

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Arid Lands

Growing populations in arid lands exert pressure on local resources, extending cultivation into marginal areas.

ARID LANDS ARE characterized by low rainfall and high evapotranspiration. Depending on definition, they are also referred to as drylands, or alternatively, as one category within drylands. For this purpose, arid lands are described in their broader definition as drylands. Drylands encompass arid, semi-arid, and sub-humid zones where average annual rainfall is lower than total evapotranspiration (classified using the aridity index). Drylands generally exclude true deserts, such as the Sahara, which are considered hyper-arid and are of low productive potential and consequently low population density. Drylands cover 41 percent of the earth's land surface and support more than one-third of its population. Every continent contains drylands that often cover extensive areas. However, they are most extensive in Africa and Asia. Australia, the United States, Russia, and China have large dryland areas. Other countries, such as Botswana, Burkina Faso, Turkmenistan, and Iraq, however, have nearly all of their area classified as drylands. Some of the commonly known drylands include the Sahel (Africa), the Australian Outback, Patagonia (South America), and the Great Plains (North America).

ENVIRONMENT AND POPULATION

Popular misconceptions conceive drylands as empty spaces that are barren and unproductive. In reality, drylands are complex ecosystems with unique biodiversity and environmental goods and services that provide a basis of living for millions of people. Drylands cover a range of ecosystems that are highly heterogeneous in their topography, climate, geology, and biodiversity. Drylands are comprised of deserts (except hyper-arid deserts), grasslands, savannas, shrublands and woodlands, agricultural lands, and urban areas. Plants and animals have to cope with scarce water supplies due to low annual rainfall, high variability, and high temperatures. Most species have adapted to the conditions, such as plants that have deep and extensive root systems and photosynthesize at night, and animals that stay inactive during the day. The lack of reliable rainfall makes other water sources, such as groundwater, streams, and dew, even more important.

Drylands are generally exposed to climate regimes that are not favorable for crop production, as rainfall patterns are unpredictable. Nonetheless, more than two billion people live in drylands, mainly in developing countries. Here, populations are among the poorest in the world. Particularly in Africa, South America, and Asia, inhabitants are heavily dependent on dryland resources to meet their basic needs. Drylands lag far behind in economy, infrastructure, well-being, and development terms. For instance, infant mortality in drylands in developing countries is twice as high as in nondryland areas, and 10 times higher than in developed countries. Moreover, access to clean drinking water and adequate sanitation is inadequate and leads to poor health conditions.

Although drylands are considered marginal for agriculture due to limited water resources, they currently account for more than 40 percent of the global cultivated area. Communities make a living as small-scale farmers or livestock herders and rely on drylands for wood fuel, construction materials, and medicinal plants. However, people are highly vulnerable to periodic droughts and are affected by food insecurity. While the majority of populations live in rural areas, large cities are located in drylands, such as Cairo, Mexico City, Teheran, Cape Town, and Las Vegas. Drylands have supported people's livelihoods for thousands of years. Their communities are highly resilient and have developed sustainable lifestyles and systems allowing them to survive in these harsh conditions and manage limited natural resources. Drylands are also the origin of important food grains (such as wheat, sorghum, barley, and millet).

CHALLENGES AND OPPORTUNITIES

Over time, there have been misunderstandings surrounding drylands and the human impact on these systems. One of the most controversial debates concerns that of land degradation and desertification. During the early 20th century, scientists started raising concern about degradation, blaming vegetation change on overgrazing, deforestation, and unsustainable land management. Global estimates on land degradation in drylands vary considerably anywhere from 20 to 70 percent. The coexistence of high levels of poverty and food insecurity with high rates of land degradation in drylands has led to the understanding that these factors are closely related. This relationship can best be described as a downward spiral of poverty and degradation, where resource-poor farmers place increased pressure on the land, while degradation affects land productivity, leading to a decline in crop yields and contributes to food insecurity. In recent years, however, evidence suggests that the relationship between poverty and land degradation is not always that causal, but highly dependent on local conditions. It is also understood that climate plays a more prominent role than previously assumed.

LIVING IN THE DRYLANDS

Drylands have some of the highest population growth rates in the world. This is not only true in developing countries, but also in the developed world. States in the southwestern United States, such as Nevada and Arizona, have some of the fastest growing populations in the country due to substantial in-migration. Within the context of high growth rates, urban areas are rapidly expanding, and growing demands for food and water have significant impacts on dryland environments. Growing populations are placing increasing pressure on available resources, which may result in the extension of cultivation into more marginal areas. Resource conflicts are increasing and destabilizing people's ability to cope with natural disasters. Land degradation, in combination with increasing populations, may trigger severe food crises in the future. These processes are anticipated to worsen over the next decades, as population growth is likely to exacerbate resource scarcity problems. Continuing oil development and ambitious water developments are anticipated to significantly impact drylands. Moreover, forecasts predict significant impacts of climate change in drylands, where drier and hotter climates are expected. This may affect agricultural potential and food security.

Drylands will continue to supply a range of goods and services and possess comparative advantages that may provide opportunities in the future. If water supplies can be stabilized, drylands provide good conditions for food and forage production. Wild varieties of major food crops are sources of plant genetic materials for developing drought-resistant crops. The potential for alternative energy production is high, through solar and wind power.

Unique landscapes and biodiversity attract tourism. There is also the potential for drylands to act as carbon sinks to mitigate climate change.

Considering their economic importance, geographic extent, environmental diversity, and human welfare, drylands should be placed high on political agendas. Historically, this was rarely the case, due to their remoteness and the perception that drylands are simple ecosystems of little economic value. With population growth, dwindling resources, and climate change, food insecurity in drylands is likely to worsen. The challenge faced by the international community is to sustain growing populations in drylands, while alleviating poverty and safeguarding the environment.

The reduction of poverty in drylands needs to become a priority, particularly within the context of international development efforts (such as the Uited Nations [UN] Millennium Development Goals). The UN declared 2006 the International Year of Deserts and Desertification, creating a platform for discussion and research.

SEE ALSO: Desert, Desertification; Sahel; Sahara Desert; United States, Great Plains.

BIBLIOGRAPHY. P. Beaumont, *Drylands: Environmental Management and Development* (Routledge, 1989); C. Hutchinson, S. Herrmann, and W. Foerch, *The Future of Drylands–Revisited: A Review of Fifty Years of Drylands Research* (United Nations Educational, Scientific and Cultural Organization, in press); M. Leach and R. Mearns, *The Lie of the Land: Challenging Received Wisdom on the African Environment* (International African Institute, 1996); M. Mortimore, *Roots in the African Dust: Sustaining the Drylands* (Cambridge University Press, 1998); A. Warren, Y.C. Sud, and B. Rozanov, "The Future of Deserts," *Journal of Arid Environments* (v.32, 1996); R.P. White and J. Nackoney, *Drylands, People, and Ecosystem Goods and Services: A Web-Based Geospatial Analysis* (World Resources Institute, 2003); R.P. White, D. Tunstall, and N. Henninger, *An Ecosystem Approach to Drylands: Building Support for New Development Policies. Information Policy Brief* (World Resources Institute, 2002).

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Aristotle

ARISTOTLE, WITH PLATO, were the two Greek philosophers who most influenced Western thought, including views of the natural world. Aristotle's original and systematic compilation of observation and speculation shaped the history of science and philosophy for centuries.

Aristotle wrote treatises on nearly every branch of human knowledge, from politics to poetry. He was profoundly interested in the facts of nature, and his best scientific work includes a number of volumes on biology, which formed the greatest synthesis of his time. Of note are his studies of the anatomy and physiology of Mediterranean animals, which show him to be a keen observer and anatomist. His work was not without error, however. Some of his more improbable ideas appear to have come from secondhand data or folklore.

Aristotle classified animals by genera and species and arranged over 500 of them into hierarchies, some of them having correspondences with modern classification systems. He also wrote on earth science, including observations on the hydrologic cycle, as well as on other terrestrial and celestial phenomena, and he presented a model of cyclical changes in the earth's history over great spans of time.

ARISTOLE'S *SCALA NATURAE*

Aristotle proposed a system to make sense of the relationship between natural beings. His *scala naturae,* or ladder of life, ranks all species from the simplest to the most advanced in terms of their "soul," or organizing principle. Plants were the lowest forms of life on the scale, having a soul that preserves itself. Animals were above, with a soul that allows them sensations, desires, and movement. Humans shared the principles of the ranks below them, but also had a rational element, which was uniquely their own. This teleological system was authoritative in Western thought until at least the 17th century.

Aristotle considered the universe as ultimately perfect, so he did not allow for any empty spaces on this ladder nor for any change in species. This restrictive concept of fixed species was not entirely rejected in science until Darwin's evolutionary theories suggested a more dynamic vision for the natural world.

It is also indicative of Aristotle's failure to recognize that the earth is neither stable nor eternal.

The "ladder of life" analogy is considered anthropocentric in that it encouraged the view that humans are the ultimate beneficiaries of the lower stages on the scale of nature. It also places humans in the privileged position of being the only species having *logos,* or reason. This criticism has been rejected by some philosophers who point to Aristotle's frequent discussions of animal intelligence as evidence that he saw some form of kinship between humans and animals and had a gradual continuum in mind for species, not a series of distinct gaps. Other philosophers argue that Aristotle's ethics provide a basis for concern for others, even nonhumans.

One of the reasons why there is much speculation about Aristotle's views on environmental issues is that he, and most Greek philosophers, said almost nothing about the subject directly. It appears that they did not see their environment as threatened, despite evidence that environmental degradation was occurring in the ancient world. Many environmentalists regard Classical and biblical attitudes toward the environment as insensitive and thus bearing some measure of responsibility for today's ecological crisis. Despite this, several ecophilosophers feel that the writings of the founders of Western philosophy make a positive contribution to discussions of environmental ethics.

SEE ALSO: Animals; Anthropocentrism; Darwin, Charles; Hydrologic Cycle; Linnaeus, Carl.

BIBLIOGRAPHY. Gabriela R. Carone, "The Classical Greek Tradition," in Dale Jamieson, ed., *Companion to Environmental Philosophy* (Blackwell Publishing, 2003); Susanne E. Foster, "Aristotle and the Environment," *Environmental Ethics* (Winter 2002); J. Donald Hughes, *Pan's Travail: Environmental Problems of the Ancient Greeks and Romans* (John Hopkins University Press, 1994); Laura Westra and Thomas M. Robinson, eds., *The Greeks and the Environment* (Rowman and Littlefield, 1997); "Works of Aristotle," http://graduate.gradsch.uga.edu/archive/Aristotle.html (cited April 2006).

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Armenia

ALTHOUGH LANDLOCKED, THIS Asian country has 1,400 square kilometers of inland water. The climate of Armenia is highland continental with hot summers and cold winters. Rivers tend to be fast flowing. Much of the terrain is mountainous, with elevations ranging from 400 to 4,090 meters. Because of the mountains, travel within Armenia is often difficult. In addition to frequent droughts, Armenia is subject to occasionally severe earthquakes that damage the environment and threaten human lives. For instance, an earthquake that hit Leninakan (Gyumri) in 1988 cost 25,000 lives.

Armenia's limited mineral resources include small deposits of gold, copper, molybdenum, zinc, and aluminum. After a long period of industrialization and resource exploitation under communism, many Armenians have returned to agrarian production. Approximately 18 percent of the land is arable, and the soil is particularly fertile in the Aras River Valley. Some 45 percent of the population is involved in agriculture. Nevertheless, Armenia imports most of its food.

Around 65 percent of Armenians live in urban areas. With a current population of 2,982,094, Armenia has a negative growth rate (minus 0.25 percent). The per capita income of $5,100 places Armenia in 129th place in world incomes. Experiencing a poverty rate of 43 percent and an unemployment rate of 30 percent, Armenia is still struggling to regain equilibrium as an independent nation.

ENVIRONMENTAL CONCERNS

Eight percent of Armenians do not have sustained access to safe drinking water, and 16 percent do not have access to improved sanitation. The United Nations Development Program (UNDP) Human Development Reports rank Armenia 83rd among 232 nations in overall quality-of-life issues.

Environmental problems, many of them legacies of authoritarian rule and conflict with neighbors, including Azerbaijan, are extensive in Armenia. The soil is heavily polluted from the use of pesticides such as DDT. Around 12.4 percent of land area is forested. Extensive deforestation began during the energy crisis of the 1990s, as Armenians burned trees for firewood. Illegal logging has continued in response to the demand for timber.

The Hrazdan and Aras Rivers are heavily polluted, and drinking water supplies have been threatened by the draining of Lake Sevan as a hydropower source. Desertification has become an issue in certain areas, and the government has replaced parks and other natural areas with homes and businesses. In 2005, the government announced plans to build a major highway through the Shikahogh Nature Reserve, placing 1,000 species of plants and wildlife at risk and destroying tens of thousands of trees.

While 7.6 percent of Armenia's land is protected, reserved areas are vulnerable to the whims of the government. Of 84 endemic species of mammals, 11 are threatened with extinction. Four of 236 species of birds are also endangered. Environmentalists around the globe are greatly concerned about the reopening of the Metsamor nuclear power plant, which closed after the 1988 earthquake.

There is considerable international pressure on the government to shut down the plant. A study by Yale University in 2006 ranked Armenia 69th of 132 countries on environmental performance, slightly below the relevant income and geographic groups. The lowest scores were in the categories of air quality, water resources, and sustainable energy.

The Ministry of Nature Protection, in conjunction with the Ministers of Health, Agriculture, and Urban Development, is responsible for implementing environmental law in Armenia. In the late 1990s, the government passed a bevy of environmental laws within the framework of the National Environmental Action Plan. Particular laws targeted the problems of desertification, ozone depletion, water resource management, and organic pollutants. Since 2000, new laws have been enacted that include land, water, and mineral resources code. Additional modernization of environmental laws is underway.

Armenia has signed the following international agreements: Air Pollution, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Wetlands. The agreement on Air Pollution–Persistent Organic Pollutants has been signed but not ratified.

SEE ALSO: Azerbaijan; Desertification; Earthquakes; Endangered Species; Kyoto Protocol; Nuclear Power; Poverty.

BIBLIOGRAPHY. CIA, "Armenia," www.cia.gov/cia/publications/factbook/geos/am.html (cited April 2006); Committee on Environment Policy, "The Report of Republic of Armenia on the Results of Implementation of EPR Recommendations" (Geneva: Committee on Environmental Policy, 2004); Country Studies, "Armenia: The Environment and Society," www.country-studies.com (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Armenia," hdr.undp.org (cited April 2006); World Bank, "Armenia," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Army Corps of Engineers (U.S.)

FOLLOWING THE Revolutionary War, where military engineering proved important to American independence, President George Washington and Congress recognized the need for a group of experts to help the American armed forces and the early Republic. The Continental Congress had organized this corps of the army in 1775, and the U.S. Congress followed suit with its formal legal creation in 1802. Over the next 40 years, the corps was repeatedly disbanded and reestablished according to need. While the corps distinguished itself in military activities throughout the 19th century, the corp's development coincided with the great period of westward expansion and economic growth, especially through the development of harbors and waterways, which would become the agency's central task for the next century and a half.

In its early stages, the Army Corps of Engineers were central to exploration in the U.S. West, including expeditions through the Rocky Mountains. They also surveyed the lines for the earliest western railroads. So too, they assisted in the planning and construction of important public buildings, especially construction projects in the area of Washington, D.C., such as the Capitol, the General Post Office, the city's aqueducts, the custom houses, and the marine hospitals.

The main objectives of the corps, however, came to relate to matters of river and harbor improvement and the interest of commerce and speedy transit between locations. The corps was crucial in the planning and construction of the Panama Canal, coastal surveys, and planning and construction of lighthouses. In addition to water infrastructure, this mandate expanded over time to include services in the area of responses to natural and manmade disasters and environmental management and restoration. An important part of civil works is the maintenance and improvement of channels of water to help with their navigation. The corps also works to protect against flood damage to areas where high amounts of wreckage are prone to occur. They advise communities on zoning regulations and warn people about possible flooding conditions in their area. During the period from 1991 to 2000, the United States suffered from $45 billion worth of property damage, and the Corps of Engineers estimates that they prevented more than $208 billion of further damage.

EMERGENCY RESPONSE

The Corps of Engineers also responds to such disasters and emergencies on state and local levels. Most of these situations involve water emergencies and the corps conducts their activities under the Stafford Disaster and Emergency Assistance Act and the Flood and Coastal Emergency Act. Water research and development is another program supported by the corps for the general public. The facilities set up by the corps conduct research in areas like water systems, soil and rock mechanics, earthquake engineering, coastal engineering, and also the effects of weapons on specific structures.

Perhaps the Army Corp's greatest challenge has been its mission, assigned since 1850, to manage flooding on the Mississippi River. It has done so through the construction of a complex system of locks, dams, and levees that have fundamentally transformed the river into a tame transportation system. The costs of doing so have included the destruction of a great many wetlands and the creation of many high maintenance locations where levees hold back flood waters against growing populations, as in New Orleans.

At times, this development-oriented mission has put the corps into conflict with both environmental interests and political agencies and offices. Most notably in 1977, shortly after the election of President James Earl Carter—himself an engineer—announced his intention to de-fund 19 planned water development projects (predominantly dams), eleven of which were Army Corps projects. Through their congressional allies on the appropriations committee, the corps was able to maintain its ongoing projects and actually extend funding for new water management projects over the next year. The successful showdown with the president shows the power and independence of the Army Corps and the way its development-oriented mandate has aided in building alliances for protection of its federally budgeted projects. Nevertheless, it remains a target of the environmental community, who continue to associate the corps with destruction of native waterways and habitat. An increased effort on the part of the corps to reach out to this community has yielded only limited results.

The corps has demonstrated remarkable adaptivity, however, in the face of changing political and environmental conditions. While maintaining its military mission, it has expanded its domestic mission, and come to face continued challenges to its budgets and existence by taking on more new responsibilities. When the National Environmental Policy Act was passed in 1969, for example, with its added burden of environmental impact assessments for all federal activities, the corps embraced the problem and revised its procedures to become one of the key providers of such assessments for the government.

A further example of this adaptation is the remarkable turnaround of the corps from a dredger and filler of wetlands to an agency that now protects and constructs them. Through Section 404 of the Clean Water Act, of 1972, the corps became a key provisioner of permits for dredging and filling wetlands, and an agency increasingly associated with conservation efforts. Indeed, the U.S. Army Corps of Engineers has come to be a specialist in ecosystem restoration, environmental stewardship such as protecting wildlife habitats from pollution and wetlands and waterway regulation. The corps also assists in the cleanup of sites that are contaminated with hazardous and radioactive waste.

The U.S. Army Corps of Engineers is currently made up of approximately 34,600 civilian members and 650 military members. Some of these people include biologists, hydrologists, geologists, engineers, and scientists. The corps headquarters is in Washington, D.C., and there is another satellite headquarters in Alexandria, VA. The corps is separated into eight divisions and is supported by 41 local districts.

SEE ALSO: Clean Water Act; Dams; Floods and Flood Control; NEPA; Recreation and Recreationists; Waste; Wetlands; Nuclear.

BIBLIOGRAPHY. Brevet Brigadier-General Henry L. Abbot, "The Corps of Engineers" (2002), U.S. Army Center of Military History, www.army.mil (cited November 2005); Clarke, J. N. and D. C. McCool, *Staking out the Terrain: Power and Performance Among Natural Resource Agencies* (Albany, State University of New York Press, 2006) U.S. Army Corps of Engineers, "United States Army Corps of Engineers" (2005), www.usace.army.mil/ (cited November 2005).

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Arsenic

ARSENIC IS AN elemental metalloid that has an atomic number of 33 and symbol "As" in the periodic table. Its name originates from the Greek word *Arsenikon* (meaning potent). It is a common element found in nature, although not in its pure elemental form but rather in ores and sulfides. Arsenic is commonly found in geologic sediments and rocks, generally in the forms of arsenopyrite, orpiment, realgar, lollingite, and tennantite. Arsenic is usually a grayish or yellowish element, and it sublimes into its oxide form upon heating.

Arsenic occurs in high amounts in the sediments of many countries, most notably Bangladesh, India, Cambodia, Laos, Vietnam, China, the United States (primarily the southwest), and Argentina.

Arsenic is commonly used in pesticides, herbicides, alloys, and semiconductor material. It has historically has been used in paint (e.g., Paris Green), pressure-treated wood, cosmetics, and antibiotics (among various other medicinal purposes). However, such uses have largely been discontinued due to the toxic nature of arsenic. Arsenic is extremely poisonous, and small quantities can kill instantly. As such, arsenic has often been called the "king of poisons" and the "poison of kings," due to its historical use in alleged and real deaths and murders, and difficulty of detection. Arsenic has been linked to the deaths of famous figures, such as Napoleon Bonaparte and King George III.

ARSENIC CONTAMINATION

In recent years, concerns about arsenic in groundwater and drinking water supplies have become a major concern. The World Health Organization (WHO) advises that drinking water should not have more than 10 microgram/liter (or parts per billion, ppb) of arsenic, as higher doses can prove to be cumulatively toxic. Arsenic ingestion can lead to gastrointestinal problems, headaches, and nausea when in smaller doses, but higher doses and chronic poisoning can lead to melanosis and keratosis of the skin, liver and kidney failure, heart problems, gangrenes, cancer, and eventually death. As such, small quantities of arsenic in drinking water (from naturally occurring arsenic in the geology or from agricultural and industrial pollution) can lead to various health symptoms of arsenic poisoning (also often called arsenicosis) over numbers of years.

One of the worst cases of arsenic poisoning is in Bangladesh, where over 35 million people are consuming well water with high concentrations of arsenic. The arsenic in geologic deposits has shown up in high concentrations in groundwater that is predominantly used for drinking water and irrigation purposes. Tests of well water have shown that over

2 million tubewells contain arsenic that is greater than the Bangladesh government's standards of allowable arsenic (at 50 microgram/liter or 50 ppb); note that this standard is not the same as the WHO's standard. Drinking water with more than 50 ppb of arsenic generally means that the person has one in 100 chance of getting cancer; presently there are over 40,000 arsenicosis patients in Bangladesh; the figures are expected to rise as more patients are identified, and because symptoms can take 5 to 15 years to fully manifest themselves. Given the large number of people currently consuming poisoned water with inadequate alternative water sources, the WHO has termed the case the "worst mass poisoning of a people in history." Present attempts to provide safe water include removing arsenic from contaminated water and nongroundwater-based water options.

In the United States, arsenic in drinking water supplies caused considerable debate in the last few years. The change of government standards from 50 ppb to 10 ppb meant a greater investment in removal costs. Some politicians argued that the standard should have been below 10 ppb, in order to make water more arsenic-free; the costs involved as well as the lack of compelling need to do so are generally argued to be reasons of retaining the WHO's recommended standard. How much arsenic is deemed safe is thus both a scientific and technological issue as well as an economic and political one.

SEE ALSO: Bangladesh; Drinking Water; Groundwater; Herbicides; Pesticides.

BIBLIOGRAPHY: Feroze Ahmed, ed., *Arsenic Contamination: Bangladesh Perspective* (Bangladesh University of Engineering and Technology, 2003); Harvard University Arsenic Project, "Chronic Arsenic Poisoning: History, Study, and Remediation," http://phys4.harvard. edu/~wilson/arsenic/arsenic_project_ introduction.html (cited April 2006); Andrew Meharg, *Venomous Earth—How Arsenic Caused the World's Worst Mass Poisoning* (Macmillan Science, 2005); West Bengal and Bangladesh Arsenic Crisis Information Centre, http://bicn.com/acic/ (cited April 2006); World Health Organization, "Arsenic in Drinking Water," Fact Sheet No. 210, www.who.int (cited April 2006).

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Asbestos

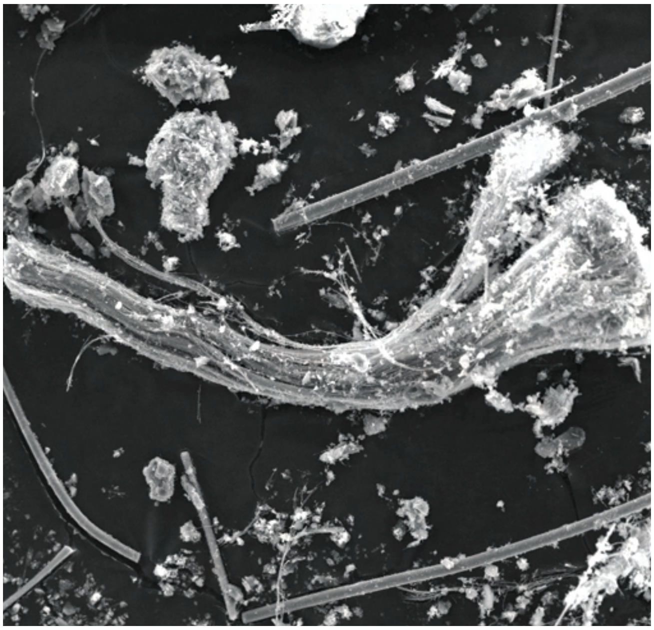
ASBESTOS IS A mineral that is separable into long and thin fibers and was used extensively in building work. Because of its toxic effects, asbestos has subsequently been phased out of uses in which it comes into contact with people, although lingering health impacts remain, as do issues concerning litigation and liability.

Although there are several different minerals that can be considered to be asbestos, the overwhelming proportion is in the form of Chrysotile ($Mg_3Si_2O_5(OH)_4$), which is a hydrous magnesium silicate known for thousands of years to be resistant to fire and also possibly injurious to health. Asbestos appears in its chrysotile form as a white fibrous mineral. Two other forms of asbestos, blue asbestos (Crocidolite) and brown asbestos (Amosite) are also important in industry and are known to be more dangerous than white asbestos.

Asbestos-bearing rock is quarried from mines and then crushed and blown to free the fibers from the accompanying rock. The longest fibers are spun into yarn, while the shorter ones are converted into various building materials, some mixed with concrete. It is the qualities of resistance to flame and chemicals that makes asbestos usage so popular with building materials and thousands of other applications. Although in itself it is difficult to work with, because of its physical characteristics, asbestos does mix well with other substances, which makes it much more versatile. Together with cotton, it has been used to form fabrics for applications such as brake linings, insulation, and safety clothing. Public buildings in many countries have been lined with asbestos for flame retardant purposes, as too were many public housing units.

PRODUCTION

Industrial-scale production began in Italy during the nineteenth century, with mines subsequently opened in many countries. The principal producers of asbestos became Canada, particularly Quebec and the Urals region of Russia. Production has subsequently declined as new health and safety regulations have restricted its use in most countries. Mine production of 3.5 million tons of asbestos in 1996 is not likely to



Chrysotile asbestos, detected in trace levels in dust and airfall debris at the World Trade Center site after 9/11.

be exceeded in the future, although production continued in earnest in China, in particular, including at several forced labor camps. Statistics about asbestosis and asbestos-related lung cancers from China are, unsurprisingly, not freely available.

INDUSTRIAL RESPONSIBILITY

Breathing in asbestos fibers leads to a lung condition known as asbestosis or the form of lung cancer known as mesothelioma, which is a deadly and swift-acting disease. Prolonged exposure to asbestos, such as living in a house in which asbestos has been used for insulation, can be sufficient for asbestosis to be caused. It was not until the 1970s that sufficient information became available for definitive judgments concerning the dangers posed by asbestos and, since then, regulations discouraging and then preventing its use have been introduced into many countries of the world.

However, this progress remains very slow, and thousands are killed annually by exposure to the substance. Moreover, the long latency periods between inhalation of asbestos fibers and the onset of disease, and the tardiness in implementing bans in the past, means that more deaths are expected in the future. The International Labour Organisation (ILO), for example, estimates that around 100,000 people contract diseases annually because of work-related asbestos exposure. Deaths in developed countries will be intense as well, since asbestos has been used in many public buildings. The extent to which this occurs was revealed around the time of the 9/11 terrorist attacks in the United States, when the concentrations of asbestos in many buildings became part of the public domain for the first time. Issues surrounding liability in terms of exposure to asbestos remain unresolved in the United States, where corporate interests have been trying to limit responsibility. The engineering company Halliburton made a $4.2 billion settlement to claimants in 2004 as a result of suits field against a business it had previously purchased. Some have claimed that asbestos exposure may prove to be the largest potential burden for business in the foreseeable future.

Although new uses of asbestos are inhibited in most parts of the world, exposure still occurs when buildings are demolished and the insulation revealed, or else ship breaking or similar industrial activities undertaken. Clearly, the poor workers of the world are disproportionately likely to suffer from this exposure because safety equipment and policy is expensive and may be difficult to obtain. Disincentives exist, therefore, and tend to discriminate against the poor and the vulnerable. Some countries, notably Canada, where asbestos mining remains an important industry, have been slow to introduce regulations to restrict the export and use of the substance, and have continued to promote its use in other countries.

BIBLIOGRAPHY. Barry I Castleman, *Asbestos: Medical and Legal Aspects, 5th edition* (Aspen Publishers, 2005); Ronald F. Dodson and Samuel P. Hammar, eds. *Asbestos: Risk Assessment, Epidemiology, and Health Effects* (CRC, 2005); International Labour Organization (ILO), “Asbestos: The Iron Grip of Latency,” www.ilo.org (cited 19, 2006); Laurie Kazan-Allen, *British Asbestos Newsletter*, No. 29, www.lkaz.demon.co.uk/ban29.htm. (cited November 1997); Abrahm Lustgarten, “The Toxic Fallout of 9/11,” *Salon*, www.salon.com (cited August 15, 2003).

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Aswan High Dam

LOCATED ON THE Nile River, just north of the border between Egypt and the Sudan, the Aswan High Dam slows the flow of the Nile River northward through Egypt. Finished in 1971, the dam controls flooding, insures a reliable and regular water supply to irrigated farms along the river, and provides hydroelectric power and water for human consumption and industrial use to the rapidly expanding populations of Cairo and other cities of Egypt. Behind the dam lies Lake Nasser, which contains some 200 billion cubic feet of water and is about 500 kilometers long and, on average, 12 kilometers wide.

Like most major dam projects, the Aswan High Dam has attracted many critics since the initial announcement of the plans for its construction. Environmentalists have worried about the effects on the river's ecological balance. Cultural observers have expressed concerns about the effects on people displaced by Lake Nasser. And antiquarians have bemoaned the loss of identified but as yet unexcavated archaeological sites.

FLOODING

In most years, the annual flooding of the Nile was a boon to Egyptian farmers. But at regular intervals, heavy floods washed away their crops, or drought dramatically lowered the river level and made it very difficult for farmers to fill their irrigation canals. The dam permits controlled and year-round releases of water. As a result, Egyptian farmers have been able to increase their output from one to three harvests per year, depending on the crop.

In addition, more than 950,000 million acres of newly irrigated land have been brought into production. On the downside, the dam has encouraged urban growth, which has eliminated about 600,000 acres formerly devoted to agriculture. Moreover, the controlled flow of the river has reduced the delta-building that formerly resulted from the river's heavy seasonal flooding. In fact, the reduction in the silt carried seaward by the Nile has resulted in increased erosion of the existing delta and adjacent shoreline. Along the river below the dam, the water table has risen, causing a buildup of salts in the soil that reduces fertility.

The construction of the dam has meant the demise of the sardine fishing industry in the Nile, but increased catches in the waters off the Nile delta have been attributed to concentrations of nutrients caused by the dam, and the development of a major fishing industry in Lake Nasser remains a promising if as yet unrealized possibility. The dam has dramatically increased the growth of vegetation in downstream stretches of the river, but that vegetation has been harvested for agricultural use as compost.

PUBLIC HEALTH EFFECTS

The dam has produced similarly mixed effects in terms of public health. On the one hand, the project has been a public-health blessing, ensuring that Egypt's population will have the sort of reliable water supply that is the most important factor in reducing the incidence of diseases—such as enteritis and hepatitis—that plague Third World nations and reduce their economic output. On the other hand, the expansion of perennial irrigation following the construction of the dam facilitated the spread of the gambiae mosquito, a key carrier of malaria, which became the focus of a resulting national health campaign. So too, the concentration of this water supply in one place also increases the incidence of other waterborne parasitic diseases such as schistosomiasis.

Ironically, the people most likely to experience increased incidences of these parasitic diseases have been the 100,000 Nubians who were forced to relocate when Lake Nasser covered the sites of their former villages and towns. In the end, the most dire predictions about increases in waterborne parasitic diseases have not proven accurate—in large part because the dam has made possible the increased development of water treatment plants and the broader availability of safe drinking water. But the tradeoffs of the Aswan High Dam demonstrate that while large-scale technologies solve environmental problems, their unintended consequences inevitably cause some as well.

SEE ALSO: Dams; Egypt; Floods and Flood Control.

BIBLIOGRAPHY. Hussein M. Fahim, *Egyptian Nubians: Resettlement and Years of Coping* (University of Utah Press, 1983); Hussein M. Fahim, *Dams, People,*

and Development: The Aswan High Dam Case (Pergamon, 1981); Leslie Greener, *High Dam over Nubia* (Cassell, 1962); Tom Little, *High Dam at Aswan: The Subjugation of the Nile* (John Day, 1965); Dale Whittington and Giorgio Guariso, *Water Management Models in Practice: A Case Study of the Aswan High Dam* (Elsevier Scientific, 1983).

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Atlantic Ocean

THE ATLANTIC OCEAN forms a broad s-shape from the Arctic Sea to the north and from Antarctica to the south. North America and South America are to the west; Europe and Africa are to the east. It is about half the size of the Pacific Ocean and slightly larger than the Indian Ocean. It covers 31,800,000 square miles (36,000,000 square kilometers) or 16 percent of the Earth's surface. If marginal seas are included, the coverage is nearly 20 percent. The ocean's principle marginal seas are the Caribbean Sea, the Gulf of Mexico, and the Hudson and Baffin bays to the west; the Arctic, Greenland, and Norwegian seas to the North; the Baltic, North, Mediterranean, and Black Seas to the east; and the Weddell Sea to the south. The Atlantic Ocean proper refers to the ocean minus its marginal seas.

The equator divides the Atlantic Ocean into the North Atlantic and the South Atlantic. Drake Passage (between the island of Tierra del Fuego and Antarctica) and the Magellan Strait (between Tierra del Fuego and South America) connects the South Atlantic to the Pacific Ocean. A broad stretch of water separating Africa and Antarctica connects the South Atlantic to the Indian Ocean. The North Atlantic's connection to the Pacific Ocean follows a circuitous series of straits among the northern Canadian islands to the Arctic Sea and thence to the Bering Strait.

Plate tectonics have given rise to the general topography of the seafloor. The gigantic north-south trending Mid-Atlantic spreading ridge makes up about one-third of the sea bottom and divides the Atlantic Ocean rather evenly into western and eastern halves. The ridge in most places rises to within

South Georgia is an island in the South Atlantic Ocean, about 1,300 kilometers east of the Falkland Islands.

about 1.5 miles (2.5 kilometers) of the surface and occasionally breaches the surface to form prominent oceanic islands: Iceland, the Azores, Ascension, St. Helena, and Tristan da Cuhna. On either side of the ridge are abyssal plains. The plains extend from the base of the mid-ocean ridge to the base of adjoining continents. The name "plain" implies that this part of the seafloor is a monotonous, uninteresting place. Actually, abyssal plains are remarkable for their deep sediments and life forms. On the landward sides of the plains, the sea bottom rises gently landward as continental shelves (submerged portions of continents). The average depth of abyssal plains is about 4 miles (6.5 kilometers). The ocean's average depth (without its marginal seas) is about 2.5 miles (4 kilometers), owing mainly to the Atlantic Ocean's broad, shallow continental shelves, which make up 13 percent of the Atlantic Ocean proper. The greatest depth (28,224 feet or 8,605 meters) is Milwaukee Deep, in the Puerto Rico Trench, north of Puerto Rico.

Available solar energy, which decreases with increasing latitude, affects the ocean's climate as well as its temperature and salinity levels. The high sun angles of the equatorial latitudes create warm tropical waters, a belt of low surface pressure, convergent trade winds, and convective thunderstorms. Salinity levels in this zone are especially low where large rivers—such as the Amazon, Orinoco, Niger and Congo Rivers—empty freshwater from the heavy rains into the sea. Moreover, the broad extent of tropical waters in the North Atlantic serve as the repository of heat energy that feeds an annual supply of tropical storms and hurricanes there.

Poleward of the equatorial low-pressure belt are subtropical high-pressure cells in each hemisphere. The high pressure inhibits cloud formation, so the annual rates of evaporation and salinity levels are high there. In the middle and subpolar latitudes, cyclonic storms form over the oceans. The storms generate above-average wave heights that are hazardous to ships and coastlines.

In polar latitudes, the air is formidably cold due to low sun angles and long winter days. The cold air pulls prodigious amounts of heat from the ocean, causing water temperatures to drop at or near the freezing mark. Salinity levels at these latitudes are high due to sea ice formation, which leaves salts concentrated in the remaining seawater. Icebergs shed from glaciers on Greenland and Baffin Island in the North Atlantic; and from Antarctica in the South Atlantic, venture into the middle latitudes as far as 40 degrees N and 50 degrees S latitudes before melting.

CURRENTS

Due to the Coriolis effect on wind-driven surface currents, major currents in the North Atlantic flow clockwise, whereas those in the South Atlantic travel counterclockwise. Each of these broad circulating loops (gyres) has an equatorial current component that flows parallel to the equator, a warm current section that carries tropical heat to polar latitudes, and a cold current that returns to the equator to store more heat from the tropical sun. The circulating water moderates the global temperatures by absorbing and transferring surplus tropical heat to polar regions. The Atlantic Ocean is also part of a global conveyor belt of Thermohaline (vertical) circulation that affects the global climate.

The Atlantic Ocean has continental, oceanic, and coral islands. The largest continental islands are made of bedrock exposures, such as Great Britain, Ireland, Greenland, and Newfoundland. Glacial deposits form smaller islands, such as Long Island (New York) and Martha's Vineyard (Massachusetts); barrier island deposits make up Hilton Head (North Carolina), Chincoteague (Virginia), and Fire (New York) islands.

Oceanic islands rise from the deep ocean floor rather than a continental shelf and are usually of volcanic origin. Atlantic examples of oceanic islands include the Azores Islands, the Canary Islands, the Cape Verde Islands, Iceland, and the Lesser Antilles. Coral islands can be of either the continental or the oceanic type. Most of those in the Atlantic Ocean are the high parts of a large limestone platform situated on continental shelves. The Bahamas and Florida Keys are examples of this type. Oceanic coral islands sit atop submerged volcanoes and are most typical of the western Pacific Ocean; Bermuda is an example of this island type in the Atlantic Ocean.

SEE ALSO: Oceanography; Oceans; Pacific Ocean.

BIBLIOGRAPHY. Cornelia Dean, *Against the Tide: The Battle for America's Beaches* (Columbia University Press, 1999); Robert E. Gabler, James F. Peterson, and L. Michael Trapasso, *Essentials of Physical Geography* (Brooks/Cole, 2004); Open University, *The Ocean Basins: Their Structure and Evolution* (Butterworth-Heinemann, 1998); J. Thomson and P. P. E. Weaver, eds., *The Geology and Geochemistry of Abyssal Plains*, Geological Society Special Publication No. 31 (Oxford: Blackwell Scientific Publishers for Geological Society of London, 1987); Harold V. Thurman and Allan P. Trujillo, *The Essentials of Oceanography* (Prentice Hall, 2001).

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Atmosphere

THE ATMOSPHERE IS an envelope of gases surrounding the solid earth. This mixture of gases provides the oxygen we need to live and is responsible for the global diversity of weather phenomena. In addition, the atmosphere protects life on the earth's surface from the harmful effects of high-energy solar radiation and keeps the average temperature of the earth at a life-sustaining level through the natural greenhouse effect.

Although the atmosphere is a fluid, it is prevented from escaping out to space by the force of gravity. This downward gravitational pull compresses the lower atmosphere, meaning that atmospheric density is highest near sea level and decreases as one ascends. As a result, most of the atmosphere is held very close to the earth's surface; approximately 90 percent of the atmosphere is within a mere 16 kilometers (10 miles) of sea level. The atmosphere doesn't have a real top—it fades away gradually as one moves away from the planet.

Atmospheric pressure is due to the weight of the overlying atmosphere pulled down by gravity. At sea level, with the entire atmosphere above us, atmospheric pressure is approximately 1,013 millibars, or 14.7 pounds per square inch (psi). As we move higher, there is less atmosphere above us, and so atmospheric pressure decreases with height. At 35,000 feet, the altitude of a typical cross-country airline flight, the air pressure will be only about 20 percent of the value at sea level.

COMPOSITION OF THE ATMOSPHERE

The composition of the atmosphere is dominated by three gases: nitrogen, oxygen, and argon. These gases are called "permanent gases" because their concentrations are nearly constant over time and space. Nitrogen (78 percent of the atmosphere) and argon (1 percent) are largely inert, meaning that they are used in very few geophysical or biological processes. Oxygen, which is crucial for nearly all life on earth, accounts for about 20 percent of dry air.

In addition to the permanent gases, there are several other gases known as "variable gases," which show up in changing amounts over time and space. Two of the most important variable gases are carbon dioxide and methane, both of which are potent greenhouse gases. The third, extremely important variable gas is water vapor, which is a strong greenhouse gas and is necessary for the formation of clouds and precipitation.

While air pressure shows a simple pattern of decreasing with height, another important atmospheric variable—temperature—exhibits a more complex vertical pattern. Changes in temperature above sea level allow us to divide the atmosphere into four layers: the troposphere, stratosphere, mesosphere, and thermosphere.

The source of the energy that warms the earth, drives the circulation of the atmosphere and ocean, and makes life possible is the sun. Energy travels from the sun to the earth in the form of electromagnetic (EM) radiation. Solar radiation is often referred to as "shortwave radiation," because the sun mainly emits radiation like visible light and ultraviolet (UV) radiation, which are characterized as having relatively short wavelengths. The atmosphere is largely transparent to these types of radiation, so most solar energy passes through the atmosphere and is absorbed by the earth's surface, which causes the surface to warm up.

As the earth's surface warms, it transfers energy to the overlying atmosphere through conduction and radiation. Because the main source of heat for the lower atmosphere is actually the ground, atmospheric temperature decreases with ascention, up to an elevation of about 12 kilometers (7.5 miles). This lower layer of the atmosphere, which contains nearly all weather phenomena, is called the troposphere.

Above the troposphere, atmospheric temperature begins to increase with height, in a layer known as the stratosphere. This layer contains most of the ozone (tri-atomic oxygen) in the atmosphere. Ozone is very good at absorbing the most dangerous forms of UV radiation. Because ozone in the stratosphere absorbs a significant amount of UV energy, the stratosphere gets warmer as you ascend through the ozone layer. The absorption of harmful UV radiation in the stratosphere provides protection to life at the surface.

The stratosphere continues up to a height of about 50 kilometers (31 miles). Above the stratosphere is the mesosphere (50–80 kilometers), which, like the troposphere, is characterized by decreasing temperature with height. Above the mesosphere is the thermosphere, which shows increasing temperature with height until the atmosphere eventually fades away. The mesosphere and the thermosphere together contain only about 0.1 percent of the atmosphere.

Compared to the sun, the earth emits what is referred to as "longwave radiation," which refers to forms of EM radiation like thermal infrared that have longer wavelengths than UV and visible light. The atmosphere is much less transparent to longwave radiation than it is to shortwave radiation, and so much of the energy emitted by the earth is absorbed by the atmosphere. The gases that are responsible for this absorption of longwave radiation are called greenhouse gases, and water vapor, carbon dioxide, and methane are the most prominent. The atmosphere also radiates longwave energy, and some of this radiation travels downward to the surface. This exchange of energy between the lower atmosphere and the earth's surface is the greenhouse effect, and it results in the earth's surface being about 30 degrees Celsius (54 degrees Fahrenheit) warmer than it would be without an atmosphere.

HUMAN IMPACT

Over the past century, human activities have had several important impacts on the atmosphere. The first of these is global warming, or the enhanced greenhouse effect. Various human activities such as the burning of fossil fuels, forest clearing, and agriculture have increased the atmospheric concentrations of greenhouse gases like carbon dioxide and methane. With more of these gases in the atmosphere, more longwave energy is absorbed, which causes the temperature of the lower atmosphere to rise. The average global temperature has increased by approximately 0.6 of a degree Celsius (1.1 degrees Fahrenheit) over the past century, and much of this warming is due to human-caused greenhouse gas increases. There have been many attempts to reach an international consensus on reducing greenhouse gases, including the Kyoto Protocol (1997). However, the United States, the world's largest emitter of greenhouse gases, has not signed on to the treaty.

The second major impact that humans have had on the atmosphere is the depletion of the ozone layer. Synthetic chemicals known as chlorofluorocarbons (CFCs) have been widely used as coolants, solvents, and propellants in aerosol sprays. Unfortunately, some of the CFCs released at the surface mix upward to the ozone layer. There, CFCs combine with and break apart ozone molecules, causing a thinning of the ozone layer. Ozone depletion was first noticed over Antarctica but has been observed over the northern hemisphere as well. Without the protection of the ozone layer, more damaging UV radiation reaches the surface, leading to increased occurrences of skin cancer and cataracts in humans, as well as having detrimental effects on animal and plant life. The dangers of ozone depletion were recognized in the 1970s, and an international agreement to phase out CFCs known as the Montreal Protocol was reached in 1987. Although the Montreal Protocol has successfully reduced CFC emissions, the concentrations of these gases in the stratosphere will remain high for decades, and the damage to the ozone layer will be slow to heal.

SEE ALSO: Carbon Dioxide; Chlorofluorocarbons; Global Warming; Greenhouse Effect; Greenhouse Gases; Kyoto Protocol; Methane; Montreal Protocol; Oxygen; Ozone and Ozone Depletion.

BIBLIOGRAPHY. Edward Aguado and James E. Burt, *Understanding Weather and Climate, 3rd edition* (Prentice-Hall, 2004); Frederick K. Lutgens and Edward J. Tarbuck, *The Atmosphere, 8th edition* (Prentice-Hall, 2001); Robin McIlveen, *Fundamentals of Weather and Climate* (Chapman and Hall, 1992); Greg O'Hare, John Sweeney, and Rob Wilby, *Weather, Climate, and Climate Change: Human Perspectives* (Prentice-Hall, 2005); Alan Strahler and Arthur Strahler, *Physical Geography: Science and System of the Human Environment, 3rd edition* (John Wiley & Sons, 2005).

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Atmospheric Science

ATMOSPHERIC SCIENCE IS the study of the atmosphere and the processes that take place within it. It has traditionally been divided into three related but separate disciplines: climatology, meteorology, and aeronomy. Climatology focuses on the statistical analysis of changes within layers of the atmosphere for extended periods, ranging up to centuries long or more. Meteorology relates to the short-term changes in the conditions of the lower layers of the atmosphere. Aeronomy, in contrast, focuses on the changes and dynamic processes taking place within the upper layers of the atmosphere above the troposphere.

Topics within atmospheric science include the chemistry of the atmosphere, the radiative processes that determine the distribution of heat within the atmosphere, and the formation and behavior of clouds. Since a number of important indicators and effects of climate change and future climate change are observed within the atmosphere, scientists working in this field have become in some cases embroiled in controversy.

While there is a broad consensus among scientists as to the impact of global climate change and its interrelationship with the actions of man, there are some who disagree and some who, motivated by political or financial reasons, attempt to obfuscate the reality of scientific data. Atmospheric science contributes to the investigation by providing rigorous collection of data, interpretation of trends, and provision of a suitable context for understanding climatologic phenomena. Understanding of these phenomena is limited by the paucity of high-quality data sets for many parts of the world dating to more than a few decades ago. Trying to rectify this lack of data has led scientists to add new types of data to try to monitor atmospheric change in the past.

Atmospheric scientists have broadened the scope of the science to also include the study of the atmospheres of other planets and of aspects of planetary science in general. The improvements in computational and observational technologies have been of considerable importance in developing these fields of study. This is particularly true in the area of computer modeling of other planets, as well as the atmospheric change that may be taking place in the future. This form of modeling is very complex because the weather system is chaotic and subject to variables which are difficult to capture effectively. This complexity has facilitated the politicization of the subject because there are so many different arguments that can be made and which are difficult to refute without extensive data collection and analysis.

SEE ALSO: Atmosphere; Climate Modeling; Climatology.

BIBLIOGRAPHY. Tim Flannery, *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth* (Atlantic Monthly Press, 2006); John Houghton, *The Physics of Atmospheres* (Cambridge University Press, 2001); John M. Wallace and Peter V. Hobbs, *Atmospheric Science: An Introductory Survey* (Academic Press, 2006).

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Atrazine

ATRAZINE IS A white, crystalline, solid, organic compound that is soluble in water and does not exist naturally in the environment. When pure, it is odorless and not very volatile, reactive, or flammable. It is widely used as a selective herbicide to prevent and/or to stop the growth of broadleaf and grassy weeds in crops—corn, sorghum, sugarcane, pineapples, macadamia nuts, soybeans, etc.—and in conifer reforestation plantings. It is also employed as a nonselective herbicide on highway and railroad rights-of-way, noncropped industrial lands, and fallow lands.

Atrazine was deemed to be the most widely used herbicide in the United States from 1987–89, but presently its uses are greatly restricted. Classified as Toxicity Class III—slightly toxic—it is not available to the general public and may be purchased and applied only by certified users.

Atrazine enters the environment primarily through spraying on farm crops, but may also be found in soils as a result of its formulation, manufacture, and disposal. If it enters the soil, it may be taken up by the plants growing in the ground or broken down by microbial activity and other chemicals, particularly in alkaline conditions, even if biodegradation takes a long time. If it enters the air, it may travel as far as 186 miles (300 km) from the application area, or it may be broken down or adhere to particles, such as dust, and then settle. If it is washed from soil into streams or groundwater, it will remain there for a long time, as its breakdown in water is quite slow.

While the general population is not habitually exposed to Atrazine, farm workers, chemical sprayers, and manufacturing and railway workers may be regularly exposed to it. Therefore, the Occupational

Safety and Health Administration (OSHA) has set limits of Atrazine content in workplace air: five mg/m³ for an eight-hour workday and a 40-hour workweek. Individuals who drink water from wells that are contaminated with Atrazine may also be exposed to the chemical. To protect human health, the Environmental Protection Agency (EPA) has set nonenforceable levels for chemicals that do or may cause health problems in drinking water for all public water supplies: The maximum contaminant level for Atrazine is set at three parts per billion.

HEATH AND ENVIRONMENTAL IMPACTS

Although Atrazine does not tend to concentrate in living organisms such as clams or fish, the EPA has also set maximum levels allowed in foods at 0.02-15 parts Atrazine per million. In specific circumstances, people who absorb Atrazine orally, by inhalation, or through the skin may suffer from some or all of these acute poisoning symptoms: abdominal pain, diarrhea, vomiting, eye and mucous membrane irritation, and skin reactions.

Studies on animals have shown that exposure to high levels of Atrazine for relatively short periods of time can provoke in some species damage to the heart, liver, lungs, kidneys, and adrenal glands as well as blood pressure alterations, muscle spasms, and weight loss. In laboratory animals, a lifetime exposure to high levels of Atrazine can cause reproductive and cardiovascular damage, retinal and muscle degeneration, and cancer. However, Atrazine is not expected to have similar effects on human health because of specific biological differences between humans and test animals.

SEE ALSO: Environmental Protection Agency (EPA); Herbicides; Safe Drinking Water Act.

BIBLIOGRAPHY. United States Government Printing Office, www.access.gpo.gov (cited November 2006); United States Department of Health and Human Services: Agency for Toxic Substances and Disease Registry, *The Toxicological Profile for Atrazine* (2003), www.atsdr.cdc.gov (cited November 2006).

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Audubon Society

AMONG THE OLDEST and largest national conservation organizations in the world, the Audubon Society maintains a century-long commitment to protecting birds and other wildlife through a network of state chapters and regional centers. The National Audubon Society sponsors annual Christmas Bird Counts, publishes the definitive Peterson's Wildlife Guides as well as other books and magazines about nature including the magazine *Audubon*, and sponsors and actively lobbies for environmental legislation. The Audubon Society also maintains local chapters in each of the fifty states, the U.S. Virgin Islands, and nine Latin American nations that promote citizen science, education, and outreach.

INITIAL SOCIETIES

The first Audubon Societies were direct descendants of the scholarly American Ornithologist's Union (AOU), founded in Cambridge, Massachusetts in September of 1883. Concerns that professional hunters were bringing many species of birds to the verge of extinction unified the membership the following year, and they began definite actions towards conservation. Identifying the largest portion of the slaughter of birds as supplying the millinery and fashion trade, the AOU members drafted and endorsed a model bird protection law, and encouraged the formation of bird protection societies and antibird-wearing leagues.

In February of 1886, AOU member and publisher George Bird Grinnel used his magazine *Forest and Stream* to promote the formation of conservation clubs to educate the public and denounce the wearing of bird products. Grinnel also suggested that the clubs be named Audubon Societies, after the famed naturalist and painter John James Audubon (1785–1851). Within a year, Grinnel began publication of *Audubon Magazine* as the organ of the rapidly growing organization, which already counted 300 local chapters and 18,000 pledged members. But the lack of a central authority and treasury undermined the attempt, the magazine ceased publication after only one year, and this first attempt at a national Audubon movement stalled out.

Although the first effort failed, the purpose and ideals of the Audubon Movement continued, and on February 19, 1896, the cousins Harriet Hemenway and Minna B. Hall organized the Massachusetts Audubon Society with the sole purpose to convince the ladies of fashion in Boston to forgo wearing plumes and other bird products. Their success prompted the revival of Audubon societies across the United States, and with the regularization of dues and a centralized treasury, the Society was able to fund the publication of *Bird Lore* magazine, a bi-monthly devoted to the study and protection of birds and renamed *Audubon Magazine* in 1941. Organized at a national level in 1905, the National Audubon Society was highly visible in the key conservation campaigns of the twentieth century, including the passage of protection acts for migratory birds throughout the western hemisphere, species reintroduction, and wilderness protection.

ANTI-DDT CAMPAIGN

In perhaps its most famous campaign, the National Audubon Society was in the forefront of the fight to ban organochlorine insecticides, especially DDT, in the wake of the publication of Rachel Carson's *Silent Spring* (1962). The Society highlighted the connection between the decline in bald eagle populations and the indiscriminate use of chemical pesticides, and made the banning of DDT a matter of national pride. With many other conservation groups, the Audubon Society was able to claim victory in 1972 when DDT was banned in the United States followed by a dramatic recovery in eagle populations. Faced with stagnant membership numbers and increasing competition from other conservation organizations, the Audubon Society is planning to step back from general environmental advocacy to a more focused emphasis upon community education and building grassroots advocacy for its core issues of wildlife conservation.

BIBLIOGRAPHY. *Audubon Magazine,* New York, N.Y.; National Audubon Society: "Audubon Online," http://www.audubon.org (cited February 2007); J. Boudreau, "The Feather Trade and the American Conservation Movement: a Virtual Exhibition From the Smithsonian Institution's National Museum of American History," Washington, D.C., National Museum of American History, Smithsonian Institution (1999); O.H. Orr, *Saving American Birds: T. Gilbert Pearson and the Founding of the Audubon Movement* (University Press of Florida, 1992); J. J. Weil, "Death, Dearth and Progressivism: AStudy of the Policies of and Reactions to the National Audubon Society," (1896–1917: iv, 88 leaves ; 28 cm).

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Australia

AUSTRALIA IS THE world's sixth largest country by land area (7,692,024 square kilometers, excluding external territories), but is sparsely populated. 86.2 percent of the population of just over twenty million people lives in one percent of the land area of the continent. This is mostly near the east coast, with a smaller population concentration in the south-west corner. The average population density of the country is less than two people per square kilometer, which is very low compared to 26 people per square kilometer in the United States and 238 people per square kilometer in Britain. Australia, in the southern hemisphere, is the driest of the inhabited continents, with much of the country being classified as arid or semi-arid. Inland settlements are often based on mining activities. Australia has 36,700 kilometers of coastline.

Australia has been home to indigenous people for at least 40,000 years. While sometimes known collectively as Aborigines, the diversity of indigenous peoples should be recognized, and the Torres Strait Islander people should also be considered as indigenous. This diversity is highlighted in the variety of languages that were present in Australia. There were about 250 Aboriginal languages at the time of European incursion into Australia; further division into dialect differences gives some 600 distinct linguistic varieties. This makes Aboriginal Australia one of the most diverse areas of the world linguistically, and in some districts an 80-kilometer journey will pass through the territories of three languages less closely related than English, Russian, and Hindi," explains language scholar Nicholas Evans.

The country of Australia is a federation of six states which were former colonies of Britain. There are also a number of territories, including two self-governing territories. These are the Northern Territory (where Darwin is the largest city and capital) and the Australian Capital Territory, which is the location of the national capital of Canberra. In 1901 Australia had a population of 3,773,801, excluding indigenous people who were not counted in the Census. The largest city was Sydney, with a population of 496,000. Other significant cities included Melbourne (478,000), Adelaide (141,000), Brisbane (119,000) and Perth (61,000).

The six states, their state capitals and largest cities in descending order of population, are New South Wales (Sydney, with a population exceeding four million people), Victoria (Melbourne), Queensland (Brisbane), Western Australia (Perth), South Australia (Adelaide) and the island state of Tasmania (Hobart). There are also over seven hundred local governments in Australia. The structure and resources of the local governments vary enormously. For example, there are 37 local governments in Sydney, ranging in population from 256 364 in Blacktown to 12 692 in Hunters Hill.

The history of European exploration in Australia is complex. There are claims of Portuguese exploration, and reliable evidence of Dutch exploration of the northern and western coasts. Dutch vessels sailing to Batavia (modern Jakarta, Indonesia) were sometimes shipwrecked on islands off the Western Australian coast if they did not turn north in time. Despite extensive Dutch knowledge of the coast of what they called "New Holland," it was not until 1770 that Captain James Cook claimed the continent for the British crown, narrowly defeating French explorers in this endeavour. The actual settlement did not occur until 1788, when Sydney was founded as a

Walter Burley Griffin

Canberra, the capital of Australia, was designed by Walter Burley Griffin who was born in 1876 at Maywood, near Chicago, Illinois, the son of George Walter Griffin, an insurance agent. Walter Burley Griffin—he always used his full name—worked for the famous architect Frank Lloyd Wright and then began work by himself in Illinois. After the formation of the Federation of Australia, the Australian government decided to build a new capital and Griffin's design won the competition. The contract which was subsequently drawn up placed the architect in effective control of the planning of the city and many of these ideas were thought to be extremely extravagant. Griffin foresaw the importance of the motor car, and Canberra is the only city in Australia that rarely has any traffic "jams," in spite of the massive growth of the city in recent years.

Walter Burley Griffin spent seven years as federal director in charge of building Canberra. His plans, hugely influenced by the City Beautiful and Garden City movements, were controversial with his plan to have the city as a series of concentric circles, and an artificial lake, subsequently named Lake Burley Griffin. However he constantly battled with bureaucrats and although cleared of malpractice by a Royal Commission in 1917, he resigned three years later. He continued to design buildings and projects in Australia.

In 1935 Griffin left for India where he had the task of designing the new library for the University of Lucknow. However when he was there he took ill, and died in 1937 of peritonitis. His widow, Marion Lucy Mahony, who had also trained under Frank Lloyd Wright, and whom he married two months after winning the competition to design Canberra, tried to continue without him. She later returned to Chicago.

penal colony on the shores of Port Jackson, or what the local Eora people called Werrong. Other Australian cities had different foundation histories. Private settlers established Melbourne as a settlement. Perth was originally settled as a free colony in 1829, but imported convict labour from 1842 onwards. By the late 19th century, some of the key components of Australia's urban pattern, and the structure of individual cities within this urban pattern, were in place. The largest Australian cities have always held a high degree of primacy (that is, the dominance of the largest city in relation to the rest of each state). The degree of primacy is less in Queensland due to the presence of other large urban centers.

The composition of the population is diverse. While there were many English and Irish people among the early settlers (not all of whom arrived by their own free will), Australia has benefited enormously from many other nationalities. Other industries, such as pearling, relied on various non-European workers. Aboriginal people were crucial in the establishment and survival of the pastoral industry in many parts of Australia. Following the second world war, "displaced persons" from many southern and eastern European countries migrated to Australia. More recent waves of immigration have included refugees and other settlers from Vietnam and other parts of Asia, and even more recently from countries such as Lebanon.

Australia also has great diversity in its environment, ranging from tropical rainforests to deserts. The north of Australia is geographically close to Papua New Guinea and Indonesia. The south of Australia is more temperate, with Perth having a "Mediterranean" climate. Water use is a major environmental issue, and the lack of reliable annual rainfall limits settlement and land use activities in much of Australia.

Australia is richly endowed with both non-renewable energy resources such as coal and natural gas, and renewable energy resources such as solar, tidal and wind power. Energy commodities are a major source of export earnings in Australia and development of these resources in a sustainable manner is a primary policy goal of the country. One of Australia's main objectives in developing a sustainable energy policy is to ensure that the country's energy sector is well placed to take advantage of economic and environmental opportunities and challenges that

Bob Brown

Bob Brown, the leader of the Australian Green Party, was born in 1944 at Oberon, New South Wales, Australia, moving to the island of Tasmania during the 1970s. He had a medical practice for many years, and was a founding member of the Wilderness Society and the Australian Bush Heritage Fund.

Bob Brown rose to national prominence over his campaign to save the Franklin River, a largely untouched natural resource in Tasmania. In a referendum about the government's proposal to dam the river, the public were given the choice of which type of dam they wanted rather than being offered the option of rejecting the dam altogether. The referendum saw up to 45 percent of the voters spoiling their ballot papers, most writing "No Dam" on their ballot paper, an unprecedented action in Australian politics, and led to the victory of the Bob Hawke Labor government in the federal elections that followed, with Hawke promising not to build a dam.

In 1983 Bob Brown and 1500 other people were arrested in the protests over the Franklin River Dam, and on his release, he was elected to the Tasmanian House of Assembly—the state legislature—holding the seat until 1993. Three years later he was elected to the Australian Senate. From 2002 until 2004, the Greens held the balance of power in the senate and Bob Brown gained international attention for interjecting during a speech by George W. Bush to the Australian parliament—Brown being a vociferous opponent of the war in Iraq. Bob Brown has won many awards including the 1987 United Nations Environment Program Global 500 Award, and the 1990 Goldman Environmental Prize. In 1996 he was named, by the British Broadcasting Corporation's *Wildlife* magazine, as the "World's Most Inspiring Politician." The author of several books, his *Memo for a Saner World* (2004) describes some of his career and also details his political aims.

will emerge both domestically and internationally in coming years.

ENVIRONMENTAL ISSUES

The Australian government is aware of the environmental challenges that are currently facing the country, including urban air quality, pollution and climate change. In order for Australian energy exports to remain competitive in world markets, the government realizes that it is both economically and environmentally in its national interest to produce these resources in the most efficient manner possible.

In 1999, in a comprehensive effort to outline the environmental responsibilities of the Commonwealth, Australia enacted the Environment Protection and Biodiversity Conservation Act. The legislation attempts to coordinate national, state and territory measures to protect the environment, providing for Commonwealth leadership, while still respecting state and territory authority. As of 2002, however, Australia's environmental progress was still slowed by a lack of clear federal leadership. For instance, in 1997 in Kyoto, Japan, Australia agreed to limit its increase in greenhouse gas emissions to 8 percent above 1990 levels by the 2008–2012 time period. According to the Australian Greenhouse Office, this represents approximately a 30 percent reduction against current business-as-usual scenarios. However, the country has not yet decided upon a national abatement strategy. In March 2002, Australia and the United States concluded the U.S.-Australia Bilateral Climate Agreement in order to jointly investigate ways to achieve the two countries' Kyoto greenhouse gas emissions goals without ratifying the protocol.

Other significant sectors of the Australian economy include manufacturing, tourism and education. These industries are increasingly mechanized, often resulting in increased production but little or negative growth in employment. Developing the Australian economy to be more ecologically sustainable economy will be a challenge.

SEE ALSO: Animal Rights; Animism; Appropriate Technology; Arid Lands; Indigenous Peoples.

BIBLIOGRAPHY. Australian Conservation Foundation, *Out of the Blue: An Act for Australia's Oceans*. (Australian Conservation Foundation, 2006); Commonwealth of Australia, *Australia's Fourth National Communication on Climate Change: A Report under the United Nations Framework Convention on Climate Change* (Department of the Environment and Heritage/Australian Greenhouse Office, 2005); David Dale, *The 100 Things Everybody Needs to Know About Australia*. (Pan MacMillan Australia, 1998); Nicholas Evans, "Aboriginal languages" in Davison, G., Hirst, J. and MacIntyre, S., eds., *The Oxford Companion to Australian History* (Oxford University Press, 1998); Phil McManus, *Vortex Cities to Sustainable Cities: Australia's Urban Challenge* (UNSW Press, 2005); Bill Pritchard and Phil McManus, *Land of Discontent: The Dynamics of Change in Rural and Regional Australia* (UNSW Press, 2000).

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Austria

WITH A PER capita income of $32,900, Austria is the 15th richest country in the world. The quality of life among the 8,184,691 people is high, in great part because of the welfare state that provides social security and health care to the Austrian people. The United Nations Development Program (UNDP) Human Development Reports rank Austria 17th among the world's nations in overall quality of life. The landlocked country has a temperate, continental climate, with cold, wet winters and moderate summers with frequent rainfall. The Alps in the western and southern section of the country are a major feature of the country's geography, and landslides, avalanches, and earthquakes are common. Austria's natural resources include oil, coal, lignite, timber, iron ore, copper, zinc, antimony, magnesite, tungsten, graphite, salt, and hydropower.

During the post–World War II period, Austria underwent major political, economic, and sociological transformations. By the mid-20th century, some 60 percent of Austrians were engaged in agriculture and forestry, and most practitioners had little knowledge about protecting and conserving the environment. Because of past agricultural practices, Austria requires that all sewage sludge for application in agriculture be analyzed to monitor levels of dioxin. As urbanization accelerated, a population shift occurred, with two-thirds of the population residing in the valleys and lowlands of Austria. Currently, only 4 percent of the workforce is engaged in agriculture and forestry.

Increased urbanization also led to greater numbers of vehicles using fossil fuels in congested areas, motivating the government to pursue alternative energy resources. At present, Austria generates 0.3 percent of the world's carbon dioxide emissions. Forty-seven percent of Austria's 2,562 kilometers is forested, and timber is a key industry. One-third of Austria's land is under national protection, and the government has been relatively successful at protecting the 83 mammals that are endemic to the country, with 7 percent of those species threatened. Bird life is even better protected, and only three species of the 230 birds endemic to Austria are threatened.

ENVIRONMENAL CONCERNS

Austria's major river is the Danube, which it shares with several other European countries. Historically, all riparians have worked together to manage the river. In the mid-1980s, major problems developed because large agricultural and industrial practices in cities such as Vienna, Budapest, and Belgrade were dumping waste in the Danube. Testing revealed that 30 percent of the Danube's tributaries had also become highly polluted. The Bucharest Declaration of 1985 brought eight Danube nations together to formulate environmental policies. Through subsequent agreements, riparians have identified four environmental goals: establishing and monitoring the use of the river, settling the issue of liability for cross-border pollution, defining rules for protecting wetland habitats, and creating guidelines for development that protect and conserve the environment. As a result of improved conditions, Austria has successfully reintroduced salmon into the Danube.

In 2006, Yale University ranked Austria 6th of 132 nations in environmental performance. Austrians are justifiably proud of their strong commitment to maintaining clean air and drinking water, for promoting recycling, and for establishing excellent sewerage connections. Austria's entire population has access to safe drinking water and improved sanitation. The government has been particularly successful at integrating environmental policies among the energy, transport, agricultural, and forestry sectors.

Austria has reduced air pollutants and promoted renewable energy. The country has also improved the quality of both surface and ground waters, and pollution abatement has continued to be a financial priority. Nevertheless, in 2003, the Organization for Economic Cooperation and Development presented the Minister for Agriculture, Forestry, Environment, and Water Management with 44 recommendations aimed at further improving Austria's existing environmental programs. The recommendations dealt with improving environmental management and increasing the number of protected areas.

Austria has established support for the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Dioxins; Recycling; Salmon; Timber Industry.

BIBLIOGRAPHY. CIA, "Austria," *The World Factbook,* www.cia.gov (cited March 2006); Country Studies, "Austria," www.country-studies.com (cited March 2006); "Europe Regional Reports: Chemicals," www.umweltbundesamt.at/en/ (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Eric Solsten and David E. McClave, *Austria: A Country Study* (Government Printing Office, 1994); Rolf Steininger et al., *Austria in the Twentieth Century* (Transaction Publishers, 2002); TFDD, "Environmental Program for the Danube River," www.transboundarywaters.orst.edu (cited March 2006); UNDP, "Human Development Reports: Austria," www.hdr.undp.org (cited March 2006); OECD, "OECD Commends Austria's Environment but Calls for More Integrated Policies," www.oecd.org (cited March 2006); UNEP, *Europe Regional*

Report: Chemicals (Global Environment Facility, 2002); World Bank, "Albania," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Automobiles

AUTOMOBILES ARE WHEELED and powered vehicles of various designs that have become hugely popular around the world for personal transportation, leisure, and status. Huge numbers of automobiles have been produced in the century since their first appearance, and they have had enormous effects on urban and suburban lifestyles, distribution of goods and services, the demand for oil and the global political system, and also on the environment. As large tracts of ground are placed under road tarmac, thousands of people are killed or injured yearly, and large amounts of gases are burned in the engines and released.

Automobiles are generally powered by petroleum or similar products derived from oil, which is burned under controlled conditions in an engine chamber, which then drives cranks that turn the wheels. This basic system is made greatly more complex by the addition of numerous systems and sub-systems that range from air conditioning to satellite guidance systems to safety features. The various configurations of systems, together with stylistic and engine power characteristics, contribute to a range of products that vary significantly in both size and cost. Automobiles have tended to become safer, larger, and more powerful as time has passed.

In countries where suburban lifestyles enable people to occupy comparatively large living areas and roads to match, the negative impacts of personal use of automobiles are not always easy to detect. However, in some developing countries, where road systems may be narrow, disorganized, and poorly maintained, the regular and very heavy traffic jams are very striking and very obviously produce negative effects in terms of noise and air pollution, deterioration of the road system, and also great inefficiencies in the use of time that strongly impact social, family, and working life. These problems have been slightly eased in recent years with the provision of some limited public mass transportation schemes. Additional measures to regulate traffic have included the imposition of tolls, such as the Congestion Charge levied in central London, and the permitting of entry only for odd or even numbered registration plates on consecutive days. However, the number of deaths and injuries continues to mount.

Although most countries enforce strict limits on drinking alcohol while driving, these limits are not always policed effectively and this, together with reckless driving, poor road safety conditions, and the sheer weight of traffic, has led to a situation in which some 1.2 million people are killed annually around the world, with another 50 million injured, and these figures are set to increase by 60 percent by 2020 based on current trends and as the ability of people in developing countries to purchase their own automobiles increases.

POLLUTION

Pollution caused by automobiles has been reduced to some extent by the imposition of the use of catalytic converters in all automobile models in Western countries and by the removal of lead from most varieties of petroleum. However, pollution reduction depends to some extent on efficient maintenance of vehicles; this is often not feasible in developing countries, which may in any case be importing second-hand automobiles with lower pollution standards in order to reduce costs. The main pollution problem with automobiles is the release of micro-particles in the exhaust smoke, which are the burnt and partially burnt remnants of fuel used to power them. These particles can cause bronchitis and other respiratory problems, which are believed to lead to hundreds of thousands of deaths per year. While the risk to individuals of serious health effects is small, the pollution covers a very wide range of people, and so becomes significant at the level of large communities. Numerous other dangerous gases are also released, including carbon dioxide and sulphurous and nitrous oxides, which may also contribute to global warming, acid rain, smog, and other hazards.

PRODUCTION

Automobile production in its early years relied upon skilled artisans employing similar techniques to those used to make horse-drawn carriages. It was Henry T. Ford, founder of the Ford Motor Corporation, who created the first mass production system involving the factory conveyor-belt system in building the Model T. This system featured specialization of activities within the factory and restriction of variants in the product portfolio to produce automobiles, which were for the first time aimed at the common consumer. On opening the factory, some 350,000 items could be produced annually with a unit price of $950; a decade later, the production total had been raised to 1 million automobiles annually with a unit cost of just $350. The result was a huge increase in the number of automobiles on the road, as people had the opportunity for the first time to control their own long-range transportation and to take advantage of the social and leisure opportunities it provided.

The attempt to provide large-scale, low-cost automobile manufacturing was replicated in a number of countries around the world, notably in Germany, where the Volkswagen organization produced large numbers of its cars for German citizens. Large-scale automobile production was generally restricted to Western countries until after the end of World War II. However, since then it has spread to most regions of the world as the manufacturing cost has been reduced in comparative terms and, to remain competitive, manufacturers have switched their production bases offshore to countries that are the intended destination for the finished automobiles and that offer lower labor and production costs.

The automobile manufacturing industry offers significant size of production sufficient for economies of scale and of scope. At the same time, a number of aspects of the manufacturing processes have matured to the extent that the use of robot technology and advanced manufacturing techniques have increasingly been replaced by human labor in a number of large companies. As regular automobile production has come to be dominated

Auto pollution in Western countries has been reduced by mandatory catalytic converters in new vehicles.

by Japan, South Korea, and other Asian countries, leaving specialty and luxury niches to be filled by some European countries, so too has production of related items such as motorcycles, pickup trucks, buses, coaches, and trucks.

The rising cost of oil has stimulated the search for alternative formulations, featuring various types of vegetable oil matter and similar items. To date, these attempts have not been wholly successful as concerns persist as to the possibility of engine damage and other technical issues, together with achieving consumer acceptance. Further, from an environmental perspective, it is not yet clear that the alternatives suggested to date would offer a superior solution than already exists. More success seems to be likely in terms of electric engines, either used entirely on their own or in combination with existing petroleum engine technology. Although reliability and battery recharging issues have not been fully resolved, many promising models have already been produced. The use of other types of energy to fuel automobiles does not appear to be feasible, as a regular flow of power to a small and highly mobile unit does not fit with current understanding of how to make solar, wave, or nuclear energy fueling work.

SEE ALSO: Carbon Dioxide; Highways; Petroleum; Pollution, Air; Transportation.

BIBLIOGRAPHY. Philip Blenkinsop, *The Cars That Ate Bangkok* (White Lotus Press, 1996); Michael L. Berger, *The Automobile in American History and Culture: A Reference Guide* (Greenwood Press, 2001); M. Krzyzanowski, B. Kuna-Dibbert, and J. Schneider, *Health Effects of Transport-Related Air Pollution* (WHO Europe, 2005); Takashi Yagi, "Industrial Robots in the Japanese Automobile Industry: Robot Equipment Trends in a Time of Steady Growth," *The Industrial Robot* (v.33/5, 2006); World Health Organization (WHO), *World Report on Road Traffic Injury Prevention* (WHO, 2004), www.who.int (cited November 2006).

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Azerbaijan

WHILE STILL STRUGGLING to assert its independence after the collapse of the Soviet Union, the Asian nation of Azerbaijan became involved with its neighbor Armenia in an armed territorial dispute over the area of Nagorno-Karabakh that continued from 1988–94. By the time a tenuous truce was declared, Azerbaijan had lost 16 percent of its territory and was forced to deal with the internal displacement of 571,000 Azerbaijanis. Economic problems and widespread corruption have plagued the country. However, Azerbaijan's generally untapped petroleum resources have improved economic prospects since a consortium of Western oil companies began pumping a million barrels a day from Azerbaijan in 2006. Other natural resources include natural gas, iron ore, nonferrous metals, and alumina.

Approximately one-fifth of Azerbaijan is arable, and 41 percent of the population is engaged in the agricultural sector. The population of 7,911,974 has an annual per capita income of $4,600, and the country is ranked 140th in world incomes. Nearly half of Azerbaijanis live below the national poverty line. Around 23 percent of the population has no sustained access to safe drinking water, and 45 percent lack access to improved sanitation. The United Nations Development Program (UNDP) Human Development Reports rank Azerbaijan 101st in the world on general quality-of-life issues.

Although Azerbaijan borders the Caspian Sea for approximately 800 kilometers, the country is landlocked. Rivers tend to be fast flowing and are generally not navigable. The climate is dry, semiarid steppe, and the terrain is diverse. The flat areas of the Kura-Araks Lowland are mostly below sea level. The Great Caucasus Mountains cover the northern section of Azerbaijan, while the Karabakh Upland is located in the west. The capital city of Baku is part of the Apsheron Peninsula that juts into the Caspian Sea. Azerbaijan is subject to severe droughts.

ECOLOGICAL CHALLENGES

Local scientists maintain that the Apsheron Peninsula and the Caspian Sea are the most ecologically devastated areas in the entire world. The sea has been polluted by decades of oil spills and raw, inadequately treated sewage. There is evidence that water levels are rising, posing a threat to coastal areas. Baku experiences severe air pollution. Although there are only 43 cars per 1,000 people, Azerbaijan produces 0.1 percent of the world's carbon dioxide emissions. Chemical and metallurgical industries are major polluters, and soil and water pollution have resulted from oil spills and the use of the pesticides and toxic defoliants. Birth defects and other illnesses have been linked to pollution.

Just over 13 percent of the land is forested. While the government has protected 6.1 percent of this land, pristine areas of Azerbaijan were destroyed during the conflict with Armenia, when highways were built for army use. Of 99 endemic mammal species in Azerbaijan, 13 are endangered. Similarly, eight of 229 endemic bird species are threatened. A 2006 study by Yale University ranked Azerbaijan 95th of 132 countries on environmental performance, well below the relevant income and geographic groups. The score on sustainable energy was abysmally low at less than 10 percent. Low scores were also given in the areas of air quality, biodiversity and habitat, and environmental health.

The State Committee for the Environment is responsible for implementing environmental policy in Azerbaijan and serves as the administrator of 14 state reserves and 20 preservations. In 1992, the government adopted the Environmental Protection and Nature Utilization, which established specific standards for environmental protection and compliance. In 1999, the Law on Environmental Protection and the Law on Environmental Safety established a new framework for additional legislation designed to make environmental policy more effective and responsive. Penalties for noncompliance with environmental laws include suspension or closure of polluting enterprises and the suspension of construction financing.

Azerbaijan has signed the following international agreements: Air Pollution, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Marine Dumping, Ozone Layer Protection, and Wetlands.

SEE ALSO: Armenia; Droughts; Pollution, Air; Pollution, Water; Poverty.

BIBLIOGRAPHY. CIA, "Azerbaijan," www.cia.gov (cited April 2006); Country Studies, "Azerbaijan: Environmental Problems," www.country-studies.com (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Azerbaijan," www.hdr.undp.org (cited April 2006); UNEP, "State of the Environment Azerbaijan," http://enrin.grida.no/htmls/azer/soe/ecology/index.html (cited April 2006); World Bank, "Azerbaijan," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Bahrain

WITH A LAND area of only 665 square kilometers, the island of Bahrain is home to 698,585 people, including 235,108 nonnationals. Bahrain's strategic location in the Persian Gulf among larger and more aggressive nations forces the government to balance its own needs against the demands of its neighbors. The ruling amir, who proclaimed himself the king in February 2002, launched major economic and political reforms in Bahrain. Since oil reserves are rapidly declining, Bahrain has shifted its economic focus to petroleum processing and refining, which provide around 60 percent of export receipts and government revenues. In addition to oil, natural resources include associated and nonassociated natural gas, fish, and pearls. The development of Bahrain as an international banking center has also helped to replace lost oil revenues.

An unemployment rate of 15 percent has been a major cause for concern, particularly because it is concentrated among young adults. With an annual per capita income of $20,500, Bahrain is ranked as the 50th richest nation in the world. In 2004, Bahrain and the United States signed a Free Trade Agreement that, if ratified by both governments, should further boost the Bahraini economy. All of Bahrain's urban residents have access to safe drinking water and improved sanitation. The United Nations Development Program Human Development Reports ranks Bahrain 43 of 232 countries on general quality-of-life issues.

Bordered by the Gulf of Bahrain, the archipelago has a coastline that extends for 161 kilometers. The land area is comprised of low desert plains rising to a low central escarpment. The arid climate of Bahrain produces mild winters and hot, humid summers. Periodic droughts and dust storms have combined with desertification in Bahrain to produce degradation and loss of arable lands. Less than 3 percent of total land area is devoted to agriculture, and only 1 percent of the workforce is engaged in this sector. Since the islands lack freshwater resources, sea water is used. Bahrain is within the route by which petroleum is transported to the West. Consequently, coastal areas are suffering from degradation caused by oil spills and discharges from tankers, oil refineries, and distribution stations. Extensive damage to coral reefs and sea vegetation has also occurred.

With 90 percent of the population living in heavily industrialized urban areas, carbon dioxide emissions have climbed in Bahrain from 22.6 per capita metric tons in 1980 to 30.6 per capita metric tons in 2002. The islands produce 0.1 percent of the world's supply of carbon dioxide emissions. Consequently, the Environmental Impact Assessment has formulated stiff requirements for improving air quality in Bahrain.

In 1977, the government of Bahrain began enacting a body of environmental laws designed to protect natural resources and promote responsible land use and development. In 1980, the Environmental Protection Committee and the Environmental Protection Technical Secretariat were established to work with other government agencies by coordinating environmental policies and enforcing laws and regulations. In 1996, the Environmental Affairs Agency, which includes the Directorate of Assessment and Planning and the Directorate of Environment, assumed the responsibility for promoting sustainable development through the implementation and enforcement of a series of environmental policies related to human health as affected by environmental practices, the protection and rehabilitation of natural resources, and the control of biodiversity.

Bahrain is home to hundreds of flora and bird species and possesses the largest colony of cormorants in the world. Special interest has been focused on conserving the mangrove forests of Hawar Islands, increasing supplies of safe drinking water, and improving waste management. In addition, Bahrain has participated in the following international agreements: Biodiversity, Climate Change, Desertification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Desertification; Oil Spills; Petroleum.

BIBLIOGRAPHY. CIA, "Bahrain," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Human Development Report: Bahrain," www.hdr.undp.org (cited April 2006); United Nations, "Institutional Aspects of Sustainable Development in Bahrain," www.un.org (cited April 2006); World Bank, "Bahrain" *Little Green Data Book,* www.worldbank.org (cited April 2006).

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Baikal, Lake

KNOWN AS THE Pearl of Siberia, Lake Baikal is the oldest, largest, and deepest freshwater lake in the world. Some 395 miles long and 50 miles wide, it contains about one-fifth of the fresh water on the globe, more than the five Great Lakes combined. More than 330 rivers and major streams feed it, but the Angara River is the only waterway that flows out of the lake. Because Baikal is very well oxygenated to even its lowest depths, and geographically isolated, it provides a rich ecosystem for an unusual range of animal species, including more than 50 species of fish and large mammals such as bear, moose, elk, deer, and the nerpa seal. Tens of millions of crayfish of several different varieties dispose of most of the natural waste in the lake. One of the clearest lakes in the world, with visibility from the surface to depths of 50 meters or more, the lake is a major tourist site, attracting about two million visitors each year. In addition, there are sites of historical and cultural interest. Olkhon Island, the largest of the lake's 30 islands, is traditionally identified as the birthplace of Ghengis Khan.

The world-class ski resort and hotels share the lake's 1300 miles of shoreline with several large-scale industrial concerns. Most significantly, the Bakailsk Paper Works empties about 140,000 tons of wastewater into the lake every day. When the plant was constructed in the mid–1960s, Soviet officials emphasized the extensive system of pollution controls built into its design. But when those controls proved inadequate, the pollution provoked what has since been recognized as the beginnings of the Russian environmentalist movement. In 2003, at the request of Russian President Vladimir Putin, the United Nations expedited a $22 million loan to modernize the Paper Works and to significantly reduce its pollution of Lake Baikal while protecting the remote region's largest employer. The construction of the Irkutsk Dam also created environmental issues on Lake Baikal because it raised the water level of the lake and precipitously reduced the population of some of the smaller fish species, upsetting the entire food chain among the fish in the lake.

The nerpa seal is the only freshwater species of seal and lives only at Lake Baikal. In 1995, the population of nerpa seals at Lake Baikal was estimated at about 100,000. But, in addition to the effects of industrial pollution, economic desperation in the former Soviet Union led to widespread poaching of protected wildlife species, including the nerpa seals. By 2000, the population had been reduced by half, to approximately 50,000. The situation was so serious that, in 2001, the Russian government invited Greenpeace to assist in discouraging poaching during the spring months when female seals are most vulnerable to poachers because they are reluctant to abandon their newborn offspring. Government officials estimated that this intervention reduced the poaching by close to 80 percent.

Lake Baikal features several deep rifts that provide singular opportunities for scientists studying both geological and climate change. In the 1990s, Russian and American scientists collaborated on drilling sediment cores from the Baikal rifts that provided data on about 250,000 years of climate history.

SEE ALSO: Lakes; Pulp and Paper Industry; Russia.

BIBLIOGRAPHY. Bartle Bull, *Around the Sacred Sea: Mongolia and Lake Baikal on Horseback* (Canongate, 1999); Valentin A. Koptyug and Martin Uppenbrink, eds., *Sustainable Development of the Lake Baikal Region: A Model Territory for the World* (Springer, 1996); M.M. Kozhov, *Lake Baikal and Its Life* (W. Junk, 1963); O.M. Kozhova and L.R. Izmesteva, eds., *Lake Baikal: Evolution and Biodiversity* (Backhuys, 1998); D.J. Peterson, *Troubled Lands: The Legacy of Soviet Environmental Destruction* (Westview, 1993).

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Balance-of-Nature Paradigm

BALANCE-OF-NATURE IS A metaphor that invokes the ideal of a universe of interrelated components that operate in harmony undisturbed by external interventions. The concept of a balance in nature is part of many cosmologies around the world. In Chinese philosophy, this ideal is symbolized by the yin (earth/female) and the yang (heaven/male). The Greeks had several deities with the power to generate and order the universe. As a common thread through these beliefs, all things were believed to be interconnected to preserve order, predictably, and resilience in nature.

The concept of the balance of nature was an implicit assumption in ecology for centuries and has influenced both its theory and practice. The principle of a balance of nature is also evident in the early conservation movement. In 1864, George Perkins Marsh wrote in *Man and Nature* that nature should be undisturbed by people so that the landscape can become almost unchanging and permanent in form. The paradigm, known as classical equilibrium, is seen in many concepts central to ecology such as bio–geography, population dynamics, carrying capacity, stability, and homeostasis. Thus, a significant feature of classical equilibrium ecology is based on the assumption that all ecosystems follow a linear path toward an end state. If left alone, undisturbed by humans, all ecosystems were potentially self-regulating, and could reach a stable "climax" state.

ECOLOGICAL ANTHROPOLOGY

Early ecological anthropology was also characterized by a search for a balance in the human ecosystem. While classical equilibrium ecology places humans outside of ecosystems, early human ecologists placed people at the center of the ecosystem. Importantly, the human ecology model retained many of the principles found in equilibrium ecology. The human ecosystem was believed to be a closed, self-regulating system that was culturally, structurally, and functionally complete. This approach informed the work of anthropologist Roy Rappaport, whose early research was concerned with humans as a species that participates in ecosystems in ways that are fundamentally similar to how other animals participate.

For Rappaport, cultures can be conceptualized as adaptations of particular groups to a particular ecosystem. Rappaport's approach, known as cultural materialism, is best exemplified in his seminal book *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People* (1968), in which cultural phenomena are explained in terms of material factors among people and the natural environment. Rappaport attributes the ritual pig feasting and warfare among the Tsembaga Maring of highland

New Guinea as an event that was critical in regulating the size of human and animal populations. *Pigs for the Ancestors* has become a classical case study in human ecology, exploring the role of culture in resource management and the application of systems theory to a human population. In a similar way to ecologists who applied the balance-of-nature metaphor to ecosystems, Rappaport and other human ecologists believed that if the human ecosystem was left undisturbed by outside forces (in this case, political and economic forces), then it would remain in a balanced, closed state of homeostasis.

PARADIGM SHIFT

The powerful metaphor of the balance of nature came into question in the 1970s and 1980s in both ecological and social sciences. Ecological studies began to demonstrate that equilibrium conditions are rare and that disturbance events are so common that most ecological systems never reach a climax stage. Ecologists describe key ecological processes as nonequilibrium (or disequilibrium) dynamics, open to restructuring through disturbance regimes and historical contingencies. Emerging nonequilibrium theory conceptualizes ecosystems as nested hierarchies of patch mosaics, and ecological dynamics are viewed as the outcome of composite patch dynamics. Daniel Botkin, a pioneer in the theory of nonequilibrium ecology, maintains that nature is in fact not in balance and disturbance is ubiquitous, if not the norm. This is not to suggest that there is no ecological stability, but rather that balance is embedded in patterns of fluctuation and ecological persistence and can be seen as order within disorder.

This paradigm shift in the ecological sciences was mirrored by a similar shift in the social sciences. Just as ecologists began to recognize that ecosystems do not remain productive indefinitely, but rather require periodic disturbances, anthropologists and geographers began to rethink humanity's role in actively shaping the landscape. It was once commonplace to talk about "pristine" areas of rainforest where "ancient" or "primeval" primary forest could be found, untouched by human hands. However, recent research in anthropology and geography has shown that much of the tropical forests around the world are the product of generations of selective human modification and interventions. These modifications are often responsible for the diversity of species, which previously might have been attributed to "natural" or nonanthropogenic forces.

Many scientists herald the transition from concern with equilibrium, homogeneity, and determinism to a widespread acceptance of nonequilibirum, heterogeneity, and disturbance in ecosystems as an important paradigm shift in ecology. This paradigmatic shift has significant implications for resource management. Conservation efforts, which often aim to remove human presence from landscapes, can focus on "real people-centered conservation," or what the geographer Karl Zimmerer calls "nature-culture hybrids." One example of this shift can be seen in the controversial issues surrounding wildfires in the western United States. Fire suppression polices, once the hallmark of forest conservation, have been replaced with the controlled-burn policy that acknowledges natural forest fires help regenerate the forest ecosystem.

SEE ALSO: Botkin, Daniel B.; Carrying Capacity; Disequilibrium; Equilibrium; Human Ecology; Rappaport, Roy A.

BIBLIOGRAPHY. Daniel Botkin, *Discordant Harmonies: A New Ecology for the Twenty-first Century* (Oxford University Press, 1992); Dennis E. Jelinski, "There Is No Mother Nature—There Is No Balance of Nature: Culture, Ecology and Conservation," *Human Ecology* (v.33/2, 2005); George Marsh, *Man and Nature* (Harvard University Press, [1864] 1965); I. Scoones, "New Ecology and the Social Sciences," *Annual Review of Anthropology* (v.28, 1999); Tabatha J. Wallington, Richard J. Hobbs, and Susan A. Moore, "Implications of Current Ecological Thinking for Biodiversity Conservation: A Review of Salient Issues," *Ecology and Society* (v.10/1, 2005), www.ecologyandsociety.org (cited May 2006); Jiangou Wu, "From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology," *Quarterly Review of Biology* (v.70/4, 1995); Karl S. Zimmerer, "The Reworking of Conservation Geographies: NonEquilibirum Landscapes and Nature-Culture Hybrids," *Annals of the Association of American Geographers* (v.90/2, 2000).

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Bananas

IN 1870, A strange fruit became a novelty purchase in New York food markets. By 1904, bananas had become the most popular fruit in the United Kingdom, and growing demand for bananas in North America and Europe lay the foundation for profound and ongoing environmental and social impacts in producer countries. Bananas, whether eaten raw (dessert bananas) or cooked (plantains), belong to the genus *Musa*. Up to a dozen bunches of fruit grow in one year from the single stalk of a fleshy plant often mistaken for a tree. The hundreds of cultivated banana varieties are sterile hybrids derived from two wild species native to Southeast Asia. Lacking viable seed, domesticated *Musa* are propagated by felling the stem to allow new shoots to grow from the rootstock. This process may go on indefinitely, or shoots can be transplanted to minimize soil depletion and maintain yields.

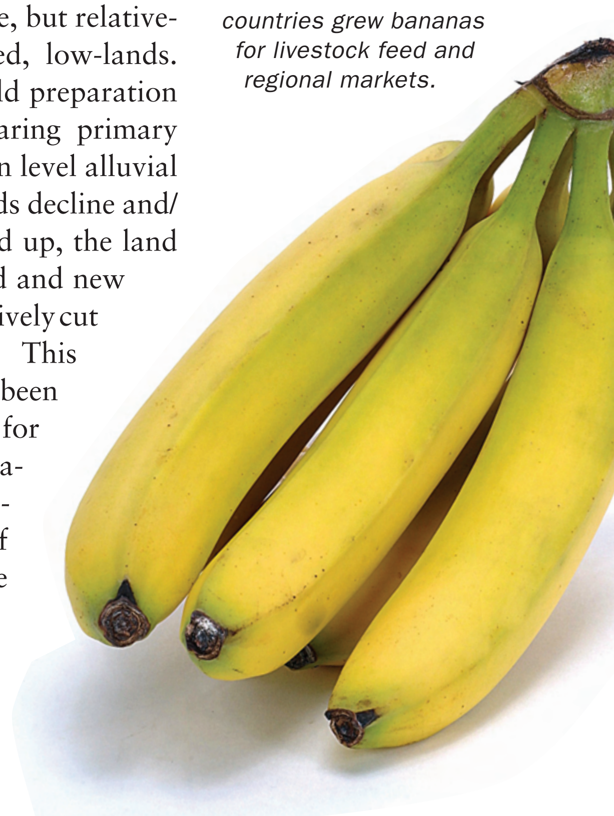
Bananas are rich in carbohydrates and nutrients (including potassium, phosphorus, calcium, and Vitamin C). A hectare of well-managed plants on rich soil can yield some 16,000 kilograms of fruit per year under hot, wet conditions. Their ease of cultivation, high yield, year-round productivity, and versatility of preparation have long made bananas attractive to people living in the tropics. The crop had spread from South Asia to Africa and the Mediterranean via Arabian land routes by at least 1 C.E., and was known throughout West Africa by the 15th century. In 1516, Spanish friars brought plants from the Canary Islands to the modern-day Dominican Republic. The banana proved so popular among tropical America's native peoples that its cultivation often diffused faster than the pace of European exploration. In 2006, millions of small farmers in 122 countries grew bananas—typically interplanted with other crops on small plots—for consumption, as livestock feed, and to supply regional markets. Approximately 80 percent of all bananas grown are eaten in the country of origin, with the highest levels of consumption in Brazil, India, the Philippines, Burundi, Indonesia, and China.

About 20 percent of global production is destined for export. In 2003, Latin American and Caribbean countries, dominated by Ecuador, supplied 80 percent of world exports, with the Philippines, Cameroon, and Ivory Coast accounting for most of the remainder. The top global banana importers were the United States, the European Union, Japan, and Russia. In 2000, total international trade was estimated at $4 billion, and was dominated by a handful of companies.

Production methods for export bananas vary. In Ecuador and the Caribbean, for example, bananas are often contract-farmed by small producers on plots rarely exceeding 50 hectares; planting stock and agrochemicals are provided on credit by a banana company. In Central America, multinationals own or rent vast tracks of land, often at favorable rates. These plantations are effectively run as enclave economies. Laborers are housed and fruit is processed on-site; company-owned facilities are also used in subsequent sea transport, ripening, storage, and distribution. As a result of this vertical integration and economies of scale, most bananas go from harvest to supermarket shelves in less than one month.

Export-bound banana cultivation has an appalling environmental record, which is best exemplified by banana plantations in Central America (which in 2003 supplied 30 percent of global exports). In the late 1800s, United States and British entrepreneurs coerced, threatened, and cajoled nascent republics into ceding vast tracts of land for banana cultivation on prime, but relatively unoccupied, low-lands. As today, field preparation involved clearing primary rainforests on level alluvial soils. As yields decline and/or pests build up, the land is abandoned and new fields successively cut from forest. This pattern has been responsible for the devastation of massive areas of biodiverse coastal rainforests from Belize to Panama.

In 2006, millions of small farmers in 122 countries grew bananas for livestock feed and regional markets.



Nutrient-demanding banana monocultures are typically maintained with massive inputs of synthetic fertilizers, fungicides, herbicides, and pesticides (pesticides alone can account for up to 35 percent of plantation production costs). Often applied aerially, chemical misuse has damaged plantation-edge forests, and caused the build-up of nematode populations and toxic chemicals in soils. Further, bananas require constant, but not excessive moisture. On plantations, channels are dug to drain water in the rainy season and irrigate in the dry season.

This greatly enhances soil erosion, as well as the delivery of silt and agrochemicals to local waterways. Due to their coastal locations, banana plantations have been blamed for considerable estuarine and coral reef pollution in the Caribbean. In addition, the on-site washing of harvested bananas adds to water demand and contaminated runoff. During the sorting process, up to 35 percent of bananas are rejected (mainly due to blemishes), and may be dumped along with cut stems into nearby streams, where their decomposition starves the water of oxygen; it is estimated the volume of this waste is equal to that of shipped fruit.

Serious human-rights abuses are also associated with the banana export industry. In the 20th century, violent and deadly repression of labor unions, denial of basic workers' rights, and the abuse of migrant laborers have been rife. Banana companies proved so meddlesome in the domestic policies of Central American nations that the latter became known as Banana Republics. For example, in 1954, the United States-based United Fruit Co. encouraged the CIA and U.S. State Department to back the coup and exile of democratically elected Guatemalan president Arbenz, who had championed the redistribution of idle banana holdings to landless peasants. In 1992, Chiquita's threat to withdraw grower contracts caused the government of Panama to cancel a planned increase in the national minimum wage. Today, banana workers continue to struggle for adequate protection from toxic agrochemicals, the right to unionize, better living conditions, and wages commensurate with rising company profits (contract growers currently earn an estimated five to 10 percent of a banana's final retail value; plantation workers, one to three percent). They accuse banana companies of keeping prices artificially low, and of rotating their operations internationally to avoid accountability to labor and environmental laws.

Since the 1990s, organic and Fair Trade initiatives, targeting environmental and social conditions in the banana industry, have met with modest success. Chiquita and other companies are now experimenting with sustainable farming methods to lessen the environmental impact of cultivation, including continuous cultivation, integrated pest management, crop rotation, and the reuse and recycling of wastes. Bananas too blemished for store shelves are processed into juices and baby food. Contract farmers, especially in the Caribbean, are also organizing into certified Fair Trade cooperatives that work with alternative distributors to sell their sustainably grown fruits for a living wage. Their success relies on the willingness of consumers to pay a premium for fairly traded organic bananas. To date, the movement has had greater success penetrating European than North American markets.

SEE ALSO: Ecuador; Monoculture; Plantation; Plantation Forestry.

BIBLIOGRAPHY. Jason Clay, *World Agriculture and the Environment: A Commodity-by-Commodity Guide to Impacts and Practices* (Island Press, 2004); Richard P. Tucker, *Insatiable Appetite: The United States and the Ecological Degradation of the Tropical World* (University of California Press, 2000); Food and Agriculture Organization, www.fao.org (cited August 2006); Jon Hellin and Sophie Higman, *Feeding the Market: South American Farmers, Trade, and Globalization* (Kumarian Press, 2003); N.W. Simmonds, *Bananas* (Longmans, 1966).

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Bangladesh

BANGLADESH IS FORMALLY called the People's Republic of Bangladesh. It is a small, deltaic country located in South Asia, with India to the north, west, and east, Myanmar to the southeast, and the Bay of Bengal (Indian Ocean) to the south. Bangladesh's land area of about 144,000 square kilometers with

147 million people (2006 estimate) makes it one of the most densely populated countries in the world. Agriculture forms the mainstay of the economy, and the majority of the population lives in rural areas, with increasing urban growth. The capital, Dhaka, is one of the fastest urbanizing cities in the world.

Bangladesh was a part of Pakistan after the Partition by British colonial rule in 1947. In 1971 it won its independence from Pakistan. Bangladesh has a parliamentary democracy, although several factors plague its rule: political instability, corruption, and poor governance. Economically, the country has made strides in developing a manufacturing base in ready-made garments (by exploiting cheap labor), along with production of other export items (such as shrimp, jute, and tea). As one of the poorest countries in the world (in terms of per capita income), development in areas of human resources, economy, literacy, and health remain enormous challenges for the government. Gender disparities in most arenas remain high, despite the country being one of the few in the world with a female head of state.

Three major rivers (Ganges, Brahmaputra, and Meghna) and numerous smaller rivers and tributaries make the country very lush and flood-prone. The country is largely flat; most landmass is one to 10 feet above sea level. The monsoon climate also means that annual rainfall in the summer months is fairly high, which contributes to the floods. In addition, tropical cyclones that form seasonally in the Bay of Bengal also cause considerable flooding from storm surges. Such natural hazards are compounded by the extreme poverty and high density of dwellings, where the social and economic outfalls are considerable for a struggling population. Marginalization of poorer people into floodplains and coastal areas further increases their vulnerability to such hazards.

Environmental problems from deforestation and loss of biodiversity are also concerns in Bangladesh, as large tracts of land are often converted to agriculture as well as to support the illegal timber trade. Recent growth of shrimp aquaculture has resulted in the loss of areas of the Sundarban mangrove forest, which is a World Heritage Site and home of the Royal Bengal Tiger. Surface water pollution has historically led to water-borne illnesses and high infant mortality rates from consumption of contaminated water. Recent changes to drinking groundwater has also come under threat from naturally occurring arsenic in the aquifer, thereby exposing over 30 million people to arsenic poisoning. Beyond water quality, water quantity also poses a problem in many areas with fluctuating groundwater tables, as well as seasonal water shortages. Disputes with neighboring India over controlling river flow remain politically contentious as a result. Air pollution from a growing number of vehicles and industries are also increasing in urban areas. As a result, many development projects in Bangladesh are focusing on the numerous environmental issues as part of overall development endeavors.

SEE ALSO: Arsenic; India; Monsoon.

BIBLIOGRAPHY. Haroun Er Rashid, *Geography of Bangladesh* (University Press Ltd, 1991); Betsy Hartmann and James Boyce, *A Quiet Violence: View from a Bangladeshi Village* (Zed Press, 1983); A. Rahman, S. Haque, and R. Haider, *Environment and Development in Bangladesh* (University Press Ltd., 1995).

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Basel Convention

ONE OF THE legacies of the industrial revolution has been the production of large quantities of hazardous waste, which over the last century has presented a serious challenge for disposal. Moreover, tightening of environmental regulation in industrialized countries in the late 1970s and early 80s led to a dramatic increase in the cost of disposing of hazardous waste. Producers and traders started looking for cheaper ways to get rid of "toxic" waste, such as shipping it to developing countries and to eastern Europe, which lack the technical capability, knowledge, and/or regulatory framework to treat this waste in an environmentally safe manner. Poorer countries were likely to accept exported wastes because their high international debt loads and weak economies positioned them poorly to reject any income-generating activities. As the problematic and unjust nature of the international toxins trade became better recognized, concern led to developing and implementing international controls. This culminated in the drafting and adoption of the landmark global Basel Convention, under the aegis of the United Nations. The Convention was adopted on March 22, 1989, by the Conference of Plenipotentiaries, which was convened at Basel (Switzerland) from March 20 to March 22, 1989.

FRAMEWORK FOR CONTROL

The Convention has set up a framework to control the "transboundary" movement of hazardous waste (hazardous waste can be toxic, poisonous, explosive, corrosive, flammable, ecotoxic, and infectious) across international frontiers with the aim of protecting human health and the environment by minimizing hazardous waste production whenever possible by using environmentally sound management techniques. This recognizes that a long-term solution to the stockpiling of hazardous wastes is a reduction in the generation of these wastes, both in terms of quantity and hazardousness. This means addressing the issue through an "integrated life-cycle approach," which involves strong controls from the generation of hazardous waste to its storage, transport, treatment, reuse, recycling, recovery, and final disposal—keeping track of it from cradle to grave.

The main goals of the Basel Convention are to ensure that generation of hazardous waste is reduced to a minimum; to ensure that as much hazardous waste as is possible is disposed of within the country of their generation; to establish enhanced controls on exports and imports of hazardous waste; to prohibit transportation/shipments of hazardous wastes to countries lacking the legal, administrative and technical capacity to manage and dispose of them in an environmentally sound manner; to cooperate on the exchange of information and technology transfer; and to work toward the harmonization of standards, codes, and guidelines.

These objectives can be achieved through factors such as active promotion and use of cleaner technologies and production methods; further reduction of transportation of hazardous wastes; prevention and monitoring of illegal traffic of hazardous waste; improvement of institutional and technical capabilities; helping to build up the capacities of developing countries and countries with economies in transition to deal with hazardous waste more effectively; and further development of regional and sub-regional centers for training and technology transfer.

The Basel Convention was adopted in 1989, but it did not come into force until May 5, 1992, when the Convention was ratified by 20 countries. As of February 2004, 158 countries had ratified the Basel Convention. Nations that have ratified the Convention are allowed to ship hazardous wastes to and from countries who are parties to the Convention, but not to countries or through countries that have not ratified it. The Convention permits an exception to this requirement if a separate bilateral agreement covers relations with a given trading partner that is not a party to the Convention. Article 11 of the Basel Convention allows parties to the Convention to develop such a bilateral agreement as long as the agreement reflects the environmentally sound management practices of wastes.

To highlight the scope of trade in hazardous wastes and hazardous recyclable materials: in 2002, Canada exported 340,000 tons of hazardous waste, primarily destined for northeastern and central United States. In the same year, Canada imported 423,000 tons of hazardous waste, 97 percent of which originated from the United States. Approximately 46 percent of imports and 70 percent of exports were destined for recycling.

In spite of huge volumes, there are enough Action Networks to monitor illegal activities. One of the cases reported in 2006 was the Clemenceau—a defunct aircraft carrier laden with asbestos—being exported by the French Government to India. It was recalled, however, after a French Court ruled that France was not abiding by the established rules under the Basel Convention. The International Maritime Organization is also developing a new convention on "International Convention for Safe and Environmentally Sound Recycling of Ships," and it is felt that it should be further strengthened to be at least as strict as the Basel Convention.

BIBLIOGRAPHY. Julie A. Bunn, *To Trade or Not to Trade?: The Basel Convention and the Transboundary Movement and Disposal of Hazardous Wastes,* (Georgetown University, 1997); J. Krueger, "The Basel Convention and the International Trade in Hazardous Wastes," *Yearbook of International Co-operation on Environment and Development 2001/02* (2001); Katharina Kummer, *International Management of Hazardous Wastes: The Basel Convention and Related Legal Rules* (Oxford University Press, 2000).

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Basin

A BASIN IS an area of land that is lower than the surrounding land. Many basins form lakes because water flows down into the lower land; however, this does not always happen. When the basin occurs underwater, for example in sea floors, then it makes little difference—as is also the case for the Kalahari Desert basin, around which all of the land receives too little precipitation or river flow to create a lake. In other cases, the flow of water is accompanied by sediment of different types and, eventually, this can cause significant filling up of the depression. In any case, the long-term changes in climate and terrain mean that any particular configuration will not be permanent. Many hydrocarbon resources are formed as the result of the presence of basins.

Basins were created principally through tectonic activity in the distant past. The interaction of tectonic plates causes some areas of land to rise and some to fall. Pressure caused by plates causes unevenness in other plates, and thus basins are formed. These can be very large. The Aral Sea and the Black Seas are examples of basins, as too are some of the lakes of central Africa and the Great Basin on South Australia.

The science of limnology is used to help classify the different types of basins. This is necessary because tectonic interactions can form basins in a number of different ways, for example by damming valleys, uplifting some surrounding area, or forcing a lower plate against a higher one. Basins may be distinguished from depressions, which are a broader group of phenomena that includes lower ground caused by meteor impact and crater formation, wind erosion, and other weathering effects. They may also be formed by volcanic activity and lava flows. Multiple factors may of course work together to create complex basin-like configurations.

Those basins into which water flows create standing bodies of water forming as lakes. As the water flows, it collects dissolved salts and small pieces of rock in suspension. These are known collectively as sediment, which are deposited in the lakes as their final destinations of the rivers. The weight of the combined sediment may cause additional subsidence of the original basin floor and may be associated with the formation of geological faults giving rise to earthquakes. Under certain circumstances, sedimentation may lead to conditions that give rise to the creation of complex chemical products, notably hydrocarbons such as oil and natural gas. Sedimentation also has an impact on the quality of soil in an area, and hence, the agricultural value of the land.

BIBLIOGRAPHY. P.A. Allen and John R. Allen, *Basin Analysis: Principles and Applications,* 2nd ed. (Blackwell Publishing, 2005); Andrew D. Miall, *The Geology of Fluvial Deposits: Sedimentary Facies, Basin Analysis, and Petroleum Geology* (Springer, 2006); Open University, *The Ocean Basins: Their Structure and Evolution,* 2nd ed. (Butterworth-Heinemann, 1998).

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Beaches

A BEACH IS a sloping accumulation of sediment, usually sand or gravel, that is a result of wave action at the edge of a water body, such as an ocean or lake. The presence of a uniform surface adjacent to water provides a prime location for recreational activities that, in turn, often drive regional economies. Beaches also hold great environmental value and provide habitat for a variety of important species. Because of the environmental, social, and economic value of beaches, societies have long grappled with how best to manage these landforms. Questions of beach replenishment, the protection of endangered species, and the public's right of access all complicate society's relationship to its beaches.

Beaches are not static features. They represent a balance between the size and regularity of waves and the availability of sediment. The action of waves reworks and sorts the sediment, washing away smaller particles and leaving larger ones, like sand or gravel. If a water body has little to no wave action, no beach will form. Similarly, the supply of sediment available to the waves must be sufficient to create a beach—too little sediment supply, and the beach will decrease in size. The supply of sediment commonly comes from nearby bluffs, a river mouth, or a reef offshore. Waves approaching the shore at an angle move the sediment and sand along the beach, which becomes important when considering how society alters beaches.

A common way humans interrupt the sediment supply is through the construction of groins—rock jetties perpendicular to the shoreline. These structures are designed to trap sand moving along the beach to produce a wider beach. Unfortunately, this trapped sediment is prevented from moving further along the shore, resulting in erosion downdrift of the groin. Similarly, homes built above an eroding bluff may be protected in the short term by the construction of a sea wall that removes the bluff as a sediment source for a nearby beach. Dams on rivers also trap sediment and prevent it from being carried by the river to the coast where it nourishes beaches. All three of these modifications—groins, sea walls, and dams—are built with good short-term intentions, but have unaccounted costs to society in the form of accelerated beach erosion. In some cases, society pays for these costs through beach replenishment, the importing of sediment from an offshore or land-based source at great expense. Artificial beach replenishment has to be repeated as long as the cause of the sediment supply reduction remains in place.

The physical dynamics of a beach are just one set of factors influencing society's use of beach environments. The public's right to beach access can be limited due to health concerns or property rights. Along many populated coasts, beach closures are common due to elevated levels of bacteria in the water, particularly after rain events that wash polluted storm water to the coast or cause sewer systems to overflow. Beaches also provide breeding habitat for a variety of species (such as horseshoe crabs and sea turtles) and, in many cases, society has chosen to restrict access to beaches during breeding times for these species.

The broader question of who has the right to access a particular beach is complex in a beach landscape that is both desirable and dynamic. Landowners adjacent to beaches are interested in protecting their privacy, while the public has an interest in preserving equal access to the beach. Laws outlining public and private rights vary by region, but many are based on some definition of the shoreline boundary, such as the mean high water line. The situation is exacerbated by global sea level rise that, in most cases, is moving the mean high water line farther ashore and narrowing the distance between the water line and private property.

The intensity of society-nature interactions is proportional to the environmental and economic value of the landscape in question. Only through acknowledgment of the processes that form beaches can society ensure its beaches will be accessible and available for future generations.

SEE ALSO: Currents, Ocean; Oceans; Private Property; Sea Turtles.

The physical dynamics of a beach are just one set of factors influencing society's use of beach environments.

BIBLIOGRAPHY. K.F. Nordstrom, *Beaches and Dunes of Developed Coasts* (Cambridge University Press, 2000); A.D. Short, ed., *Handbook of Beach and Shoreface Morphodynamics,* (John Wiley & Sons, 2000).

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Belarus

THE TERRITORY OF Belarus covers 207,600 square kilometers, and it has a population of 10.2 million people. The country was declared an independent republic in September 1991, after the collapse of the Soviet Union. Subsequent reforms were slow and did not indicate rapid economic change. The first president of the independent Belarus, Alexander Lukashenko, was elected in 1994 and has aimed to create a dictatorship; his politics have been criticized by the international community, especially by the European Union (EU). The outcome of the presidential elections in 2006, when Lukashenko won around 85 percent of the votes, was not approved by the international community, except Russia. Following the election, the EU banned Belarusian leaders to enter the territory of the EU.

One of the most important environmental issues is radioactivity due to the destruction at the Chernobyl Nuclear Power Plant in the Ukraine on April 26, 1986. Radio nuclides are deposited very heterogeneously due to weather and wind over Belarusian territory. To date, about 135,000 persons have been resettled or evacuated. Some of them have moved back to these areas with or without the right to resettle, which poses significant health problems. It is hard to estimate the total environmental toll of the nuclear catastrophe in Belarus, but a very significant share of the Belarusian flora and fauna has been affected by the deposit of Chernobyl plume.

Environmental quality in Belarus has improved since the early 1990s, but this was largely the result of a decline in economic activity. Only a little can be accredited to new production technologies and to the shift from industrial to postindustrial production. Water quality in general has been poor, and hygienic standards have not been met since the late 1980s. Water quality problems are even more serious in rural areas served by shallow wells, where the level of microbe pollution is high. High nitrate and iron content in groundwater has reported in the early 1990s, and remains a major environmental issue. Air is relatively clean in Belarus, even compared to EU countries or to the United States. Urban air pollution is low, due to the low number of vehicles.

Central institutions have played an important role in environmental issues in Belarus. National and international non governmental organizations (NGOs) have to face several difficulties posed by the central government. Complex regulation, occasional intervention from authorities, and the lack of central financial support has created difficult situation for most of the NGOs. Furthermore, their information can be distributed only if the material is registered by the authorities. Complex taxation has cut off donations significantly to environmental NGOs, therefore only a very limited sources of aid are available. In addition, collaboration with NGOs and media is not encouraged. As a result, public participation is only limited in environmental issues. Due to the increasing isolation of Belarus, that trend is likely to continue into the future.

SEE ALSO: Chernobyl Accident; European Union; Non governmental organizations (NGOs); Russia (and Soviet Union)

BIBLIOGRAPHY. Elena Rosalind Marsh and Colin Lawson, *Contemporary Belarus: Between Democracy and Dictatorship* (Routledge, 2003); Karen Dawisha and Bruce Parrott, eds., *Democratic Changes and Authoritarian Reactions in Russia, Ukraine, Belarus and Moldova* (Cambridge University Press, 1997).

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Belgium

THE KINGDOM OF Belgium is known as the “crossroads of Western Europe” because most other western European capitals are located within 1,000 kilometers of the capital city of Brussels. Bordering on the North Sea, the climate of Belgium is temperate with mild winters and wet, cool summers. The topography of Belgium varies from the flat coastal plains of the northwest to hills in the central part of the country to the mountains of the Ardennes Forest in the southeast. Belgium has protected large areas of land, particularly in the Ardennes, which is home to many of the 191 species of birds and the 58 mammal species endemic to Belgium. Close attention is also paid to the peat bogs of the Hautes Fagnes Reserve. Flooding is a constant threat on the coast, and the government has created a protective system of concrete dikes along the 200 square miles of reclaimed coastal land. Belgium's natural resources are somewhat limited, consisting of construction materials, silica sand, and carbonates. With a per capita income of $31,800, the quality of life in Belgium is among the highest in the world, and the United Nations Development Project (UNDP) Human Development Reports place Belgium in ninth place.

CONSEQUENCES OF INDUSTRIALIZATION

Long a leading industrial nation, Belgium continues to be heavily industrialized, particularly in Flanders. As a result, the environment has suffered from intense urbanization, transportation and agricultural contamination, and industrial pollution. The Ministry of Public Health and Environment works closely with provincial and local governments to implement environmental policies derived from the Mature Development Plan, the Environmental Policy Plan, and the Waste Plan. In 2006, a study by Yale University ranked Belgium 39 among 132 nations on environmental performance. Belgium's chief environmental concerns are acidification and air, water, and soil pollution. Pollutants include nuclear radiation, mercury, pesticides, phosphorous, and other metals. Because of intense urbanization, Belgium is also a major emitter of carbon dioxide.

Less than 3 percent of the Belgian population live in rural areas, and only 1.3 percent of the labor force are involved in agriculture. Intensive use of the pesticide mirex (Dechlorane), which was used as a fire retardant in plastics, rubber, paint, paper, and electric goods, and as a method of controlling fire ants, was common from the 1950s to the 1970s, and residues of mirex have been identified in water emissions and rain water. Belgium subsequently became more environmentally responsible; and since the 1990s, acidifying and eutrophying emissions have dropped by 35 percent due to a decrease in the number of livestock and to more responsible use of fertilizers and nutrients.

Because Belgium is one of the most urbanized countries in the world, household waste has presented major environmental problems. Since 2000, however, much progress has been made in other areas. Energy consumption has begun falling, and a water purification policy has led to lower levels of pollution in ground water. Increased attention to reducing acidification has resulted in decreased rates of DenOx and DeSox units and to a rise in the use of low-sulfur fuels. Additionally, rates of heavy metals identified in wastewater have continued to decrease.

Because Belgium is a federal system, much of the responsibility for environmental policy lies with local governments. In response to the 1992 United Nations Conference on Environment and Development, provincial and local governments began generating action plans for environmental protection and sustainable development. Belgium has expressed its commitment to the environment by signing the following agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Seals, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands. The agreement to control Air Pollution–Persistent Organic Pollutants has been signed but not yet ratified.

SEE ALSO: Floods and Flood Control; Pesticides; Pollution, Air; Pollution, Water; Wastewater.

BIBLIOGRAPHY. CIA, "Belgium," *The World Factbook,* www.cia.gov (cited March 2006); Flemish Environment Agency, *MIRA Report on the Environment and Nature in Flanders* (Mechelen, Belgium, 2003); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Con-*

tinental Overview of Environmental Issues (ABC-CLIO, 2003); George Thomas Kurian, *The Benelux Countries* (Facts on File, 1989); UNDP, "Human Development Reports: Belgium," www.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Belgium," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Belize

BELIZE IS LOCATED on the eastern coast of Central America, bordered by Mexico to the north, Guatemala to the west and south, and the Caribbean Sea to the east. Covering 22,806 square kilometers (8,805 square miles), Belize is the second smallest nation in Central America and the only one without a Pacific coastline. Belize is also the only English-speaking country in Central America, and with approximately 291,800 people, the least densely populated. Known as "British Honduras" until 1973, Belize was a British colony for more than a century before gaining independence on September 21, 1981.

Belize's landscape is marked by diverse topography. The northern region is primarily tableland covered by scrub vegetation and hardwood tropical forest. A narrow coastal plain, much of it covered with mangrove swamp, stretches along the Caribbean coast. Inland, the Maya Mountains, Cockscomb Range, and the Mountain Pine Ridge form the backbone of the southern half of the country, the highest point being Doyle's Delight at 1,124 meters (3,688 feet) above sea level. This region is covered primarily by tropical rain forest. Belize's coast is bordered by the second longest coral reef system in the world, spanning approximately 322 kilometers (200 miles) with over 450 islets and cays.

Belize is one of the world's most biologically diverse countries with over 2,894 species of plants and 877 known species of amphibians, birds, mammals, and reptiles. Belize is home to more jaguars than any other Central American country and hosts the world's only reserve for these felines, the Cockscomb Basin Wildlife Sanctuary and Jaguar Preserve.

The livelihoods of many Belizeans are tied to the land. Sugar and citrus fruits are Belize's main sources of export revenue, while the banana industry is the country's largest employer. Until the 1950s, timber

Cayes Ecotourism

This former British colony in Central America has recently developed into a center for ecotourism with its small islands, or "cayes."

Traditionally, Belize has been regarded as unsafe for tourists and was not visited by many wealthier tourists, who were worried about robberies and drug dealing in Belize City. However, the country has undergone great changes, and with a warm climate, a relatively low cost of living, and unspoiled beaches, tourism to Belize increased in the 1990s.

The most popular caye in Belize remains Caye Caulker, which has attracted tourists since the 1980s. In the pirate era, the caye had a small fishing settlement, and derived its name from boats arriving to the port for repair or caulking. It soon became important during the War of the Castes, which took place between 1847 and 1901. In 1870, Luciano Reyes bought the land and left some to descendants, many of whom still live there. The beaches and the jetties are on the Caribbean side of the peninsula, and is accessed from Belize City by light aircraft or boat.

St. George's Caye, near Belize City, was the site of the Battle of St. George's Caye, which was fought on September 10, 1798. The bigger Spanish boats found themselves unable to maneuver, whereas the baymen from Belize had ships with shallow drafts. It was the last Spanish attempt to take British possession, and September 10 is now a public holiday. Mythology surrounding the battle suggests that freemen and slaves fought side by side, with the slaves eager to support their masters rather than be ruled by the Spanish.

dominated the economy. Timber was selectively logged, leaving much of the canopy intact, and until recently much of the country had little road access and relatively light development. As a result, nearly 75 percent of Belize is still under forest cover, although the transfer of land from forest to agriculture continues to accelerate.

The Belizean government and citizens have largely embraced environmental conservation for protecting the landscape and attracting tourism and foreign investment. The creation of the Ministry of Tourism and the Environment and the passage of major environmental legislation, including the Belize Environmental Protection Act of 1992, have further strengthened this rhetoric of conservation. Consequently, 42 percent of Belize is under a form of legal protection, the greatest proportion of any country in the western hemisphere.

However, these laws are limited by a lack of financial support. In response, the government has developed partnerships with nonprofit environmental groups, for-profit groups, and local community associations in order to support the institution and enforcement of these protections. Recently, these conservation efforts have been criticized as being "ecocolonialist," favoring the management of the environment at the expense of the economic and cultural needs of the Belizean people. The greatest challenge in Belize remains balancing the needs of the human population with conservation programs.

SEE ALSO: Bananas; Timber Industry; Tourism.

BIBLIOGRAPHY. Tom Barry, *Inside Belize* (Resource Center Press, 1995); Government of Belize website, www.belize.gov.bz (cited May 2006); Richard B. Primack, David Bray, Hugo A. Galletti, and Ismael Ponciano, eds., *Timber, Tourists, and Temples: Conservation and Development in the Maya Forest of Belize, Guatemala, and Mexico* (Island Press, 1998); Alan Rabinowitz, *Jaguar: One Man's Struggle to Establish the World's First Jaguar Preserve* (Island Press, 2000); Anne Sutherland, *The Making of Belize: Globalization in the Margins* (Bergin and Garvey, 1998); P.A.B. Thomson, *Belize: A Concise History* (Macmillian Caribbean, 2004).

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Beneficial Use Doctrine

THE BENEFICIAL USE Doctrine refers to the principle of water management adopted by the western United States during a period of expansion during the 19th century. The California Gold Rush and other stimuli led to a rapid population increase in the western states that was plagued by little standing groundwater, among other features. The Beneficial Use Doctrine stipulates that land rights, which may be transferred or bought, are also accompanied by a right to water that exists on that property, insofar as any use of the water is beneficial and not wasted in any way, with the risk of forfeiture of those rights for individuals who fail to comply with that stipulation.

CHALLENGES

The concept of beneficial use has remained in practice, although it has been challenged on a number of grounds since its introduction. One set of challenges has centered on practical issues related to the implementation of laws based on the doctrine and as expressed in the legislation of the separate states. This has included the comparative weakness of the laws when it comes to monitoring and prosecution. However, a more persistent set of challenges has arisen on a more fundamental, ideological basis. Many people believe that market-based allocation of resources would be equal or even superior to the Beneficial Use Doctrine, and that the latter should, therefore, be phased out of the legislation.

Much has changed over the past century in terms of the demand for water resources, which has grown enormously, as well as the ability to use technology to efficiently manage water, route it, and recycle it to an extent previously unimagined. The purpose of the original doctrine was to hinder the seizing of a monopoly and concomitant speculation and price gouging in water resources. This does not necessarily encourage the most efficient and parsimonious use of water, but simply deters its use in ways that openly flout the regulations. Modern requirements have changed, and it may be that adjustment of the doctrine will better reflect these requirements. In any case, it will be important to ensure that any such adjustment is the result of genuine public consultation and is not hijacked by corporate interests.

SEE ALSO: Prior Appropriation; United States, Mountain West; Water Conservation; Water Law.

BIBLIOGRAPHY. Micha Gissa, "Groundwater: Focusing on the Real Issue," *Journal of Political Economy* (v.91/6, 1983); Janet C. Neuman, "Beneficial Use, Waste, and Forfeiture: The Inefficient Search for Efficiency in Western Water Use," *Environmental Law* (v.28, 1998); T.D. Tregarthen, "Water in Colorado: Fear and Loathing of the Marketplace," in *Water Rights: Scarce Resource Allocation, Bureaucracy and the Environment* (Pacific Institute for Public Policy Research, 1983).

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Benin

ARISING OUT OF the 15th-century kingdom of Dahomey, the Republic of Benin won its independence from France in 1960. In the early 1990s, Benin became the first African nation to successfully transform itself from a Marxist-Leninist government to a multi-party democracy, though local elections were not actually held until 2002. With a per capita income of only $1,100, Benin is the 27th poorest country in the world. One-third of the people live in poverty, and a fifth of them are seriously undernourished. Benin's economy is generally underdeveloped and is chiefly dependent on subsistence agriculture. Less than 45 percent of the people live in urban areas. In addition to small offshore deposits of oil, Benin's natural resources include limestone, marble, and timber.

Bordering on the Bight of Benin in the Atlantic Ocean, this West African country has a coastline of 121 kilometers and shares land borders with Nigeria, Niger, Togo, and Burkina Faso. Because the coast of Benin has no natural harbors, river mouths, or islands, sandbanks limit coastal access in some areas. The land is mostly flat with a few hills and low mountains. Elevations range from sea level to 658 meters at Mont Sokbaro. Benin's climate is tropical, varying from hot and humid in the south to semiarid in the north. From December to March, northern areas may experience the harmattan, a hot, dry, and dusty wind that accelerates soil degradation. Cotonou, which is the economic capital, experiences frequent flooding and may become even more vulnerable in response to global warming.

HEALTH AND ENVIRONMENT

Benin's population of 7,460,025 is seriously threatened by a 1.9 percent HIV/AIDS rate that caused 5,800 deaths by 2003. Another 68,000 Beninese have been diagnosed with the disease. Benin has a shortage of potable water. Some 32 percent of the population lacks sustained access to safe drinking water, and 68 of Beninese do not have access to improved sanitation (12 percent in rural areas). This lack of safe water and basic sanitation has created a very high risk of contracting food and waterborne diseases, including typhoid fever and hepatitis A. Beninese are also at risk for contracting meningococcal meningitis, a respiratory disease. In some areas, the risk of contracting vectorborne diseases such as malaria and yellow fever is also high.

Because of the high disease rate, the Beninese experience low life expectancy (53.04 years) and high infant mortality (79.56 deaths per 1,000 live births) and death rates (12.22/1,000). Thus, the population grows at a rate of only 2.73 percent. The Benin fertility rate is extremely high at 5.9 children per female. Low literacy rates (46.4 percent for males and 22.6 percent for females) make the dissemination of health and environmental information difficult. The United Nations Development Project (UNDP) Human Development Reports rank Benin 162 of 232 countries on overall quality-of-life issues.

In 2006, scientists at Yale University ranked Benin 84 of 132 countries on environmental performance, slightly above the comparable income and geographic groups. Desertification is spreading in Benin, and deforestation occurs at a rate of 2.3 percent each year. Approximately 247,000 acres of forest have been cleared to provide fuel, as there is no other source of energy for cooking and heating. These problems are particularly severe in the arid areas of the north. The government has protected 11.4 percent of land area. Of 188 mammal species identified in Benin, eight are endangered, as are two of 112 bird species. Wildlife populations are at great risk from poaching.

Coastal erosion in Benin that has resulted from decades of dam building and the practice of removing a million meters of sand each year for construction have led to loss of land for development and to the destruction of existing buildings. For instance, in the cities of Grand Popo and Finagnon, hundreds of houses have vanished, along with the expensive Palm Beach Hotel that was built along the Atlantic coast of Benin in 1982. Approximately 20 meters of coastal land per year is being reclaimed by the sea. Such losses not only produce massive human displacement and environmental degradation, they also damage the already fragile Beninese economy.

In 1990, Benin's Constitution declared that a clean environment was the right and responsibility of all Beninese. Two years later, the Ministry of Environment, Housing, and Urban Development was created and charged with the implementation and monitoring of Benin's environmental laws. The following year, an environmental framework was set out in the Environmental Plan, which operates on the principle that polluters pay for the damage they create. Modeled after international and regional plans, Benin's environmental policies seek to promote sustainable development while dealing with issues that range from improving the quality of water and waste disposal to severe coastal erosion.

Checking coastal erosion is considered a major priority in environmental planning, and the government has begun constructing groins, a system of levees that are built at right angles to the sea, to check the damage created by ocean currents. The ultimate success of this project will depend on obtaining the roughly $60 million necessary for full implementation. Benin participates in the following international agreements on the environment: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Acquired Immune Deficiency Syndrome; Beaches; Coastal Zone; Deforestation; Infant Mortality Rate; Life Expectancy; Malaria; Poverty; Subsistence; Typhus; Yellow Fever.

BIBLIOGRAPHY. CIA, "Benin," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); IRIN, "Benin: A Forgotten Threat Called Coastal Erosion," www.irinnews.org (cited May 2006); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); One World, "Benin: Environment," www.uk.oneworld.net (cited May 2006); UNDP, "Human Development Report: Benin," www.hdr.undp (cited May 2006); World Bank, "Benin," *Little Green Data Book,* www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Berry, Wendell (1934–)

POET, NOVELIST, ESSAYIST, social critic, and small farmer, Wendell Erdman Berry was born August 5, 1934, in rural Henry County, Kentucky. The years after World War II witnessed large farms replacing small ones, machines replacing horses, and internecine, debt-ridden, assistance-dependent farmers replacing a tight-knit, largely self-sufficient rural community. This agri*cultural* transition that took place in Henry County (and more broadly, the rural United States) during Berry's formative years would have a lasting impact on his values, livelihood, and ultimately his writing. After completing the creative writing graduate program at Stanford University as a Wallace Stegner fellow, Berry spent one year in Europe as a Guggenheim fellow and two years teaching at New York University, finally to return home to Kentucky in 1964. For over a decade, he split time between teaching at the University of Kentucky in Lexington and farming in Henry County. With the exception of another short teaching stint in the late 1980s, he has farmed and written from his small farm in Henry County since 1977.

To summarize Berry's work is nearly impossible; even to label him an "environmental writer" is almost unfair. His earliest works were novels of rural life in Kentucky, and his more recent writings include overtly political essays with little central focus on things natural. In all, Berry has published 15 novels and short story collections, and over 30 volumes of poetry. It is perhaps in his agrarian essays, however, that Berry has received his widest readership, highest critical acclaim, and forged what will be his most lasting influence.

Berry's first collection of nonfiction essays was 1972's *A Continuous Harmony: Essays Cultural and Agricultural*. His Jeffersonian agrarian ideals shine through in countless passages, such as the following taken from the essay "Think Little":

> What we are up against in this country, in any attempt to invoke private responsibility, is that we have nearly destroyed private life. Our people have given up their independence in return for the cheap seductions of 'affluence.'

Most tragically, for Berry, is that rural Americans—even its farmers—have followed this urban trend. The fallout is a rural landscape that is at once depopulated, environmentally degraded, and devoid of the sense of community that held these once ecologically and culturally rich, if always (relatively) monetarily poor, places together.

These themes are most forcefully expressed in his 1977 collection *The Unsettling of America: Culture and Agriculture*. Here Berry makes his first focused attacks on the irredeemably unjust U.S. agricultural-policy/agribusiness-corporation nexus. Often echoing the sentiments of Aldo Leopold, but always more bitter and pessimistic, *The Unsettling of America* exposes the modern, corporate farm as a wasteful, unnatural, antiecological, profit-driven use of the land. Berry argues that unless small landholders—self-sufficient, community-minded growers and makers—return to an appropriate scale and method of practice, the landscape of natural and human communities will continue to suffer the increasingly toxic effects of modernity. A good starting place for Berry's biting but crystal-clear and prescient critique is the 2002 collection *The Art of the Commonplace: The Agrarian Essays of Wendell Berry*.

SEE ALSO: Agriculture; Leopold, Aldo; Nature Writing.

BIBLIOGRAPHY. Andre J. Angyal, *Wendell Berry* (Twayne, 1995); Wendell Berry, *The Art of the Commonplace: The Agrarian Essays of Wendell Berry* (Counterpoint, 2002); Wendell Berry, *A Continuous Harmony: Essays Cultural and Agricultural* (Harcourt Brace Jovanovich, 1972); Wendell Berry, *The Unsettling of America: Culture and Agriculture* (Sierra Club Books, 1996).

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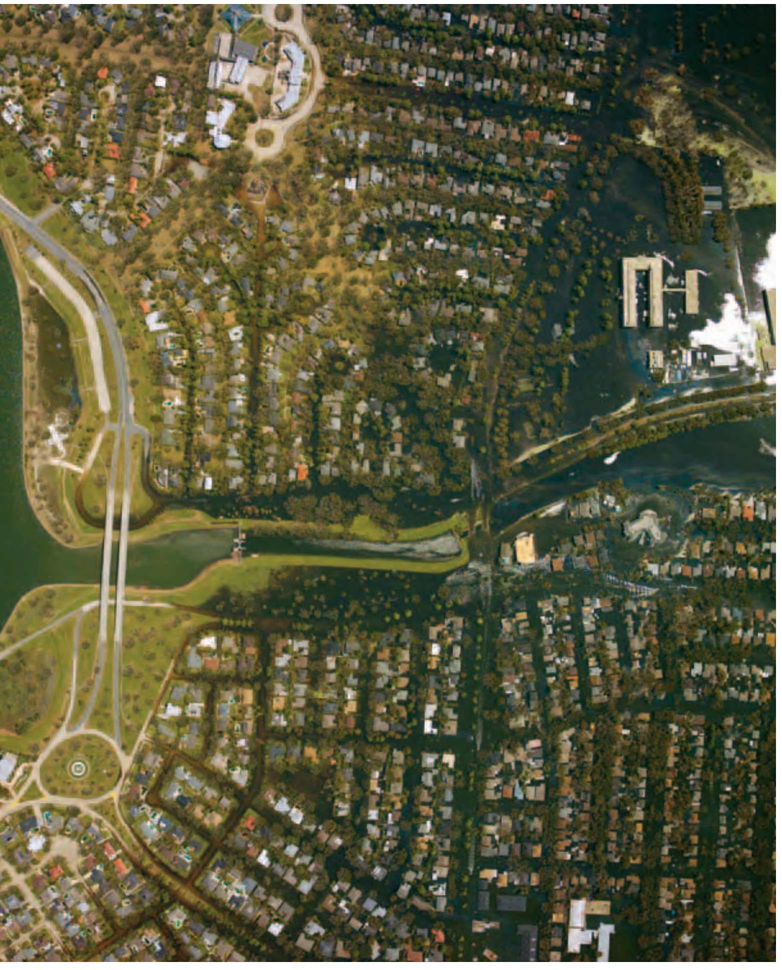
Best Available Technology (BAT)

BEST AVAILABLE TECHNOLOGY (BAT) refers to a doctrine, sometimes adopted in enforcement of environmental policy, to pursue only the most state-of-the-art, technological solutions and processes, regardless of efficiency or expense. For permitting of industrial effluents under the Clean Water Act, for example, levels of allowed toxic pollutants have been set as matching those that might be reached with the "Best Available Technology." The doctrine of BAT differs significantly from cost-benefit decision-making, as employed by the U.S. Corps of Engineers, for example, in balancing the costs of a project against the potential gains or losses.

The difference between the two can be seen in the strength of the levee system in New Orleans, Louisiana prior to Hurricane Katrina on August 29, 2005. When the levees broke, catastrophic damage occurred. The Corps of Engineers had used state-of-the-art technology in their cost-benefit studies, including the likelihood of a great hurricane striking the city. The cost of rebuilding New Orleans will probably be more than the cost if the BAT doctrine had been applied. If the levees of New Orleans had been protected by the BAT doctrine, it would have appeared excessively expensive; however the decision to use BAT would have had a different environmental impact.

Many future-oriented businesses have adopted a BAT strategy in order to beat competition in the struggle for market share. Environmental issues can also benefit from the BAT approach if the situation is an emergency like an oil spill, or the survival of a species. Congress has mandated BAT be used to control air pollution in the Clear Air Act.



When the levees broke in New Orleans during Hurricane Katrina in August of 2005, catastrophic damage followed.

Both state laws and other federal laws related to the Clean Air Act have mandated the use of BAT. The courts are in the process of applying BAT to cases as a legal doctrine.

In the area of pollution control, a modified form of BAT is the Best Available Control Technology (BACT) approach. Using BACT means that the best technology for controlling pollution, such as nuclear waste, is accomplished by whatever means at any cost. BACT is used in contrast to the most economical pollutions-control approach to environmental problems, which runs the risk of failures that will result in major ecological disasters. The policy decision to avoid risk in order to save money is a decision more concerned with excellent results than with costs. Under the Clean Air Act, a polluter must show that pollution emissions cannot be controlled by BAT. Usually, whichever technology produces the greatest reduction of air pollutants is the technology that must be used by a polluter regardless of the cost.

SEE ALSO: Clean Air Act (U.S.); Clean Water Act (U.S. 1972); Cost-Benefit Analysis; Hurricanes.

BIBLIOGRAPHY. Robert W. Collin, *The Environmental Protection Agency: Cleaning up America's Act* (Greenwood Press, 2006); David Hosansky, *The Environment A to Z* (CQ Press, 2001); Robert H. Spencer and Randolph P. Johnston, *Technology Best Practices* (John Wiley & Sons, 2003).

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Bhopal Gas Tragedy

ON DECEMBER 3, 1984, one of the worst industrial disasters of the 20th century occurred in Bhopal, India, a city located in Central India's state of Madhya Pradesh. Here, at about 1 a.m., a highly poisonous vapor (methyl isocyanate, or MIC) leaked from the Union Carbide pesticide plant. This incident not only left about 300,000 people injured and about 2,000 dead immediately (it is reported that later about 15,000 people died), but also had an impact on local plants and animals. The majority of deaths and serious injuries were related to pulmonary edema, but the gas caused other ailments such as cough, dyspnea, chest pain, eyelid edema, and unconsciousness leading to acute lung injury, cardiac arrest, and death. Other problems included partial or complete blindness, gastrointestinal disorders, impaired immune systems, and post-traumatic stress disorders. After this tragedy in Bhopal there was a rise in spontaneous abortions and stillbirths; offspring with genetic defects were also noted.

There are a few reasons for leakage of MIC. Water accidentally entered the tank where MIC was stored, which started the exothermic reaction of excessive heat and eventual bursting of the tank's safety valve. The pressure of this burst even broke the concrete of the tank, releasing MIC. With a chimney height of just 30 meters and high moisture content in the discharge, the heavy gas sank to the ground. The weak winter wind changed direction quickly, which contributed to the spread of the gas and covered a large area in a short period of time. But the main reason for the tragedy is a combination of human factors and the faulty design of the safety system. According to some reports, part of the safety equipment was faulty, and by the time the alarm was sounded, an hour had elapsed since the gas was released into the atmosphere. Some other causes have been debated, but there seems to be a combination of human and technical fault—the same plant experienced six accidents between 1981 and 1984. These accidents should have alerted the authorities, but were neglected. India, a poor nation with a need for pesticides, did not raise any concern.

The Indian government sued Union Carbide for $3 billion, and the case was settled in 1989 for $470 million, but very little money reached the victims of the tragedy. Even more than two decades after the accident, due to lack of political will and resources, the environment surrounding the plant are still laced with toxic wastes. The plant and the surrounding areas are still contaminated, causing slow poisoning and diseases in humans, destroying the local biodiversity, and affecting the ecosystem. The contamination of groundwater (the main source of drinking water) in the neighboring areas of Union Carbide was a serious problem even before the tragedy hit Bhopal. The condition has worsened since then because the area has not been cleaned.

The Bhopal gas tragedy is one of the worst industrial disasters in history, but it did start a public debate on the hazards of the chemical industry, which led the Chemical Manufacturing Association to start the Responsible Care Program. The main goal of the Responsible Care Program is to improve community awareness, emergency response, and employee health and safety. The tragedy also started an environmental movement in India and has made the general public more aware of the impacts of industrial accidents. Following this tragic event, Indian Environmental legislations have also undergone drastic changes. The Ministry of Environment and Forests has been created to administer and enforce environmental laws and policies, and an Environment Protection Act was passed in 1986. The ministry was established to integrate environmental strategies into all industrial development plans for the country, but in spite of all these commitments to the environment and public health, development has taken precedence.

SEE ALSO: Disasters; India; Pesticides.

BIBLIOGRAPHY. William L. Benoit, *Accounts, Excuses and Apologies: A Theory of Image Restoration Strategies* (University of New York Press, 1995); William Bogard, *The Bhopal Tragedy: Language, Logic and Politics in the Production of a Hazard* (Westview Press, 1989); Dan Kurzman, *A Killing Wind: Inside Union Carbide and the Bhopal Catastrophe* (McGraw-Hill, 1987).

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Bhutan

IN THE EARLY 20th century, Bhutan was a Protectorate of Great Britain, who took responsibility for directing Bhutan's foreign affairs, theoretically leaving internal affairs to the Bhutanese government. They ceded that role to India in 1947, with the relationship formally defined in 1949. Bhutan has one of the smallest and least-developed economies in the world. Some 93 percent of the population is engaged in agriculture, chiefly in subsistence farming and animal husbandry, and there is a substantial lack of modern technology. Only 8.5 percent of Bhutanese are urbanized.

One-fourth of the workforce is engaged in industries, and employers are faced with a massive labor shortage. The economy is highly dependent on regular subsidies from India. With a per capita income of $1,400, Bhutan is ranked 197th of 232 nations in world incomes. A current and ongoing political crisis revolves around the issue of 100,000 Bhutanese refugees of Nepali ethnicity, expelled by Bhutan in the early 1990s, who remain in camps under the administration of the United Nations Office of the High Commissioner for Refugees.

Population estimates for Bhutan vary from 810,000 to 2,200,00. Life is harsh in Bhutan, and life expectancy is low at only 54.39 years. On the other hand, infant mortality is high (100.44 deaths per 1,000 live births). Partly for this reason, the fertility rate is also abnormally high at 4.81 children per female. Low literacy rates contribute to the labor shortage. Less than half of the adult population can read and write, and the literacy rate for females is abysmally low (28.1 percent). About 38 percent of Bhutanese lack access to safe drinking water, and 30 percent have no access to improved sanitation. The United Nations Development Project (UNDP) Human Development Reports rank Bhutan 134th in the world in overall quality-of-life issues.

Nestled between China and India, Bhutan controls some of the major passes through the Himalayas. The country is landlocked and has no freshwater resources. The climate is diverse, ranging from tropical in the southern plains to cool winters and hot summers in the central valleys to severe winters and cool summers in the Himalayas. The Kingdom of Bhutan received its name, the "Land of the Thunder Dragon," from the frequent thunderstorms that occur during the rainy season. Bhutan is also subject to landslides. The terrain is mostly mountainous, interspersed with fertile valleys and savanna. Due to a lack of roads, transportation is difficult.

HEALTH AND ENVIRONMENT

In addition to the lack of potable water, soil erosion and land degradation are the major environmental problem for Bhutan. Other problems include air and water pollution, overgrazing, uncontrolled fires, road construction, solid waste management, and poaching. The Glacial Lake Outburst Floods, which are composed of 24 glacial lakes, are in danger of bursting due to climate change. Bhutan ranks in the top 10 countries of the world in species density. To protect these important resources, the National Assembly issued a mandate that forest cover must be maintained at least 60 percent at all times. Bhutan is home to some 200 mammal species that include the golden langur and the clouded leopard. More than 700 bird species and 800-900 butterfly species are also found in Bhutan. Twelve bird species and 22 mammal species are in danger of extinction.

In 1969, the Bhutanese government passed the Bhutan Forest Act and followed it up five years later with the National Forest Policy. It was not until 1998, however, that the government set up a comprehensive framework for environmental policy by strengthening the National Environment Commission and the Nature Conservation Division, which share the responsibility for environmental planning, assessment, and enforcement in Bhutan. The 1998 legislation also established the National Biodiversity Centre. A number of nongovernmental organizations are also active in protecting the environment. Bhutan has signed the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Endangered Species, and Hazardous Wastes. The Law of the Sea agreement has been signed but not ratified.

SEE ALSO: Infant Mortality Rate; Land Degradation; Life Expectancy; Poaching; Poverty; Soil Erosion; Subsistence.

BIBLIOGRAPHY. CIA, "Bhutan," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993); One World, "Bhutan: Environment," www.uk.oneworld.net (cited April 2006); UNDP, "Bhutan," www.hdr.undp.org (cited April 2006); World Bank, "Bhutan," *Little Green Data Book,* www.worldbank.org (cited April 2006).

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Bicycle

THE BICYCLE IS a two-wheeled, human-powered mode of personal transportation that transforms muscle power with chain-driven gears into motive force. Numbering perhaps one billion today, bicycles and analogous tricycle rickshaws accomplish a significant component of the world's commuting and light transport. Bicycle ownership and use is globally very uneven. Western European countries have the most bikes per capita, and in the Netherlands and Denmark, as many as one-third of commuting trips are by bicycle. Japan, Australia, and the United States have about the same number of bicycles per capita, but Japanese commuters use bicycles far more. In some south and southeast Asian cities rickshaws haul more goods and passengers than motorized vehicles. The world's preeminent cycling society is China, with at least 300 million machines and high rates of urban and rural use.

Bicycles are an efficient and relatively cheap means of transportation. Energy use in cycling averages 35 kilocalories per mile, three times more efficient than walking and 53 times more than an automobile getting 20 mpg. In 1975 dollars, cycling costs for a U.S. commuter covering 2,500 miles per year were (including road construction and maintenance costs) 10 cents per mile, compared to 56 cents for cars, 27cents for trains, and 18cents for buses.

WHEELS OF CHANGE

Despite its reputation as a green alternative to the automobile, the bicycle is an artifact of the same modernity that spawned the car. The cycling boom in Europe and the United States in the 1890s contributed to and was affected by a belief in scientific and social progress liberating the individual from the constraints of Victorian life. The changes to women's dress and mobility brought on by cycling articulated with feminism, and the bicycle's democratization of access to peri-urban parklands allowed more leisure time in the countryside.

At the same time, the boom presaged contradictions of automobile culture like dependence on neocolonial resource economies and the engineering of cities around personal vehicles over pedestrians or public transit. The demand for bicycles contributed to the scramble for rubber, which motivated the savage variety of European colonialism seen in the Belgian Congo. The political action of bicyclists in the United States in the 1890s centered on improving urban roads and reducing the street presence of trolley car lines. This put bicycles at odds with mass transit, and defined fast roads designed for private vehicles as the epitome of progress, an ideology of personal mobility amplified in the automobile age.

The bicycle was embraced by the European working classes for utilitarian purposes in the inter-war decades, but lost out to automobiles in the 1960s. At the same time, cycling rebounded in China, booming especially in the economic liberalization of the 1980s. Mass use of bicycles was a transport solution for rapid urbanization and industrialization without heavy investments in infrastructure, vehicles, or petroleum that the government encouraged through street engineering and support for domestic bike manufacturing. The rickshaw, a Japanese innovation influenced by European carriages, became the cycle rickshaw when fused with Western bicycle gearing and pedals. Human-powered urban transport fueled Asian urban economies with limited animal power or motorized vehicles, and created working class political power through paralyzing rickshawmens' strikes.

The *Critical Mass* phenomenon, where cyclists ride together to occupy street space typically given over to cars, began in San Francisco in 1992 and has since diffused to cities the world over. Celebratory and oppositional, *Critical Mass* challenges automobile culture and its connections to oil wars, global climate change, and the privatization of urban space. The term was coined by American cycling activists visiting China who observed Chinese bike commuters' tactics of negotiating street space with cars. The recent explosion in Chinese automobile use poses a unique question: What happens when the world's largest bicycling culture runs into the world's fastest growing car culture?

BIBLIOGRAPHY. C. Carlsson, *Critical Mass: Bicycling's Defiant Celebration* (AK Press, 2002); J. Forester, *Bicycle Transportation* (The MIT Press, 1983); D. Herlihy, *Bicycle: The History* (Yale University Press, 2004); M. Lowe, *The Bicycle: Vehicle for a Small Planet. Worldwatch Paper #90* (Worldwatch Institute, 1989).

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Bikini Atoll

BIKINI ATOLL IS located in the North Pacific at 11 degrees 30' North Latitude and 165 degrees 25' East Longitude, and comprises one of 29 atolls in the

Marshall Islands. The atoll consists of 36 islets that surround a lagoon of 594 square kilometers in area. Culturally part of the Micronesian region, archeologists place their best estimates of human colonization of the Marshall Islands between 3,000 – 2,000 years before present, with Bikini being settled more toward the recent portion of this date range. One controversial assessment of Bikini's settlement, based on carbon dating of charcoal, pushes that date back to between 4,000 – 3,600 years ago, although this date range supersedes geologic estimates of the Atoll's formation by 600 – 1,000 years (it is possible that the charcoal could have drifted in from elsewhere). Bikini Atoll is currently part of the Republic of the Marshall Islands, an independent state since 1979; a Compact of Free Association was signed with the United States since 1986, and its independence was formally recognized internationally in 1990 after the United State's trusteeship of the region was formally terminated by the United Nations.

BOMB TESTING AND RELOCATION

Bikini Atoll is best known as the site of U.S. nuclear testing between 1946 and 1958, during which 23 nuclear devices were detonated on the atoll, including the 15 megaton "Bravo" hydrogen bomb. As such, Bikini Atoll is often remembered as a symbol of U.S. imperialism in the Pacific Region, primarily for the forced relocation of the atoll's inhabitants, the destruction of the atoll and lingering effects of the radiation that prevent the peoples' return.

For its Project Crossroads, the U.S. military needed a large, remote test site that protected the U.S. population from radiation, in order to test the effectiveness of nuclear weapons against naval fleets as well as serve as a demonstration of military and technological prowess. Bikini Atoll was considered an ideal location for these and other reasons, except that it was inhabited.

The U.S. military characterized Bikini Atoll as a marginal environment incapable of providing a healthy standard of living for its inhabitants, and sought to move them to nearby Rongerik Atoll amid considerable fanfare. Although the U.S. military indicated that Rongerik was essentially identical to Bikini, their assessments ran counter to the perceptions of the Bikinians themselves. Contrary to the claims of the military, the people of Bikini atoll had strong cultural ties to the Atoll, having lived there for over 1,000 years. They viewed the area as a rich resource where their ancestors were buried, in contrast to the considerably smaller Rongerik that was viewed as inhabited by a maleficent spirit that had poisoned the food resources and consequently remained uninhabited over the same timespan. Indeed, within two months after relocation to Rongerik in early 1946, the Bikinians complained of inadequate food and water resources and were requesting repatriation to Bikini Atoll. Their plight was ignored by the military until 1948, after an anthropologist revealed that the Bikinians had been suffering from starvation and ciguatera poisoning (resulting from the consumption of fish that have fed upon toxic marine algae). The military relocated the Bikinians first to a camp on Kwajalein, and then to the island of Kili, which was smaller than Rongerik. Today, roughly one-third of the 3,100 Bikinians live on Kili, and the rest are scattered through the Marshall Islands.

The people of Bikini remain expatriated, despite being allowed to return, over lingering fears of radioactive contamination. The 23 nuclear detonations inundated the atoll with radiation, with the Bravo blast being especially destructive in vaporizing two islets, leaving a large crater in the lagoon and causing thyroid disorders from the radiation in nearby Rongelap Atoll to this day. The U.S. government declared Bikini Atoll safe for repatriation after 1960, but the Bikinians themselves opted not to return until they felt more certain of their safety. Some began to return after 1970, but after five years exhibited concentrations of radioactive caesium and strontium in their bodies over ten times the safe levels (from eating contaminated local foods), and were forced to leave again in 1978. Recent assessments suggest that permanent settlement is currently possible, provided certain remediation efforts are undertaken, such as applying potassium fertilizer that the crops will take up more readily than caesium. Bikinians are nevertheless skeptical of the scientific assessments, having been falsely reassured of the atoll's safety before, and have yet to resettle. Bikini Atoll is currently being developed as a tourist destination, with scuba diving among the sunken ships used in the nuclear testing as a primary attraction.

Nuclear testing in the Pacific remains a sore point in geopolitical relations between Pacific Island citizens, and the United States and France in particular. New Zealand emphasizes this fact in its Nuclear Free Pacific policy, which it uses as a diplomatic tool to maintain friendly relations with the various Pacific Island Countries. Most recently, France resumed its nuclear testing at Mururoa Atoll (French Polynesia) in 1995, despite vociferous opposition from the citizenry of French Polynesia; this move sparked regional protests and renewed calls for independence from France from some factions within French Polynesia. Comparisons with Bikini were made during these protests, with the United States and France being vilified for their historical lack of respect for Pacific Island peoples. New Zealand opposed the testing under its Nuclear Free Pacific policy, and strengthened its diplomatic ties with many Pacific Island Countries.

BIBLIOGRAPHY. Jeffrey Sasha Davis, "Representing Place: 'Deserted Isles' and the Reproduction of Bikini Atoll," *Annals of the Association of American Geographers* (v.95, 2005); Kili/Bikini/Ejit Local Government Council, "Bikini Atoll," www.bikiniatoll.com (cited 2006); Max Quanchi and Ron Adams, eds., *Culture Contact in the Pacific* (Cambridge, 1993); Frank R. Thomas, "Historic Preservation in the Marshall Islands: 2003 – 2004 Research," *Micronesian* 3 (2004).

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Biocentrism

DERIVING FROM FAMOUS precursors such as Aristotle and his work, *Virtue Ethics,* which stresses the importance of character traits and the inherent value of all life, *biocentrism* is a whole of life—a centered, environmental ethic that positions the environment and all living things as equal to human beings.

The interconnectedness of humans to nature is emphasized, as is the idea that all living things have an equal right to life, and are each unique in their own right. As a concept, it is best understood in relation to its opposite, *anthropocentrism,* which positions humanity at the center of the world, uniquely different from and superior to all other life forms.

The notion of "biotic justice" underpins biocentrism, which posits that moral values should not only be attributed to humans but a whole range of other entities. P.W. Taylor argues that a biocentric perspective morally obliges humans to consider the impacts of their actions, insofar as they might negatively impact on or harm nature. Taylor further argues that we are obliged to other living things in their own right, a principle based on the notion of "inherent worth," which is a concept he identifies as *species impartiality*. This intrinsic well-being, or good of each species, is identified as a "teleological-center-of-life."

In application to decision-making processes, proponents of the "biocentrist" theory argue that there are limits to what humans can do with the environment; and they emphasize the need for the development of systems and processes that promote stability, conservation and the interdependency and connectedness of all life systems.

Allocation of resources within a biocentric paradigm would be on the basis of a decision-making system that ascribes all organisms—humans included—equal values and rights. As such, biocentrism advocates an approach to environmental decision-making based on the precautionary principle, and the recognition that environmental systems need to be protected in the short and long term.

MORALITY OF BIOCENTRISM

Consequently, the animal rights, Gaia, and deep ecology movements stem from a biocentrist foundation, that human society is but part of a wide number and scope of organisms and systems. For example, key tenets of deep ecological theory reflect biocentric principles, that: 1) all human and non—human life on earth has value in itself and equal rights to flourish and experience quality of life and well—being; 2) the richness and diversity of all life forms contribute to the realization of these values and are also of value in themselves; and 3) that humans have no right to reduce this richness and diversity except to satisfy vital needs.

Peter Singer, an environmental ethicist who focuses on animal rights, takes the view that we share with other species a relationship to earth; that we are but one species amongst others; and that the integrity of the entire biosphere is related to the welfare of both human and nonhuman communities of life. He argues for the adoption of three other principles to guide ethical human action: that animals have the ability to reason; are sentient; and that the capacity to experience pleasure or pain is not limited to humans, nor can it be applied as arbitrary criteria for moral consideration.

Biocentrism has been criticized in that its moral concerns are directed toward the responsibility of the individual, rather than to ecological life forms and systems. While the protection of such collective entities is of major concern, none qualify as being sentient, a "subject-of-a-life," or a "teleological-center-of-life." Advocacy by biocentrists of the notion of well-being and worth has also been critiqued for being descriptive rather than prescriptive and therefore difficult to apply.

Biocentrism offers an alternative way of thinking about the world, and describes an ethical system that prioritizes a moral duty of human beings to place limits on human population, development, technology, and all other negative environmental impacts that diminish the welfare of life systems overall.

BIBLIOGRAPHY. R. Attfield, *Value, Obligation and Meta-Ethics* (Rodopi, 1995); B. Devall and G. Sessions, *Deep Ecology* (Gibbs Smith Publishers, 1985); P. Singer, *Animal Liberation* (Avon, 1990); P. Singer, *Writings on An Ethical Life* (Ecco 1990); P.W. Taylor, R*espect for Nature* (Princeton University Press, 1989).

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Biodiversity

BIODIVERSITY IS GENERALLY used to refer to all aspects of variability evident within the living world, including diversity within and between individuals, populations, species, communities, and ecosystems. Differences in pest resistance among rice varieties, the range of habitats within a forest ecosystem, or the global extinction of species of lake fish all illustrate different aspects of biological diversity. Biodiversity therefore embraces the whole of the incredible variety of life found on earth.

Globally, about 1.75 million species have been described and formally named, and it is believed that millions more species are yet to be discovered and described. In general, biodiversity is highest in and around the equator and continuously decreases toward the poles. The highest terrestrial biodiversity is found in tropical lowland rainforests. They cover only 6–7 percent of the earth's total land area, but contain probably more than 50 percent of all species. Seasonal variation in climate and any environmental extreme are some other important factors causing a decrease in diversity of plants and animals.

DEFINITIONS AND APPROACHES

Biodiversity is often described in hierarchical terms including genetic diversity, species diversity, and ecosystem diversity. Genetic diversity refers to the genetic differences between populations of a single species and between individuals within a single population; species diversity refers to the frequency and variety of species within a geographical area; and ecosystem diversity refers to the variety of habitats, the dynamic complexes of plant, animal, and microorganism communities and their nonliving environment, which interact as a functional unit and their change over time.

Varieties of rice, number of plants and animal species coexisting in a geographical area, and number of ecosystems in a forest area exemplify genetic, species, and ecosystem diversity, respectively.

Species diversity can be further distinguished into three types: *alpha*, *beta*, and *gamma* diversities. Alpha diversity refers the diversity at one site, i.e., the number of species coexisting within a single biological community. Beta diversity is species turnover across an environmental or geographical gradient, and gamma diversity refers to the total number of species in all habitats within a region. The "region" means a geographical area that includes no significant barriers to dispersal of organisms.

Some scientists have argued for the necessity of making distinctions between "functional" and "compositional" perspectives in approaching biodiversity, rather than using hierarchical terms. The functional approach is primarily concerned with ecosystem and evolutionary processes, while the compositional approach sees organisms as aggregated into populations, species, higher taxa, communities, and other categories.

Despite a wide range of definitions, biodiversity emerges as a concept linked primarily to the idea of biological variation that is largely unknown in its extent, and its future values.

WHY DOES BIODIVERSITY MATTER?

Biodiversity is important for human beings in a number of ways. First, species have utilitarian (subsistence and commercial) value to humans. Diversity of biological organisms is a crucial component in the livelihood of many poor people, as they often depend on the diversified plants and animals to meet their nutritional, medicinal, and energy needs. Different cultures and societies use, value, and protect these resources and services in a variety of ways. Moreover, there are huge prospects of benefiting from unknown genetic and species diversity. Second, biodiversity represents the natural balance within an ecosystem. Detoxification and decomposition of wastes by biological communities (particularly bacteria and fungi); generation and renewal of soil fertility, including nutrient cycling; and pollination of plants are just a few examples of ecological services associated with biological diversity. As biodiversity is reduced, internal and natural controls must be replaced by more artificial controls (in the form of management and resources), which may not be successful to the same extent. Third, species have intrinsic value. Many argue that protecting them from the terrible finality of extinction by saving their habitats is an ethical responsibility.

THE RAPID LOSS OF BIODIVERSITY

Highly valuable biodiversity is being lost at a great rate, and extinction of species is the most serious aspect of this loss. It is estimated that every hour we are losing one species forever; this rate is about 10,000 times higher than the natural rate of extinction. One million species have been estimated to

Tropical lowland rainforests contain the highest terrestrial biodiversity, with more than 50 percent of all species.

have been lost, and scientists working in this field generally agree that several more million will be lost in the first few decades of the 21st century, unless we have effective measures to control the current rate of species extinction.

The causes of species extinction can be natural as well as human activities. The causes in prehistoric times were mainly natural, whereas the extinctions in historic and present times are mainly human-caused. Our concern today is related to human-caused extinctions that result from human activities such as destruction, degradation, and fragmentation of natural habitats (e.g., agricultural clearance of forest land); exploitation of species for human use (such as commercial logging); introduction of invasive exotic species, such as certain species of fish; pollution (e.g., pesticides and industrial wastes, particularly sulfur and nitrogen oxides); international trade of wild animals and animal body parts; and increased spread of diseases. Climate change could become the main threat in the future.

These direct or proximate causes of biodiversity loss are considered to be the results of underlying causes, including rapid growth of human population, drive to globalization, and inequality of ownership and property rights. Globalization, for example, has increased reliance on a small number of crop species that can be traded in the global market; for example, demands in industrialized countries encouraged conversion of tropical rainforests into rubber or cocoa plantations, and mangroves into shrimp farms. Overconsumption by developed countries, which acts as a driving force to exploit resources from developing countries for a short-term gain, exemplifies the inequality of ownership and property rights. Governmental and international support for industrial forestry, agriculture, and energy programs over and above traditional usage patterns, and state subsidies for the cattle industry (e.g., in the Amazon region) and agribusiness (e.g., to grow export crops in Brazil) are some other examples of underlying economic and political causes of the loss of biodiversity.

Concerns are also being expressed in some quarters that the introduction of intellectual property rights, under the aegis of World Trade Organization (WTO) in the biological resources—including agriculture—may lead to erosion of biological diversity in many bioresource zones. The underlying disparity between the private and social costs and benefits of biodiversity use and conservation can be considered as another main reason for the decline of biodiversity. Private costs and benefits refer to losses and gains as perceived by the immediate user, such as the farmer or the industrialist, while social costs and benefits refer to losses and gains that accrue to society (the local area, country, or world). These two interests often do not coincide.

The high rate of biodiversity loss has been a matter of great concern among conservation scientists, especially since the late 1980s. The concern has been increased by our incomplete knowledge of biodiversity: We don't know the exact number of species on earth, nor do we fully understand the relationships that bind them. The loss of even one species can ruin an entire forest ecosystem of plants and animals because the animals that depended on this vanished species as prey have now lost their food source. In turn, the animals that it fed on have lost a predator, and these species often undergo population explosions that are devastating for the plants or animals that they feed on. The entire ecosystem can collapse in this manner, and will therefore be prevented from performing its usual "ecosystem services" (a utilitarian term for the natural processes that provide rich soil, clean water, and the air we breathe). The seriousness of the problem also lies in the fact that it takes millions of years for new species to evolve in the place of the species that have gone extinct.

ADDRESSING LOSS OF BIODIVERSITY

The major issue for biodiversity is how its conservation may be integrated with other needs of society. This has become an important issue in the world especially after the Earth Summit held in Rio de Janeiro in 1992. In that summit, more than 150 states signed the Convention on Biological Diversity, acknowledging the sustainable management of the world's biological resources to be one of the most urgent issues of the modern era, and expressed their commitment to address this collectively. Since then, around 180 countries have ratified the convention. The convention recognizes the need for a multisectoral approach to ensure that biological diversity is conserved and used sustainably, the importance of sharing information and critical technologies, and the benefits that can accrue from use of biological resources. The treaty is considered a landmark in the international community's approach to environment and development. It has increased the coordination of cross-sectoral action within and between countries for biodiversity conservation, and has also led to the release of substantial international funds to support developing countries. Some international nongovernmental organizations, such as the World Conservation Union (IUCN) and World Wildlife Fund (WWF), are also actively involved in conservation of biodiversity on a global scale.

Investments in public education and awareness, increased stakeholder involvement in decision making, effective implementation of the national biodiversity strategies and action plans, improvement in sectoral and cross-sectoral integration, and strengthening protected area networks are some of the most important priority areas for further action by countries as identified by the *Global Biodiversity Outlook 2002*. Moreover, it is essential to take a holistic view of biodiversity and address the interactions that species have with each other and their nonliving environment to increase the efficiency of management interventions.

SEE ALSO: Biopiracy; Bioprospecting; Convention on Biodiversity; Cost-Benefit Analysis; Ecosystem; Endangered Species; Extinction of Species; Food Webs (or Food Chains); Genetic Diversity; Invasive Species; Property Rights; World Wildlife Fund.

BIBLIOGRAPHY. P.L. Angermeier and J.R. Karr, "Biological Integrity vs. Biological Diversity as Policy Directives: Protecting Biotic Resources," *Bioscience* (v.44, 1994); James R. Miller, "Biodiversity Conservation and the Extinction of Experience," *TRENDS in Ecology and Evolution* (v.20/8, 2005); D. Pearce and Dominic Moran, *The Economic Value of Biodiversity* (Earthscan, 1995); C. Perrings and D.W. Pearce, "Threshold Effects and Incentives for the Conservation of Biodiversity," *Environmental and Resources Economics* (v.4, 1994); Robert E. Ricklefs and Gary L. Miller, *Ecology,* 4th ed. (W.H. Freeman and Company, 1999); Secretariat of the Convention on Biological Diversity, *Global Biodiversity Outlook 2002*.

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Bioenergy

USING WOOD BIOMASS for energy started since creation to provide heating under harsh winter conditions. Biomass energy is still used to provide cooking fuel, heat, and electricity to many communities, homes, and industries globally. Using wood biomass for energy can help mitigate global warming effects and improve water and air quality.

Using forest-related biomass for energy has become the subject of many international mandates, such as the International protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Also, the International Energy Agency has dedicated offices that research biomass energy potentials. Many international, governmental, academic and private institutions are developing fast-growing woody crop species for a higher yield of biomass per unit acre. Efforts are also directed toward improving machinery that can handle dispersed wood biomass in an efficient manner.

Many scientists believe that trees sequester carbon, and therefore reduce Greenhouse Gas Emissions. However, when biomass is burned, this carbon is released again into the atmosphere. Therefore, by growing more trees, this emitted carbon is sequestered again. Growing trees for energy makes this source a renewable one.

The term *biomass* in forestry is used in conjunction with the production of energy from trees. Biomass is derived from plant photosynthesis, and is formed from the storage of solar energy in the form of carbon, hydrogen, and oxygen. Biomass can be obtained as a direct outcome or as a joint production from forest operations. Usually, forest biomass energy is derived as a joint product from timber harvesting and management operations. In this case, the term normally refers to forest residue, such as treetops and branches. Nonmerchantable stems and dead, diseased, and downed trees are a source for forest biomass energy. Wood biomass also includes short-rotation woody crops, such as fast-growing hybrid poplars, willows, and eucalyptus plantations.

The world's largest biomass power generation facility is the Alholmens plant in Pietarsaari, Finland. Finland has invested in improving biomass-handling technology, with the aim of having biomass energy, which is more cost and energy efficient. Countries such as Sweden and Brazil grow short-rotation, intensive cultures from willows and eucalyptus for energy.

One way to make forest biomass less expensive is to cofire it with other nonrenewable sources, such as coal. However, if wood biomass is burned alone, wood ash can return to soils as a nutrient that replaces the wood removed for energy. However, if wood is cofired with coal biomass, then it cannot be used as a soils nutrient. Other soil-fertilization options need to be considered to avoid soil nutrient depletion.

The ability to have a sustainable supply of biomass to generate heat and electricity is another concern attached to biomass harvesting. Unlike many other industries, the more biomass that is required for energy, the more expensive it becomes. This is because biomass procurers need to collect biomass material from longer distances. Therefore, more road construction, energy, and costs are involved. Growing dedicated plantations for energy can reduce these factors, since only one site is accessed for a significant number of years, with already-prepared roads for harvesting.

In addition, biomass energy industries offer job opportunities to local communities. Many research and development projects are underway to offer a cheaper, more energy- and cost-efficient methods for biomass utilization and collection from forests.

SEE ALSO: Forests; Reforestation; Renewable Energy.

BIBLIOGRAPHY. Semida Silveira and Dr. Semida Silveira, eds., *Bioenergy: Realizing the Potential* (Elsevier Science & Technology Books, 2005); Taishichiro Sato and H. I. Madgwick, *Forest Biomass* (Springer-Verlag, 2002); OCED, *Biomass and Agriculture: Sustainability, Markets and Policies* (Organization for Economic Cooperation and Development, 2004).

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Biogeochemical Cycle

A BIOGEOCHEMICAL CYCLE refers to the cycling and transport of a chemical element or compound, usually in multiple forms and physical states, through the biotic (living) and abiotic (nonliving) components of the earth system. Some of the most commonly examined biogeochemical cycles include carbon, nitrogen, oxygen, water, and phosphorous, which are highly interdependent and connected to both the physical environment and human activity. Biogeochemical processes include cycling to and from living organisms in the biosphere, rock minerals in the lithosphere, hydrological processes in the hydrosphere, and air circulation in the atmosphere, making the spatial and temporal variability of biogeochemical cycles quite complex. Biogeochemistry attempts to understand the physical processes that control and make up these cycles, as well as the natural and anthropogenically-induced variation in these cycles, including potentially harmful alterations. Humans depend upon biogeochemical cycles for, among other things, food production, water supplies, and oxygen, so the dynamics and disturbances of these processes are a major concern for environmental scientists and policymakers. Similarly, concerns related to global warming, air pollution, and biodiversity also require an understanding of biogeochemical cycles, as well as their interaction with humans and human activity across the world.

Biogeochemistry is an interdisciplinary science because it requires knowledge of living and nonliving processes that occur at various temporal and spatial scales in all components of the earth system, including the world's oceans, forests, and urban areas. A biogeochemical cycle may include the occurrence of pools or sinks (where an element or compound is stored for longer periods) and sources (where an element or compound is freed from a sink, often in a short time and in relatively large quantities). Both human and nonhuman processes and activities (such as fire) may alter the spatial and temporal cycling of elements such as carbon and oxygen from sources and sinks, which can make it difficult to clearly distinguish "natural" and "human" perturbations of biogeochemical cycles. Furthermore, biogeochemical cycles occur and can be altered at a range scale from molecular to global, making it challenging to study entire biogeochemical cycles at one time. As a result, biogeochemistry examines past, current, and future time scales though the use of paleo-ecology, physical science, and statistical modeling.

CARBON AND NITROGEN

Biogeochemistry attempts to determine the interrelated and multidirectional connections and feedback loops that make up the physical environment. Biogeochemical cycles interact with other chemicals and compounds, human and nonhuman processes, and various components of the earth's spheres. The carbon and nitrogen cycles are provided as examples of the complex interactions that constitute biogeochemistry.

Carbon is one of the most studied elements in biogeochemistry because it is the primary element of living tissue, is essential for plant photosynthesis, and is an important greenhouse gas (as carbon dioxide and methane) in the earth's atmosphere. Carbon cycles through plants, animals, oceans, vegetation, the atmosphere, and lithosphere, and is driven largely by photosynthesis and respiration in plants, animals, and other living organisms. This cycle has been dramatically altered through human activity, such as the burning of fossil fuels, cement production, urban development, and grazing, all of which can release carbon dioxide into the atmosphere. Higher concentrations of carbon dioxide since the industrial revolution have been shown to contribute to global warming by increasing the atmosphere's greenhouse effect, which may raise global temperatures, cause a rise in sea level due to the melting of sea ice, alter precipitation patterns around the world, and change storm frequency and intensity.

HUMAN ACTIVITY

At the same time, however, human activities that increase atmospheric CO_2 have also been shown to alter the rate at which plants take up carbon through photosynthesis. Specifically, some studies have shown that higher carbon dioxide levels in the atmosphere may increase the rate at which some plants photosynthesize, offsetting some carbon dioxide emissions (in what has been called CO_2 fertilization). These spatial and temporal changes, however, must be understood within the complete biogeochemical cycling of carbon, because the potential for short-lived increases in CO_2 uptake during increased photosynthesis is unlikely to offset decades of human increases of atmospheric CO_2.

Similarly, human activity has been shown to alter the nitrogen cycle through the application of fertilizers, production of power, combustion engines, and increases in human and animal waste. In an attempt to increase plant growth and photosynthesis, humans have applied fertilizers containing nitrogen and phosphorous to agricultural lands worldwide. Though productivity rates may be temporarily improved, the excess nitrogen released into the biosphere has damaged certain aquatic habitats through eutrophication, where the excessive growth of particular organisms can deplete the water of oxygen. Acid rain has also been attributed to increases in certain forms of nitrogen, which can disturb water systems and aquatic life, leach important nutrients from soils, and damage plants and buildings. The biogeochemistry of both carbon and nitrogen reveal the connections between various processes and components of the earth system, both human and nonhuman.

Biogeochemical cycles are of incredible significance to society because the science related to the biogeochemical cycling of chemicals becomes the basis for various policies, programs, and actions by individuals, states, and corporations. For example, climate policy is based upon the understanding of changes in carbon sources and sequestration, while interactions of the land and atmosphere with hydrological systems become the basis for water quality measures. Because biogeochemistry examines multiple elements and systems, it is essential to understand the spatial and temporal variability of biogeochemical cycles and the complex connections between human activity and physical responses. Isolating any one particular part of a biogeochemical cycle may not accurately characterize the complete interaction between the physical environment and human activity. Biogeochemistry works to uncover and more fully understand the connections between various elements, parts of the earth system, and biotic and abiotic processes.

BIBLIOGRAPHY. Todd S. Glickman, ed., *Glossary of Meteorology*, 2nd ed. (The American Meteorological Society, 1999); L.R. Kump, J.F. Kasting, and R.G. Crane, *The Earth System,* 2nd ed. (Pearson, 2004); Stephen P. Long, Elizabeth A. Ainsworth, Andrew D. B. Leakey, Josef Nösberger, Donald R. Ort, "Food for Thought: Lower-Than-Expected Crop Yield Stimulation with Rising CO_2 Concentrations," *Science* (312: 5782, 2006); William H. Schlesinger, *Biogeochemistry: An Analysis of Global Change* (Academic Press, 1997).

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Biological Oxygen Demand

BIOLOGICAL OXYGEN DEMAND (BOD), or biochemical oxygen demand, is an index or measure of the concentration of biodegradable organic matter in a body or quantity of water. BOD is a natural phenomenon, but is also a test used to determine the condition of water for maintaining natural ecological processes of human use. Oxygen dissolved in water is a naturally occurring resource, provided by waterfalls, rapids, winds, and waves, without which organic materials would build up beyond the capacity of water bodies to sustain life. BOD occurs naturally as organic debris wash into streams, rivers, and lakes. These organic materials are oxidized by bacteria and other microorganisms, which decompose organic wastes (e.g., dead leaves, fish, plants, manure, sewage), consuming oxygen in the process. Should oxidation outpace the availability of oxygen, the water can become anoxic (depleted of oxygen). The lack of oxygen in water will render a lake or a sea dead. For example, most of the water of the Black Sea is anoxic water.

Pollutants in water in high levels—nitrates, phosphates, or manure—cause the rate of oxygen consumption to increase as the available bacteria consumes the waste and grows in number. Rises in water temperature can also contribute to a reduction in the oxygenation of water, which promotes the growth of algae and other plants. They also die more rapidly, which increases the amount of organic material in the water, and thus, the food supply for bacteria. If the BOD is high, the levels of dissolved oxygen will decrease, threatening the water quality. Human pollution deprives water of oxygen, and is a threat to both natural and human life.

The greater the organic matter in the water, the greater will be the oxygen consumption by the microorganisms laboring to dispose of the waste. The Royal Commission on River Pollution first used BOD as a way of measuring water pollution in England in 1865. After the work of the Royal Commission on Sewage Disposal in 1898, BOD tests were developed to define the amount of pollution in rivers. The test took five days, the length of time for water in English rivers to travel from the source to an estuary. An additional element of 30 ppm (parts per million) was added in 1912 as the maximum concentration of organic material that a sewage system could discharge into a river. The test was later refined.

Direct measurement of BOD is used to report the amount of oxygen that a biological process is consuming as it reduces organic material in water. BOD can also be used to describe an indirect measurement of the amount of waste in a solution by measuring the concentration of the biologically degradable organic material in a given unit of water. The term then applies to the amount of oxygen needed in five days if a biological process is to break down a quantity of organic waste. From the results, the quality of the water may be inferred. If the water quality is rated as poor because the level of organic material in the water is high, then the water may be considered polluted, and unsafe for humans to drink or swim in.

SEE ALSO: Biogeochemical Cycle; Oxygen; Sewage and Sewer Systems; Water Quality.

BIBLIOGRAPHY. Wesley Eckenfelder, *Developing Industrial Water Pollution Control Programs: A Primer* (CRC Press, 1997); Gail R. Smith, ed., *Oxygen Dynamics in Chesapeake Bay: A Synthesis of Recent Research* (University of Maryland, 1992); Roy Keith Smith, *Third Century of Biochemical Oxygen Demand* (Water Environment Federation, 2002).

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Biomagnification

BIOMAGNIFICATION REFERS TO the tendency of some chemicals to concentrate in living organisms and to pass up the food chain as they are consumed. Especially pernicious are those chemicals that are easily absorbed, not easily metabolized or excreted, have long half-lives, and an affinity for fat. These include methyl mercury; polychlorinated biphenyls (PCBs); and the chlorinated hydrocarbon pesticides such as DDT, aldrin, dieldrin, lindane, and heptachlor. Substances that are water-soluble and biodegradable are not generally subject to biomagnification.

The loads of these chemicals increase in small, ostensibly harmless increments, but are concentrated in higher trophic levels, as organisms eat and in turn are eaten. Over time, the repeated consumption of contaminated prey ultimately results in the accumulation of high and possibly toxic levels within the consumer, compared with ambient levels of the contaminant in air, soil, and water that may be quite low. Additionally, since predators may preferentially select prey with the highest levels of contaminants (that is, those experiencing sublethal symptoms of chemical poisoning), predators may be exposed—not to average pollutant concentrations—but to maximum levels.

Because of the slow and incremental nature of biomagnification, there is often no indication that poisoning has occurred until toxic levels are reached. Poisoning at high levels can be lethal; while at lower doses, neurological, developmental, reproductive, and behavioral disorders—among other problems—may arise.

SPECIES AT RISK

Biomagnification is a special concern for species that occupy the higher trophic levels and those that have long average life spans. Particularly at risk are terrestrial mammalian carnivores, marine mammals, birds of prey, and predator fish species. Studies have demonstrated that the degree of biomagnification, however, is not merely related to the trophic levels of the consumer, but also to the species' bioenergetic conversion efficiency, which relates activity and energy expenditures to growth and bioaccumulation rates. It is also associated with the species' physiological ability to detoxify the chemical.

Predatory birds are especially vulnerable to biomagnification because their detoxification capability is poor. In fish-eating birds—such as the bald eagle and osprey—the biomagnification of DDT created toxic levels of DDE, a metabolic product of DDT that interferes with calcium absorption. This led to the thinning of eggshells and caused eggs to crack under the weight of the roosting parent, leading to plummeting numbers of these species. In the decades following the prohibition of DDT use in the United States in the 1970s, some of these populations have recovered.

As a high trophic level feeder, humans are not excluded from the process of biomagnification. A tragic example of this occurred in Minamata, Japan, in the 1950s. Mercury was released into a nearby river by a factory and then methylated by bacteria. The methyl mercury was bioconcentrated by organisms and subject to biomagnification, eventually poisoning the humans who consumed contaminated fish. This resulted in a host of health disorders and deaths, creating health problems even for successive human generations.

Mobile and migratory organisms have the capacity to move chemical contaminants in their bodies from one ecosystem to another. Global air and ocean circulatory patterns, in addition to transport by rivers, can move contaminants long distances. Thus, biomagnification of toxins occurs in organisms living in ecosystems far removed from the original sources of contamination.

Salmon are high trophic level feeders, relatively large, and have high lipid content. As such, they may accumulate a high concentration of toxins over their life span. Because of their anadromous life history, they can transport toxins from marine to freshwater systems. In the Great Lakes, salmon transport contaminants from the lakes to small tributaries. After spawning in freshwater tributaries, salmon die. Many species, both aquatic and terrestrial, consume their carcasses and take on their burden of toxins, thereby passing them to terrestrial food webs.

In aquatic environments, biomagnification occurs at every trophic level and toxins are ingested not only through the consumption of food, but also through the intake of water and sediments containing contaminants. As a result of the global transport of pollutants, the amplified process of biomagnification in aquatic systems, and the impact of cold climates on processes of chemical transformation, elevated levels of persistent organic pollutants (POPs) have been found in the arctic—far from their place of origin—in arctic-dwelling species of fish, birds, and mammals, including polar bears and marine mammals. With diets high in these species, humans living in arctic communities, such as the Inuit, have been found to have high levels of POPs in their bodies. The breast milk of Inuit women has been found to have DDT and PCB concentrations many times higher than that of women in more temperate latitudes. In a final step of biomagnification, these toxins are passed via breast milk to infants. The implications of this on the health and development of these infants is not yet completely understood.

BIBLIOGRAPHY. Rachel Carson, *Silent Spring* (Houghton Mifflin Company, 1962); Gary A. Polis, Mary E. Power, Gary R. Huxel, eds., *Food Webs at the Landscape Level* (University of Chicago Press, 2004); Carl Sindermann, *Coastal Pollution: Effects on Living Resources and Humans* (Taylor and Francis, 2006); C.H. Walker, S.P. Hopkin, R.M. Sibley, D.P. Peakall, *Principles of Ecotoxicology,* 3rd ed. (Taylor and Francis 2006).

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Biomes

BIOMES ARE COMPRISED of the major, regionally distinct biotic communities. They are the largest ecosystem units, delineated at a global scale. Biomes are not distinguished by the taxonomic identities of the organisms they contain, but rather on the basis of the life forms of these organisms, their structure, life history, and responses to environmental change. Although specific plant and animal species differ among continents, the same biomes with similar structure, seasonality, productivity, niches and uses by humans exist in different regions. For example, northern conifer forests exist in North America and Asia, and tropical rain forests are found in Africa, Central and South America, and south and southeast Asia. Biomes are usually associated with their climax community vegetation; however, they encompass successional and subclimax community species and animal species, as well as soils. Generally, they are not divided by sharp boundaries; rather, adjacent biomes grade into each other, interact, and function as interdependent parts of the biosphere as a whole.

Classifying the earth into major biome types is a useful approach that allows the development of a common framework and mapping system for these large-scale systems. This facilitates communication among scientists, comparative analyses, and the development of resource and environmental management strategies. However, it is important to note that maps of biomes are human constructions and not usually drawn to reflect a current reality. Rather, they tend to depict an imagined world devoid of human impacts and influence, and one in which processes of succession have reached a climax end-state.

Biomes are delineated by a combination of ecological gradients, including temperature, precipitation, altitude/depth, latitude, longitude, proximity to various features such as oceans and mountains, soil type, salinity, and range of tidal activity. These factors determine the assemblage of animals and plants that live in the biome, and their biological productivity.

HUMAN IMPACT ON BIOME CLASSES

Various classification systems have been developed to organize biomes. Some scientists apply the biome concept exclusively to terrestrial systems because their structure and connections to other aquatic environments differ from terrestrial systems, and they are perceived to be less responsive to climatic cues. Other scientists, however, include freshwater and marine systems in their biome classifications. Whittaker provides a classification system that is more detailed than some, with 36 discrete biome types. Cox and Moore identify ten terrestrial and four aquatic biomes. These encompass the arctic tundra, northern coniferous forest, temperate forest, tropical rain forest, tropical seasonal forest, temperate grassland, tropical savanna grassland and scrub, desert, chaparral, mountains, freshwater, oceans, rocky shores, and muddy or sandy shores.

Desert biomes are arid, with low and often irregular precipitation coupled with high evaporation. They have relatively low productivity and are one of the harshest environments on earth. Human activities, such as animal grazing, have actually extended the range of deserts in the world through the process of desertification. Tundra is identified with low temperatures and permafrost, and is predominantly found in northern polar regions with less occurring in the southern hemisphere. Many animal populations in the tundra are migratory and/or have large cyclic changes in abundance. Significant human impacts on the tundra include those associated with fossil fuel and mineral extraction, military operations, and the exploitation of both marine and terrestrial animal resources.

The northern coniferous forest (or taiga) occurs adjacent to the tundra region, encircling the northern latitudes of continents, and is also found in high-altitude regions in lower latitudes. It is comprised primarily of evergreen conifers and represents one of the world's largest, most intact biomes. Logging coupled with large-scale mining, however, are degrading this biome. This degradation is exacerbated by the impacts of acid rain (caused by emissions of air pollutants primarily from mid-latitudes) on terrestrial and freshwater aquatic systems. In the mid-latitudes, temperate forests have a seasonal climate distinguished by warm summers, cold winters, and deciduous treed land cover. A large extent of these biomes has been converted to human settlements and boasts large agricultural, urban, and industrial areas with concomitant deforestation, habitat fragmentation, and production of waste and air pollution.

Tropical rainforests occupy the equatorial region between the Tropics of Cancer and Capricorn, and are characterized by high solar radiation, temperature precipitation, species diversity, and nutrient-poor soils. Intense logging, especially in the Amazon region of South America, coupled with land conversion for agricultural operations—particularly animal grazing—are of special concern. Cox and Moore estimate that at the current projected rates of destruction, the tropical rainforest biome could be eradicated completely within this century.

Temperate grasslands have precipitation levels greater than those found in deserts, but too low to support forest vegetation. They are characterized by grasses, large herds of grazing mammals, and soil rich in organic matter. These biomes have been altered by development of animal and plant agricultural operations and by the introduction, both purposeful and accidental, of new plant species. This has changed the ecological balance and made soils vulnerable to moisture loss and erosion, and as a result, intact examples of this biome are quite rare. Tropical savannas have warm climates with significant dry seasons and generally poor soils. They are comprised of grasslands, shrubs, and woodlands with significant grasses as well as a diverse fauna, including large herds of grazing mammals. Fire is an important abiotic aspect of this biome. Chaparral or sclerophyll ecosystems are characterized by a Mediterranean climate of wet, mild winters and dry, hot summers. The short trees and shrubs found in these areas are adapted to withstand summer droughts. These areas support large human settlements and, as a result, have been degraded by urbanization, pollution, and introduced species.

Overarching all of these human impacts is the impact of greenhouse gas pollution on the earth's atmosphere and its climate system. All of the world's biomes are affected by climate change, with the arctic tundra and ice-covered regions experiencing the

The arctic tundra and ice-covered regions experience the most serious impacts of climate change.

most serious and visible impacts. Future impacts of climate change pose arguably the greatest threat to the stability of the world's biomes.

SEE ALSO: Bioregionalism; Desert; Rainforest; Grasslands.

BIBLIOGRAPHY. C. Barry Cox and Peter D. Moore, *Biogeography: An Ecological and Evolutionary Approach,* 5th ed. (Blackwell Scientific Publications, 1993); Mitchell B. Rambler, Lynn Margulis, René Fester, eds., *Global Ecology: Towards a Science of the Biosphere* (Academic Press, 1989); Ian Simmons, *Biogeographical Processes* (George Allen & Unwin, 1982); Robert H. Whittaker, *Communities and Ecosystems,* 2nd ed. (Macmillan, 1975).

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Biophilia

COINED BY EDWARD O. Wilson, the *biophilia* hypothesis suggests that humans have an "innate tendency to focus on life and life-like processes." With "innate" meaning "hereditary and hence part of ultimate human nature," Wilson claims a biological basis for humans' attraction to living things and to nature at large, and argues that such an affinity was selected evolutionarily; not only does being "biophilic" confer a competitive advantage, it also provides the key to our achieving meaningful and fulfilling existences. The biophilia hypothesis is rooted in sociobiology, a discipline popularized by Wilson and Richard Dawkins in the 1970s to examine the genetic bases of social behavior within different species. Sociobiology has been critiqued, perhaps most notably by Richard Lewontin and Stephen Jay Gould, for being biologically deterministic, undervaluing the effects of culture and learning and, significantly, drawing the majority of its claims from research conducted on insects and other nonhuman animals. Sociobiology has been somewhat reworked through evolutionary psychology and human behavioral ecology, and it has enjoyed resurgence in light of the Human Genome Project.

Wilson and other proponents describe biophilia not as a single instinct, but rather as a "complex of learning rules that can be teased apart and analyzed individually." The learning rules mold feelings, or types of emotional response, that can range from attraction to aversion and from serenity to fear. These "multiple strands of emotional response" together form symbols that constitute a large part of culture. Spread by natural selection within a cultural context, genes prescribe the learning propensities that influenced cultural elaborations. This process is called biocultural evolution: According to Wilson, "a certain genotype makes a behavioral response more likely, the response enhances survival and reproductive fitness, the genotype consequently spreads through the population, and the behavioral response grows more frequent." Human tendencies to make meaning from these feelings—to explain, depict, and dream—have led to our cultural elaborations of art, worldview, and more.

A classic example would be what has been called the "maternal instinct," but should accordingly be described as a complexity of behaviors within many species that arguably confers advantages to the protected offspring, who would then survive to reproduce additional individuals as well as protective behaviors. Another example would be the readily observed behaviors supporting the claim that many species have evolved to be genetically averse to snakes. Such a tendency to aversion, called biophobia, fulfills the premises of the biophilia hypothesis.

Proponents of the biophilia hypothesis argue that the natural environment—that which defined much of our evolutionary experience—has been increasingly degraded. What happens to the human psyche as we become further separated from nature? In his book *Last Child in the Woods*, Richard Louv tracks what he calls "nature deficit disorder" among American children. Louv defines nature deficit disorder as the cumulative effect of withdrawing nature from people's experiences, which leads to increased stress, decreased attentiveness, and feelings of "not being rooted in the world." Nature deficit disorder is not biophobia; rather, it is the kind of disengagement from the natural environment that alarms supporters of the biophilia hypothesis and its attendant biophobic manifestations. Nature deficit disorder has become a societal disorder, Louv suggests. Children are victimized by it through the mutually reinforcing patterns of being increasingly confined to rigid, artificial environments; labeled ADHD; and not encouraged to exercise via unstructured play, such as the emphasis on team sports and fixed schedules.

The biophilia hypothesis suggests that humans benefit from exploring and trying to understand other life forms and processes. Wilson, a self-identifying conservationist, actively promotes the protection of biodiversity for its vast material wealth, ecosystem services, information value (including ecological and evolutionary processes), and spiritual value. He argues that our emotional bonds with the natural world can lead to a meaningful environmental ethic that overcomes the constraints of resource economics (where plants, animals, and other so-called natural resources are assigned prices and thus exchange values), as well as the aprioristic species-rights approach. Wilson argues it is best to state that we need biodiversity in order to remain human—an anthropocentric agenda that, by extension, protects other species and accords them value without necessarily being reductionist.

SEE ALSO: Biodiversity; Human Genome Project; Human Nature; Sociobiology.

BIBLIOGRAPHY. Lee Cronk, "Human Behavioral Ecology," *Annual Review of Anthropology* (v.20, 2005); Richard Dawkins, *The Selfish Gene* (Oxford University Press, 1976); Stephen R. Kellert and Edward O. Wilson, eds., *The Biophilia Hypothesis* (Island Press, 1993); Richard Louv, *Last Child in the Woods: Saving Our Children From Nature Deficit Disorder (*Algonquin Books, 2005); Edward O. Wilson, *Biophilia: The Human Bond with Other Species* (Harvard University Press, 1984).

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Biopiracy

BIOPIRACY IS THE practice whereby pharmaceutical companies or research scientists collect and remove biological specimens and related indigenous knowledge, without authorization, acknowledgment, and/or due compensation, in order to develop commercial products, such as modern medicines, for profit. The term *biopiracy* is highly controversial and has emerged as a critique of bioprospecting. In this highly polarized debate, cases regarding the research and development of biological resources are generally characterized in one of two ways: as bioprospecting, which is the acceptable practice of research and development of medicinal plants and believed to result in win-win scenarios for local communities and international actors; or as biopiracy, in which villains and victims are seen as perpetuating the sustained history of colonial exploitation of developing nations. One of history's most notorious biopirates was Henry Wickham, an Englishman who smuggled 70,000 rubber tree (*Hevea brasiliensis*) seeds from the Manuas region of Brazil in 1876. With Wickham's seeds, British-owned rubber plantations in Asia quickly outproduced those in Brazil, resulting in the collapse of the Amazon rubber boom.

CRITICS OF BIOPIRACY

The biopiracy narrative, critiquing the win-win scenarios championed by supporters of bioprospecting, draws on the solidarity of farmers, rural poor, and indigenous people, and suggests that the activities of scientists and pharmaceutical companies result in the plunder of the poor and the exploitation of their resources for economic gain.

Vandana Shiva, a vocal author and antibiopiracy activist, argues that biological resources should not be removed from the realm of public good to private property rights. In this view, all external attempts to patent biological resources are acts of piracy. For Shiva, the ability to patent life forms is seen as a classic case of bio-colonialism, in which the Western system of intellectual property rights and neoliberal economics jeopardizes the cultural rights and natural resource practices of local peoples.

A recent victory for opponents of biopiracy was won in 2005, when the European Patent Office revoked a patent based on the fungicidal properties of the neem tree (Azadirachta *indica*). Opponents to the patent argued that the neem tree's fungicidal properties have been known about and used in

India for centuries. This case signals to researchers that they can not equate indigenous knowledge with free and public information. For those questioning the patenting of life forms based on traditional knowledge, this case presents a clear victory in the struggle of indigenous rights against global commercial interests.

SEE ALSO: Bioprospecting; Indigenous Peoples; Property Rights; Shiva; Vandana.

BIBLIOGRAPHY. Alan Hamilton, "Medicinal Plants, Conservation and Livelihoods," *Biodiversity and Conservation* (v.13, 2003); Martin Khor, "Why We Must Fight Biopiracy," Science and Development Network website, www.scidev.net (cited August 2002); Cormac Sheridan, "EPO Neem Patent Revocation Revives Biopiracy Debate," *Nature Biotechnology* (v.23/5, 2005); Vandana Shiva, *Biopiracy: The Plunder of Nature and Knowledge* (South End, 1997); Hanne Svarstad, "A Global Political Ecology of Bioprospecting," *Political Ecology across Spaces, Scales and Social Groups* (Rutgers University Press, 2005).

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Bioprospecting

WHEN PRIVATE COMPANIES that produce pharmaceuticals, agrochemicals, cosmetics, flavoring, fragrances, and industrial enzymes seek plant material to integrate into their commercial products, their undertaking is often termed *bioprospecting*. Bioprospecting is usually conducted by private companies that search in a variety of ecosystems for certain parts of plants, ranging from barks to genetic material. Although the task of bioprospecting seems to be beneficial in terms of producing important products such as medicines, it is an activity engulfed in politics between the global north (the "developed" world) and the south (or "underdeveloped" world).

There have been several cases in which northern-based private companies have bioprospected in southern ecosystems for particular plants. However, such companies have neglected to share profits with those in the south who are the custodians of the plant, such as indigenous peoples. Additionally, claims have been made in which bioprospectors have patented indigenous knowledge regarding a particular plant, while failing to protect or compensate intellectual property rights of traditional knowledge of those in the south. These claims are known as biopiracy, which is a result of unfair or inequitable bioprospecting.

Bioprospecting, as an acceptable practice of research and development of medicinal plants, is legally supported by two international treaties. The 2002 Convention on Biodiversity (CBD), which many countries have ratified, provides those nations that recognize CBD with the legal and regulatory means to protect citizens who own plant material that is in demand through the Access and Benefit Sharing (ABS) mechanism. The ABS creates economic incentives to conserve biodiversity and traditional knowledge while building equitable commercial partnerships between private companies and citizens who claim their rights over natural resources. The CBD's actions were further strengthened by the Trade Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPs), which institutionalized a modern intellectual property rights system that allows for the patenting of life forms.

SHARING ACCESS AND BENEFITS

In addition to sharing profits and protecting intellectual property rights, countries in the south may also be able to benefit from the transfer of technology, training, and infrastructure development once a resource has been identified during the process of bioprospecting. However, the extent to which bioprospecting has occurred, has helped to conserve biodiversity, and increased profits for extractors and guardians of the resource is difficult to assess, especially because what is the highly subjective concepts of "fair" or "equitable" are difficult to define.

The most well-known positive case study of bioprospecting comes from a partnership between Costa Rica's Instituto Nacional de Biodiversidad (InBio) and the U.S. pharmaceutical giant Merck and Company. InBio was designed to identity and find ways to sustainably use natural resources. In 1991, InBio made an agreement with Merck to provide natural resources from protected areas for scientific evaluation. In exchange, Merck provided $1,000,000 over two years and $135,000 worth of equipment and training to Costa Ricans involved in this partnership. The agreement also involved profit sharing between these two parties, if commercial products resulted from scientific evaluation. Although this partnership may seem equitable and fair, questions been raised regarding how fair Merck's payments are.

A more negative incident occurred between Shaman Pharmaceuticals, which desired access to the croton tree to produce antivirals, and the Pan American Indigenous Peoples Federation (COICA) of Amazonian South America who would harvest this plant for the private company. Critics of this partnership question the compensation Shaman provided COICA and how Shaman has claimed exclusive monopoly over this plant. Shaman has also been criticized for patenting this plant and claiming "novelty" over the product, when knowledge about this plant has been held in the public domain by COICA, which is the custodian of this plant.

The extent to which bioprospecting has occurred is debatable, however. Some have claimed the media has created an "alarmist" perception that exaggerates the occurrence of bioprospecting. Because bioprospecting is expensive, time consuming, and uncovers resources that are of low or at least unpredictable value, many private companies have not invested in it, thereby forestalling what V. Bolsvert and F.D. Vivien call a "green gold rush." It is also unclear if bioprospecting will lead to greater conservation of species because of the potential health and economic benefits they could bring or greater exploitation of ecosystems when genetic resources become dispensable. Nevertheless, bioprospecting is an activity that will remain in the spotlight because of the various ethical and political debates associated with it, such as fair trade, intellectual property rights, and access and benefit sharing.

SEE ALSO: Biodiversity; Biopiracy; Indigenous Peoples; Property Rights.

BIBLIOGRAPHY. V. Bolsvert and F.D. Vivien, "The Convention on Biological Diversity: A Conventionalist Approach," *Ecological Economics* (v.53, 2005); C. Crook and R.A. Clapp, "Is Market-Oriented Forest Conservation a Contradiction in Terms?" *Environmental Conservation* (v.25/2, 1998); A. Hughes, "Who Speaks for Whom? A Look at Civil Society Accountability in Bioprospecting Debates in Mexico," *IDS Bulletin* (v.33/2, 2002); S.P. Mulligan, "For Whose Benefit? Limits to Sharing in the Bioprospecting 'Regime,'" *Environmental Politics* (v.8/4, 1999).

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Bioregionalism

ECOLOGICAL WRITERS AND thinkers Allen Van Newkirk, Peter Berg, Jim Dodge, Raymond Dasmann, and Gary Snyder developed the concept of *bioregionalism* in the mid–1970s. It is a framework for the organization of society, based on the idea of an ecological area or "bioregion" defined by a local pattern of ecological and social characteristics, rather than static political boundaries. In the words of Peter Berg, bioregionalism is both a geographic terrain or place, and a terrain of consciousness, a way of thinking about how local communities can produce a sustainable future. Bioregionalism research looks specifically at the experiences of local social and ecological organization based on an understanding of community and shared identity as embedded in local ecology, geography, history, and social and cultural context.

A bioregion is defined according to the main ecological features found in a continuous geographical terrain, such as climate, soils, watersheds, and distribution of native species, including humans. For example, the Cascadia Bioregion in the Pacific Northwest of the United States and Canada includes the Alaskan panhandle, British Columbia, Washington, Oregon, Idaho, northern California and western Montana. Geographically, it includes the Columbia River Watershed and the area around the Cascade Mountain Range. The region is historically defined as the "land of the Chinook Jargon speakers," a trade language used for communication at the end of the 18th century between Native American tribes and white traders.

The primary objectives of bioregionalist thinkers and activists are to restore and maintain natural ecosystems, practice sustainable livelihoods by establishing local systems of trade and food provisioning to satisfy basic human needs, and support the work of re-habitation. Re-habitation refers to the restoration of degraded areas and the subsequent development of a relationship between people and nature that involves a sustainable way of life. For example, residents of the Cascadia bioregion work to restore salmon runs and develop ways to use plant-based fuels as a renewable energy source.

PROPONENTS AND CRITICS

While bioregionalists are mainly concerned with the relationship between local communities, environmental habitats, and local forms of democratic governance, recent works by bioregionalist thinkers also consider the relationship between local bioregions and global environmental and economic contexts. Bioregionalists critique the state governance system by arguing that artificial political boundaries are unable to effectively address ecological problems. Instead, they envision a confederation of local and bioregional communities that acknowledge the connections between diverse ecological communities and bioregions, and work together to preserve local cultures and diversities that comprise the larger global whole. Bioregionalists recognize the relationship between local communities and global environmental problems; for example, they view global warming as the consequence of local activities and practices that are linked in a global political economy.

Critics of bioregionalism point out that the approach "naturalizes" human life in a way that recalls environmental determinism, that regions are not actual or given but historically and culturally constructed, that all earth processes (including human social and economic practice for millennia) are multi-scaled and never isolated in convenient regions, and that "blood and soil" discourses like bioregionalism recall the grim ideologies of fascism. Nevertheless, recent scholarly interest in the concept of place within a variety of disciplines including sociology, anthropology, geography, and philosophy includes a discussion of bioregionalist thinkers as pioneers in the development of new conceptions of place. In this sense, bioregionalists prioritize the construction and analysis of place from the ground up, with the development of new social systems by local residents based on the material limitations of local ecological places and regions.

SEE ALSO: Geography; Regions; Sustainability.

BIBLIOGRAPHY. Daniel Berthold-Bond, "The Ethics of 'Place': Reflections on Bioregionalism," *Environmental Ethics* (v.22, 2000); Mike Carr, *Bioregionalism and Civil Society: Democratic Challenges to Corporate Globalism* (UBC Press, 2004); D. Meredith, "The Bioregion as a Communitarian Micro-region (and its Limitations)," *Ethics Place and Environment* (8(1): 83-94. 2005); "The Bioregion as a Communitarian Micro-region (and Its Limitations)," *Ethics Place and Environment* (8(1): 83-94); Michael McGinnis, ed., *Bioregionalism* (Routledge, 1999); Planet Drum Foundation, www.planetdrum.org (cited July 2006); Robert Thayer, *LifePlace: Bioregional Thought and Practice* (University of California Press, 2003).

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Biosphere

THE TERM *BIOSPHERE* refers to the totality of life on earth and its interdependency on abiotic environmental factors. It encompasses the interactions between the atmosphere, hydrosphere, and lithosphere to support the entirety of earth's organism through climate (temperature and precipitation), soil formation, hydrology (surface water, ground water, and soil moisture storage), solar energy input (variation in intensity and daily and seasonal accumulation with latitude), and the cycling of energy and nutrients through food webs. The biosphere is the highest level of the ecological hierarchy.

The lowest level of the ecological hierarchy focuses on individual species, with a single individual of a species at the lowest level of classification, and moving upward to a population of that species (the total number of individuals of a species in a given area) and metapopulations (the total number of individuals of a species across the total number of disjunctly distributed populations). Above the species level of classification is the community, which is concerned with the number of species co-occurring in a given location. Emphasis is placed strictly upon the species that are present and the nature of their competitive or mutualistic interactions in creating stable or unstable species compositions.

Above the community level, the ecosystem level is concerned with both the specific community composition in addition to environmental factors of nutrient and energy input as well as the cycling of these nutrients through food webs. At this level, both biotic and abiotic factors are considered to be components. At broader spatial scales, the abiotic inputs are grouped according to climatic patterns and their support of terrestrial ecosystems whose vegetation have similar physiognomic structure, giving the biome level of classification. For example, the tropical rainforest biome is characterized by high biomass and broadleaf evergreen trees forming multiple canopy layers, although the actual species composition and nutrient cycling specifics (i.e., ecosystems) will differ between the tropics of the various continents. Above the biome level is the globally inclusive classification of the biosphere, in which the interconnectedness of global climatic systems forms a principal analytical focus.

HUMAN–BIOSPHERE INTERACTION

Environmental concerns at the biosphere level focus on human–environment interactions, especially as these interactions contribute to global climate change and mass extinction of species. Ecologists consider the contemporary period of history, especially after the mid-20th century, to be unique in the history of the planet, in that human activity is altering the environment on a global scale. Furthermore, environmental management efforts are being targeted at the biosphere level as well.

Current extinction rates of known species exceed the background extinction rate by 40 times, but could be as high as 400 times the background rate based on estimates of total species. For this reason, many biologists consider these extinctions to be the beginning of a major extinction event. Ecologists have identified habitat loss as being the primary cause of these extinctions, as extractive activities (forest clearing for timber and agriculture, urban sprawl), with the introduction of nonnative species (either by direct human introduction or accidentally through transportation networks), pollution, and direct exploitation of species contributing greatly to these extinction rates. Regions of the world with highly specialized species and endemics are particularly at risk of extinctions, and identified as "biodiversity hotspots." Due to high rates of endemism, many islands environments and Mediterranean shrubland ecosystems have been identified as biodiversity hotspots.

Global climate change is also a human-driven aspect of environmental change that affects the entire biosphere. Although scientists debated for years whether observed warming trends were normal climatic variations or the result of interglacial warming as opposed to being anthropogenically driven, by 2001 the persistence of increasing carbon dioxide levels in the atmosphere, in conjunction with results from analyzing the dissolved gas content in ice core samples taken from Antarctica and Greenland, have settled the debate in favor of human causes for the phenomenon. The data from the ice cores provide a record of environmental change extending back 900,000 years, and indicate that the rate of carbon dioxide accumulation since the beginning of the Industrial Revolution has been at an unprecedented high. Carbon dioxide concentrations in the atmosphere currently have reached their highest levels during this 900,000 year period, and temperatures are expected to rapidly follow. The polar regions have been warming more rapidly than models have predicted, causing many arctic species to be threatened with extinction.

If climatic conditions change more rapidly than species can adapt or disperse, then climate change could have severely adverse effects on the entire biosphere. The solutions require coordinated political action between international governments, but multilateral cooperation has proven difficult to achieve. Industrialized nations invariably consume the greatest amount of the worlds' resources, especially fossil fuels that produce greenhouse gases, while many of the world's developing nations do not, but view increased consumption of fossil fuels as being necessary for economic development.

For example, the newly industrializing countries of south and east Asia, in conjunction with their high populations and rates of growth, are expected to consume more fossil fuels in the near future. Political tensions have thus arisen around perceived inequalities in both consumption and economic impacts to emissions reductions. The Kyoto Protocols, an international agreement setting goals for reductions of greenhouse gas emissions, became international law in March of 2005, despite the United States and Australian delegations not participating.

Habitat loss tends to occur on a more local scale, but is greatly affected by social, political, and economic linkages in the global economy. The articulation of precapitalist modes of production with market economies tends to increase the amount of cultivated land required to meet a household's needs, as well as exacerbate gender and age differences within the household mode of production. Developing countries rely heavily on primary production of agricultural and timber products, driving deforestation and often putting various social groups into conflict.

SEE ALSO: Atmosphere; Biodiversity; Biogeochemcial Cycles; Biome; Carbon Dioxide; Climate; Conflict; Deforestation; Ecosystem; Energy; Gaia Hypothesis; Global Warming; Habitat; Nutrients; Species; Urban Sprawl.

BIBLIOGRAPHY. Raymond L. Bryant and Sinéad Bailey, *Third World Political Ecology* (Routledge, 1997); Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Tom L. McKnight and Darrel Hess, *Physical Geography* (Pearson Prentice Hall, 2005).

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Biosphere Reserves

BIOSPHERE RESERVES ARE areas of natural significance that are designated under the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and the Biosphere Program. A reserve may comprise a terrestrial or coastal ecosystem or, in some cases, encompass multiple types of ecosystems. A biosphere reserve may be a national park or other type of protected area that is recognized either nationally or internationally. Biosphere reserves collectively form a World Network, the purpose of which is to share information relating to conservation, development, and logistics.

Biosphere reserves are different from other protected areas in three ways. First, they are part of the designated UNESCO Man and the Biosphere Program. Second, the outer boundary is more flexible than legally defined. Third, the water and land contained in a biosphere reserve may be managed by more than one owner or agency. In practice, however, the main binding concept is the first designation as part of the World Network of the Man and the Biosphere Program.

A national committee nominates an area to be designated by UNESCO as a biosphere reserve. Funding for the biosphere reserve comes from various sources such as national or local municipalities, nongovernmental organizations, tour operators, and other such sources. UNESCO does not provide funding except occasionally to fund pilot projects at the local level. Each biosphere reserve has its own management system.

INTENTS AND ORIGINS

Biosphere reserves were originally intended as places for scientists and public agencies to conduct scientific research together in order to meet the changing needs of the environment on a global scale. The biosphere reserve network established through the Man and the Biosphere Program was intended to facilitate the compilation and international sharing of information, especially for ecosystems that were heavily impacted by human activities.

The origin of biosphere reserves dates to the Biosphere Conference, which was organized by UNESCO in 1968. It was the first intergovernmental conference of its kind to address both the themes of conservation and use of natural resources, which were the precursor to present-day notions of sustainable development.

The primary result of the Biosphere Conference was the establishment in 1970 of the Man and the

Biosphere Program. Within this program is the World Network of biosphere sites, which sought to have the main ecosystems of the world protected and monitored, with some scope for training. The term *biosphere reserve* was in reference to the overall UNESCO Man and the Biosphere Program.

Biosphere reserves were seen in the 1970s as sites of natural excellence in the areas of science, conservation, and natural resource education, and were intended as model places from which lessons could be learned and applied more widely to other protected areas. Plants and animals within the biosphere reserves were to be protected, particularly in regard to genetic diversity. Environmental and ecological research was to take place within biosphere reserves, and facilities for training and education were to be provided.

In the early 1980s, emphasis shifted as key links between conservation and development were made more widely in the world. Partly as a result of experience from the first decade of biosphere reserves, local people were increasingly regarded as critical to the success of a biosphere reserve. This is reflected in the expansion of purpose of a biosphere reserve, which moved beyond the original concept of conservation, monitoring, and training. Indeed, the concept of biosphere reserves is an evolving one. In addition to conservation, biosphere reserves are also intended to provide logistical support for the research, education, monitoring, and exchange of information made possible through the activities within the biosphere reserve. Both human and economic developments are to be fostered in a socioculturally and ecologically sustainable manner.

The 1990s forwarded the concepts of conservation and sustainable development. One of the most important events during this time was the International Conference on Biosphere Reserves in Seville in March 1995. The resulting Seville Strategy proposed that the original concept of research and monitoring comprised only two of ten key directions. Subsequent actions have evaluated the Seville Strategy and show it to be of varying impact, depending upon local and national circumstance.

One of the benefits of a biosphere reserve designation is the potential economic benefit through tourism or other forms of external funding. Another benefit is that some biosphere reserves are located on the boundaries of more than one country and, as such, are ideal ways to develop long-term cooperation. Finally, one of the most important benefits is to promote awareness about sustainable development and conservation among local people, governmental authorities, and other stakeholders.

The model biosphere reserve area comprises a core zone, buffer area, and transition area. The core zone is the strictly protected area, and the buffer area is for limited public access, research, and education. Activities such as low-impact farming, settlement, and recreation may take place in the outer transition area. The boundaries of the protected area may be quite fixed, with the transition area as more flexible and changing. In fact, the entire zonation scheme is, like the biosphere reserve concept itself, subject to evolution and revision according to local and global concerns.

SEE ALSO: Biosphere; Conservation; Ecosystem; Man and the Biosphere Program (UNESCO); United Nations.

BIBLIOGRAPHY. Michel Batisse, "Developing and Focusing the Biosphere Reserve Concept," *Environmental Conservation* (v.9/2, 1986); J. Sanford Rikoon and Theresa L. Goedeke, *Anti-Environmentalism and Citizen Opposition to the Ozark Man and the Biosphere Reserve* (Edwin Mellon Press, 2000); United Kingdom Man and the Biosphere Program, www.defra.gov.uk (cited December 2006); United Nations Educational, Scientific, and Cultural Organization, www.unesco.org (cited December 2006).

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Biotechnology

BIOTECHNOLOGY HAS RECENTLY emerged as a technology of promise and peril in the lexicon of environmental controversies. The Organization for Economic Cooperation and Development (OECD) defines biotechnology as "The application of Science and Technology to living organisms as well as parts, products and models thereof, to alter living or nonliving materials for the production of knowledge,

With genetic engineering, biotechnology became negatively associated with for-profit development.

goods and services." The Convention on Biodiversity defines biotechnology in similar terms in regard to its biosafety protocol and its revenue-sharing agreements for genetic resources.

Early applications in biotechnology promised significant improvements in society roughly corresponding with the enthusiasm for the project of modernism. The vision of putting life processes to work for humans was naturally an extension of the high modernism of dead engineering. The Baconian ideal of controlling nature was in many ways a reproduction of Enlightenment ideas. For example, early in this century it was suggested that bioreactors could produce single-cell proteins that could be a food source for developing countries. Even today biotechnology enthusiasts describe genetic solutions to hunger, environmental degradation, and cancer that can be solved by the technology. However, with the advent of genetic engineering, biotechnology became associated in some circles with the negative consequences of industrialism and capitalist-led research and development. Activists and scientists who were concerned with the uncontrollability and irreversibility of some manipulations of life's processes questioned the technology.

Some suggest that the earliest products of biotechnology were plants domesticated through human selection. Others date the beginnings of biotechnology to Egyptian beer brewing and the use of yeast to bake bread. The work of Louis Pasteur on microbial origins of fermentation is often described as the earliest scientific work in biotechnology with significant implications for industry. The work of Pasteur led to the widespread adoption of pasteurization. In *The Uses of Life*, Robert Bud takes this broad definition for biotechnology to mean any technology that directs life processes toward production or product development. He bases his definition on the language commonly used to describe fermentation reactors in the early to mid 20th century.

In the 20th century, biotechnology emerged out of chemical engineering and its marriage to biochemistry, bacteriology, and industrial microbiology. Zymotechnology, a discipline that harnesses life processes for industrial processes such as fermentation, was an early precedent. Again influenced by the work of Pasteur, zymotechnologists understood how to industrially produce alcohol through fermentation. It was at this time that Karl Ereky, a Hungarian agricultural scientist, coined the term *Biotechnologie*.

By World War I, biotechnology was being used to produce lactic, citric, and butyric acids; industrial alcohols; treated sewage; and isoprene to make rubber. With the war cutting off grain supplies to Germany, where zymotechnology was at its zenith, 60% of the fodder protein needs of the nation were provided by yeast cultivation on molasses, preventing widespread wartime famine.

By the World War II, biotechnology became well known for the industrial production of antibiotics and research on the threat of biological warfare. The production of penicillin is regarded by historians of technology as a major feat of engineering because of the complications of producing the living organisms at considerably larger scales. This era of industrial microbiology saw the scaling-up of biological production of acetic acid, penicillin, and enzymes, ushering in a pharmaceutical industry based on microbiology. Some of the world largest chemical companies, Pfizer, BASF, and Dow, were among the first commercial producers of the products of biotechnology.

Because of cheaper alternatives from synthetic chemistry, based on inexpensive fossil fuels, many of the promises of biotechnology in these early years remained unfulfilled. Other major chemical companies preferred stocks derived from petroleum and coal. However, popular writers like Aldous Huxley continued to write about the utopian vision and aesthetic of biotechnology. Even social critic Lewis Mumford adopts the historical category he labels the *Biotechnic* to describe a utopian epoch of production that was good for both the worker and the consumer.

PROMISES AND PITFALLS

The increasing support for molecular biology in universities also played a large role in the development of biotechnology. MIT (1939) and UCLA (1947) had units in biological engineering and biotechnology. Together with private sector support, universities helped initiate the development of continuous process fermentation, as opposed to batch fermentation, which significantly shaped the industrial production of living organisms. The National Institutes of Health saw dramatic increases in funding availability in biomedicines in the postwar period, which help spur growth in areas like the Santa Clara Valley in California and Cambridge, MA.

By the 1970s, with decreasing support for university research and incentives for private-public research partnerships, biotechnology in universities came under significant scrutiny. It was asserted that the quest for patents in the public sector was contrary to the public mission of the university, and would affect both the free flow of information and materials in the university. Yet, many universities today have patent offices explicitly to deal with the products of biotechnology.

Much like nuclear power, the public discourse about biotechnology remained benign and an efficient answer to the effects of industrialization. It was particularly in the context of the famines of the 1960s that biotechnology was viewed with great promise. Biotechnology would produce plants that could fix nitrogen and eliminate the need for synthetic fertilizers, and its fermentation vats would provide low-cost industrial foodstuff to the world's poor. Likewise, with the energy crisis of 1973, biotechnological products like biogas and gasohol were seen as viable alternatives to fossil fuels—and still are, particularly in places like Cuba and Brazil.

But beginning in the 1980s, biotechnology was discussed in the context of potential nefarious social and environmental consequences of industrialization. Critics of biotechnology often describe the wider implications of technological change as well as the direct consequences. In particular, genetic engineering, genetically modified organisms, and agricultural biotechnology has raised the ire of activists.

The controversies associated with the new biotechnologies are both political and in part a consequence of the scale of scientific intervention. Beer, bread, and penicillin all intervene as the level of the organism. New techniques characterized as biotechnology move to smaller scales such as the molecular or cellular scale, or as with nanotechnology, at the atomic scale. The new biotechnologies include recombinant DNA transfer, protoplast fusion, and tissue culture, all techniques that are widely used in the sciences today.

Today the private firms that engage with the commercial development of biotechnology are known as the life sciences industries, which are politically and commercially represented by The Biotechnology Industry Organization. With the life sciences industries emerging out of the much-disdained chemical industry, great skepticism was associated with biotechnology. Much of today's controversy stems from questions about intellectual property rights. A key Supreme Court decision, *Diamond v. Chakrabarty*, ruled that living organisms were subject to patents after a General Electric biologist developed a microorganism to eat crude oil, an environmental application that could be applied to oil spills. Central to the question about patenting organisms is what exactly constitutes an improvement worthy of patenting, as well as many of the other questions attributed to the process of commodification. For example, farmers have improved plants through selection for eons, yet their work falls into the domain of common heritage. However, scientific improvements using genetic engineering fall under the auspices of patentable subject matter, implying a labor theory of value that favors modern science and the developed world.

Developments in cloning have also raised many ethical and political questions. The cloned sheep known as Dolly introduced much of the world to the implications of new biotechnological interventions at the cellular level. Because cloning often involves significant numbers of miscarriages, birth deformations, and clinical failures, human cloning is quite controversial beyond questions about social justice and reproductive technologies, but about the direct loss of human life consequent to the cloning process itself.

While biotechnology still holds much promise, the controversies around genetic engineering and genetically modified organisms continue to take center stage. Today, the promising tools coming out of biotechnology include the development of biosensors as well as plant breeding techniques that could help breed perennial crops. But until questions about property rights, economic concentration, the shape of the research trajectory, and any social consequences of biotechnology are sorted out, the promises of biotechnology will remain embattled in the realm of discourse.

SEE ALSO: Cloning; Genetically Modified Organisms; Genetics and Genetic Engineering.

BIBLIOGRAPHY. Robert Bud, *The Uses of Life: A History of Biotechnology* (Cambridge University Press, 1993); Martin Kenney, *Biotechnology: The University Industrial Complex* (Yale University Press, 1986); Jack Kloppenburg Jr., *First the Seed: A Political Economy of Plant Biotechnology 1492-2000* (University of Wisconsin, 1988).

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Birth Control

BELIEFS, RESEARCH, AND debate about birth control have been present in societies since Ancient Rome. People have had more efficient means available (such as the latex condom and the anovulant pill) since the 1950s. With the advent of these widely available types of birth control has come increased ethical, religious, social, and familial debates. The Catholic Church, in particular, has maintained a position of only approving natural family planning via the calendar method.

On a personal level, birth control enables people to plan for or against pregnancy within their own timeframes. However, birth control can also be a matter of public policy to manipulate population growth. For instance, governments like Israel created noncoercive pronatalist measures that reward bigger families with tax reductions and other incentives. In other cases, the state may have provisions for giving financial help to couples who face infertility problems. From a business standpoint, some corporations provide pay while employees are on adoption leave, particularly when couples are going abroad for international adoptions.

At the other end of the spectrum are governments that have established antinatalist efforts, which are policies to inhibit big families. The most notable example is the one-child policy in China, which has created an imbalance of boys and girls, as many families prefer to have a boy. This imbalance has exacerbated social issues such as prostitution, sex tourism, homosexuality, and forced migration.

In the early 21st century, the world population was more than 6 billion, compared to a worldwide population of 1 billion in the early 19th century. Countries like India and China alone have more than 1 billion citizens. These numbers raise questions and concerns about prosperity, poverty, the limits of growth, and the future.

Overpopulation is regarded as a contributing factor to problems like environmental pressures, global warming, the food crisis in the developing countries, poverty, starvation, and megacities. The overpopulation issue is not new—two centuries ago, economist Thomas Robert Malthus (1766-1834) published *An Essay on the Principle of Population, as It Affects the Future Improvement of Society* in 1798. Malthus argued that "population must always be kept down to the level of the means of subsistence." Concerns related to overpopulation and limited food supplies have visited almost every generation.

The issue of overpopulation has had many prophets and followers. Paul Ehrlich's bestseller *The Population Bomb* was published in 1968, when the U.S. population reached 200 million. The book sold three million copies and was so influential that even the title remained a popular catchphrase. As we now know, many of Ehrlich's overly pessimistic scenarios did not come to pass, and some were even removed in subsequent editions. Still, many people who were influenced by the book opted to have sterilization surgery. Other authors also cashed in with predictions related to overpopulation and the food supply. Donnella Meadows's book *Limits to Growth* in 1972 sold 10 million copies in 30 languages. An updated version titled *Limits to Growth: The 30-Year Update* was released in 2004. Most recently is Lester Brown's apocalyptic book, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble* (2006).

Despite statistics that confirm the increased number of people on earth, overpopulation is not really a fact. It is better understood as a worldview that is part of a complex debate regarding issues such as global warming. Politicians, decision makers, and the population in general must rely on experts's interpretations of existing research. While some find grounds for concern, others do not. Economist Julian Simon, for example, wrote *The Ultimate Resource*, which has been reissued twice since 1981. Simon argues that overpopulation is a myth; with new technologies, nuclear plants, and resourcefulness, humans have proven that they can adapt to challenging situations and find new ways to face global issues. Therefore, the main cause for starvation in emerging countries is often corruption, and not lack of resources.

Economics professor Jacqueline Kasun, of Humboldt State University in California, also challenges the seriousness of overpopulation. She argues that overpopulation is an ideology and often a means of propaganda. She criticizes Ehrlich's *The Population Bomb*, maintaining that there is still room on the planet, except in megacities and some autodependent suburbs.

After the baby boom generation (those born between 1946 and 1964), subsequent generations seem to have adopted the two-child model as a standard in many Western countries. But this is not the norm worldwide. Peter Berger found that women in India refused to use oral contraceptives, even when given for free by nurses, because most Indian women did not see big families as a problem. Similarly, many African males refuse to use condoms. In sum, population control is quite different from birth control, although the two concepts are often linked.

SEE ALSO: China; Fertility Behavior; India; One Child Policy, China; Social Ecology; Sustainable Development.

Mechai Viravaidya

Mechai Viravaidya (b. 1941) is a politician and activist in Thailand who has become well-known for popularizing of the use of condoms in Thailand. The son of a Thai father with connections to the Thai Royal Family, and a Scottish mother, he was educated at Geelong Grammar School in Australia. Returning to Thailand, he started to work on population control. He quickly became nicknamed "Mr Condom" for his promotion of the use of condoms for birth control, and later for the prevention of the spread of venereal diseases. He also supported vasectomies and other methods of contraception. In 1973 he left the government; in the following year he formed his own Population and Community Development Association, and also runs a restaurant called "Cabbages and Condoms" in Bangkok. For many years, condoms in Thailand were often known colloquially as "mechais."

Mechai was deputy minister of industry from 1985 until 1986, and senator from 1987 until 1991, and again from 2004. During the mid-1980s, when AIDS appeared in Thailand, Mechai urged the use of condoms to prevent its spread, conducting public awareness campaigns in schools, universities, and among sex workers in Bangkok and elsewhere in Thailand. In 1991, the new military government gave their backing to his campaign, appointing Mechai as Minister of the Prime Minister's Office, responsible for Tourism, Information, Sports, Economic Cooperation, Zoological Gardens, and AIDS Prevention Coordination. His role in both birth control and AIDS awareness is known around the world, and he has been given many awards by international institutions.

BIBLIOGRAPHY. Peter L. Berger, *Pyramids of Sacrifice: Political Ethics and Social Change* (Basic Books, 1975); Lester R. Brown, *Plan B 2.0: Rescuing a Planet Under Stress and a Civilization in Trouble* (W. W. Norton, 2006); Paul R. Ehrlich, *The Population Bomb* (Sierra Club-Ballantine Books, 1968); Joseph Marion Jones, *Does Overpopulation Mean Poverty? The Facts about Population Growth and Economic Development* (Center for International Economic Growth, 1962); Jacqueline Kasun, *The War Against Population: The Economics and Ideology of Population Control* (Ignatius Press, 1999); Thomas Robert Malthus, *An Essay on the Principle of Population, as It Affects the Future Improvement of Society* (Oxford University Press, 1999); Donnella Meadows, *Limits to Growth* (Signet, 1972); Donnella Meadows, Jorgen Randers, and Dennis Meadows, *Limits to Growth: The 30-Year Update* (Chelsea Green Publishing Company, 2004); Julian L. Simon, *The Ultimate Resource* (Princeton University Press, 1998).

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Birth Rate

THE BIRTH RATE, or the crude birth rate (CBR) as it is sometimes referred, refers to the number of childbirths per 1,000 of the population per year. When combined with the crude death rate (the total number of deaths per 1,000 of the population per year) the rate of natural population growth or decrease is calculated. However, for a more complete and accurate picture of population growth or shrinkage, patterns of migration must also be considered.

The levels of birth rate are affected by numerous factors. Of significant impact is government policies, which can either stimulate or depress the level of fertility and the number of births within a nation. For example, China has a relatively low birth rate (about 13 per 1,000 people) due to the Chinese national government advocating a policy of one child per family. Birth rate can also be affected by socio-religious beliefs, especially in regards to the use of contraception, as well as a country's age-sex structure, economic prosperity, and levels of poverty. In relatively wealthy nations, the birth rate is usually low, even though families can adequately afford to have large families if they desired.

In wealthier regions of the world, such as Europe, North America, and parts of Asia, it is commonplace to find small family sizes and low birth rates. The birth rates in some affluent nations are so low that the total population level is approaching a point of decline, as in Japan. On the other hand, within societies where poverty is prevalent, it is not unusual to find that the birth rate is high; the level of the birth rate can be further exacerbated when the age-sex structure of a nation is relatively young, that is, at a sexually active age. When societies are less economically developed, their fertility rates will be higher than nations that have already undergone economic advancement. At present, the global birth rate is about 20 per 1,000, yet in some economically developing nations it is higher than 50 per 1,000, as in Niger and Mali. In contrast, affluent parts of the world like Hong Kong, Monaco, and Singapore have rates of less than 10 per 1,000.

Regardless of the influence of culture, economics, or politics, where the infant mortality level (the number of children dying under one year of age divided by the number of live births annually) is high, it is also common to find a high birth rate. This is partly a behavioral response of families, which may have more children given their knowledge some might die in childhood. In African nations like Angola, where the child mortality rate is 192 per 1,000, and in Asian nations like Afghanistan, with an infant mortality rate of 166 per 1,000, the birth rate is in excess of 45 per 1,000, some of the world's highest.

SEE ALSO: Birth Control; Fertility Behavior; Fertility Rate; Gender.

BIBLIOGRAPHY. Cecilian Nathans, *Accepting Population Control: Urban Chinese Women and the One-Child Family Policy* (Curzon, 1997); Zeba Ayesha Sathar and James F. Phillips, *Fertility Transition in South Asia* (Oxford University Press, 2001); Kathleen Tobin, *Politics and Population Control: A Documentary History* (Greenwood Presss, 2004).

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Bison

ONCE FOUND THROUGHOUT most of the Northern Hemisphere, bison are now found only in limited areas of North America and Europe. Large herbivores, bison typically move in herds composed of cows, calves, and adolescent or elderly males. Bulls of mating age are somewhat more solitary, staying at the fringes of the herd except during the rut, when they compete to mate with the most fecund cows in the herd. The bison's size has protected it from all but the largest natural predators—grizzly bears, wolves, and cougars. The American bison has more commonly been known as the American buffalo, even though bison are a distinct species from buffalo. The American bison once roamed in huge herds from Alaska and northern Canada to northern Mexico, as well as from the Rocky Mountains to the Appalachians. Although the largest herds were found on the open plains, smaller numbers spread into the woodlands. When Europeans first arrived in the Americas, there were an estimated 60 million bison in North America. The Native American tribes of the Central and Great Plains not only depended on the bison for food, clothing, and shelter, but also created a vibrant culture around their seasonal migrations with the herds.

In the 19th century, when Anglo-Americans began to build railroads across the continent to the Pacific coast, companies hired professional hunters to provide meat to the large work crews. The most famous of these hunters was William "Buffalo Bill" Cody, who sometimes shot several hundred bison on a single day. The hunters and those passengers who shot bison for "sport" from the moving trains contributed to a casual attitude toward killing buffalo. The herds were so immense that they seemed impervious to any culling, no matter how destructive. Nonetheless, in the decade following the Civil War, political and commercial pressures soon led to the rapid destruction of the great bison herds of the plains. The U.S. military recognized that as long as the herds sustained the plains tribes' way of life, they would be reluctant to move onto reservations. The government thus sanctioned the destruction of the herds as a way to bring the tribes under control and to open their lands to development. At the same time, coats made from buffalo hides became as popular as hats made from beaver pelts had been several decades earlier.

Organized companies of hunters moved first out onto the southern plains, killing almost four million bison in less than two years. Hunters such as Josiah Wright Mooar, James White, John Webb, Frank Mayer, Steele Frazier, and Billy Dixon each killed many more bison than Cody ever did, but there was no romance in this slaughter. They used long rifles that they rested on tripods and poured water over the barrels to keep them from overheating. Their hide men moved among the carcasses, heaping the hides and tongues onto wagons, and leaving everything else to rot. The hides sold for $3.50 apiece, and the tongues were salted and sold in hundred-pound bundles. The last herds on the Staked Plains of west Texas disappeared after the defeat of the Comanche at Adobe Wells and Palo Duro Canyon. The northern herds lasted about a half-decade longer. By the time the Ghost Dancers were massacred at Wounded Knee, those herds were as much a memory of a lost time as Crazy Horse and Sitting Bull. Only a few hundred bison remained in a few pockets of Western wilderness.

REBUILDING THE HERDS

Over the last half-century, efforts have been initiated to expand the bison herds, especially on public lands such as national parks. These efforts have been opposed by most ranchers, who have argued that the bison cannot be contained on public lands, that their cattle will have to compete with the bison for already limited range land, and that bison carry diseases that can decimate their herds. Ironically, some ranchers have either developed commercial bison herds or have inter-bred bison and cattle, marketing the meat as a lower-fat alternative to beef. Of the approximately 250,000 bison in the United States, only 16,000 live in wilderness areas. As farming communities on the Great Plains have declined and in many instances simply disappeared, serious proposals have been made to return the depopulated areas back to their pre-settlement state as prairie. Beyond the environmental implications, such proposals envision sustainable economic benefits from eco-tourism and managed commercial exploitation of the reintroduced bison herds.

SEE ALSO: Buffalo Commons; Native Americans; United States, Great Plains.

BIBLIOGRAPHY. Larry Barsness, *Heads, Hides, and Horns: The Complete Buffalo Book* (Texas Christian University Press, 1985); David Dary, *The Buffalo Book: The Full Saga of the American Animal* (Sage, 1974); Martin S. Garretson, *The American Bison: The Story of Its Extermination as a Wild Species and Its Restoration under Federal Protection* (New York Zoological Society, 1938); Francis Haines, *The Buffalo* (Crowell, 1970); Andrew C. Isenberg, *The Destruction of the Bison: An Environmental History, 1750–1920* (Cambridge University Press, 2000); Dana C. Jennings and Judi Hebbring, *Buffalo Management and Marketing* (National Buffalo Association, About Books, 1983); Dale F. Lott, *American Bison: A Natural History* (University of California Press, 2002); Mari Sandoz, *The Buffalo Hunters: The Story of the Hide Men* (Hastings House, 1954).

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Black Death

BLACK DEATH WAS an epidemic that spread to Western Europe and Britain in 1347–50. It caused havoc because about one-third of the European population died from the disease. The plague was weather related, because temperature and humidity were associated with multiplication of the carrier insects—Oriental rat fleas—which transmitted the bacteria from rats to human beings. After a flea fed on blood from the skin of an infected rodent, the ingested plague bacteria (*Yersinia pestis*) multiplied in the flea's upper digestive tract, blocking the flea's stomach. When the flea fed again on a human or another rodent, the blockage caused the freshly ingested blood to be regurgitated back into the bite, along with the plague bacteria. The infected human beings then carried these bacteria throughout their circulatory system. The first signs of illness in humans appeared within about a week. The plague caused a high fever, and the lymph nodes throughout the body, especially those in the groin and the thigh, become swollen and extremely painful. The enlarged lymph nodes, called buboes, become filled with pus, and the disease spread through the infected bloodstream and the lymphatic system. The disease also caused spots on the skin that were initially red and then turned black, which some believe inspired the name Black Death. In 60–90 percent of untreated victims, the inflection became overwhelming, leading to death within a few days.

The Peasants' Revolt

Following the Black Death in England, the labor force throughout the country was massively reduced with the result that agricultural laborers could demand higher wages and better conditions. To get around this, the government enacted the Statue of Labourers in 1351. This stopped wage increases and also restricted peasants from freely moving about the country. This was highly unpopular, especially with the artisans and some peasants. With the need to raise more money for the Hundred Years' War in France, the government in 1381 decided to raise a poll tax (or "head tax") of one shilling on everyone in the country. In 1377, taxes were at a quarter of the 1381 level.

Many people throughout the country objected to this and protests started. In Kent and Essex, men gathered and decided to march on London. This became known as the Peasants' Revolt of 1381, or Wat Tyler's Rebellion (after one of the leaders of the revolt) or the "Great Rising of 1381."

When the peasants arrived in London, they stormed the Tower of London and killed the Archbishop of Canterbury and the Lord Treasurer. They then sacked the Savoy Palace of John of Gaunt, uncle of King Richard II. This forced Richard II to agree to meet the rebels at Smithfield. He paid tribute to the rebels and told them of concessions he had made, giving his supporters time to raise a militia that later put down the rebellion with ferocity. Large numbers of rebels were arrested and executed for their role in the Peasants' Revolt.

Pneumonic plague is caused by the same bacteria, as in the case of bubonic and septicemic plague. It is acquired when plague bacilli, discharged into the atmosphere via infected droplets during coughing or heavy breathing, is inhaled by the victim. This form of plague is highly contagious; the largest epidemic occurred in Manchuria in 1910 and 1911, when 60,000 people died.

This urban community plague, originating in China, first spread with the movement of the Mongol armies and traders. In the beginning, Caffa—a Crimean port on the Black Sea—was afflicted by the disease in Europe in 1346. The Italian traders from Genoa brought the disease to the western European soil, from where sea traders and caravans carried the disease to France, Germany, Denmark, Poland, Finland, and Greenland. From its central Asian foci it diffused southward to Africa, eastward to China, and northwestward to Russia. Within three years, the disease reached the British Isles, and the first afflicted ports were Bristol and Southampton.

The impact of Black Death in England was not only immediate; it also lasted for at least two centuries. About half of the English population died during the bubonic form of plague that first appeared in the summer of 1348 in England. The bacteria also mutated into a dreadful pneumonic form in the winter, and London was attacked by both pneumonic and bubonic plague. The Parliament was prorogued; three archbishops of Canterbury died in quick succession.

Plague, which killed both rich and poor alike, could not be treated by the physicians. The monks were also of no help. Many blamed the disease to be a curse of the God. As a result, a group of people, *Flagellant Brahren*, inflicted punishment on themselves. Others tried to find a scapegoat, such as the Jews, who were in turn persecuted; many were forced to move from western Europe to eastern Germany, Poland, and western Russia.

The effect on economy was staggering. Large numbers of farmers who tilled and harvested the land died. There was a tremendous dearth of working people, and an acute shortage of skilled craftsmen of any kind. Many building programs were abandoned. The feudal society that had created serfs started to crumble; domesticated animals roamed unattended. As there was a shortage of law enforcement personnel, lawlessness prevailed. People had witnessed so much death that even funeral processions became subjects of jokes. The mass death changed the nature of art. Coffins bore the pictures of corpses on the cover. Sculptures displayed worms and snails; paintings contained skeletons. Christian-based idealistic paintings were replaced by paintings of sad and dead people.

A mass of Yersinia pestis bacteria (the cause of bubonic plague) in the foregut of the flea vector.

The first episode of the Black Death plague epidemic died out by 1350. The second episode occurred in 1361–64, the third in 1368–69, and the fourth in 1371–75. The later episodes were less destructive. Eventually, by the 15th century, incidents of plague declined and virtually disappeared from Europe. The reasons attributed are the replacement of the black rats by brown rats (the former were associated with human beings as they preferred to live in homes), and the fact that such devastating plagues occur in a time span gap of between six hundred to one thousand years. Thus, this pandemic had its own cycle.

The causative organism, *Pasteurella pestis,* was discovered by a Japanese, Shiramiro Kitasato, and a Swede, Alexander Yersin, during an outbreak in Hong Kong in 1884. Prevention of plague is achieved by inoculation with a killed vaccine; antibiotics cure infected patients. Rats and fleas can be killed with pesticides. The possibility of a Black Death-type of pandemic reoccurrence is remote, because the scientific knowledge has advanced to the level that plague can be prevented and cured.

SEE ALSO: Disease; Epidemic; Health.

BIBLIOGRAPHY. F. Cartwright, *Disease and History* (Mentor Books, 1972); C. Dyer, *Making a Living in the Middle Ages: The People of Britain 850–1520* (Yale University Press, 2002); C. Platt, *King Death: The Black Death and its Aftermath in Late-Medieval England* (UCL Press, 1996).

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Black Sea

THE BOSPHORUS AND the Dardanelles, the narrow straits into the Black Sea, have long been the division between Europe and Asia. Istanbul, founded as Constantinople on these straits, has long been a rival with Rome and Jerusalem as the center of the world. Ever since Jason and the Argonaut's legendary journey to the region, the Black Sea has been a corridor between North and South and Europe and Asia, and an ancient place of trade, culture, and cross-fertilization of ideas. That vigorous trade continues today with about 50,000 cargo ships and 1,500 tankers crossing in and out of the Black Sea annually.

Six different countries—Romania, Bulgaria, Ukraine, Russia, Turkey, and Georgia—along with a narrow access for Moldova, all share the Black Sea coastline. With so many claims to the Black Sea's resources from countries with different religious and cultural values, the environmental consequences of the Black Sea region's economic development are difficult to manage.

The Black Sea was formed only some six or seven thousand years ago, when the rising Mediterranean breached into a freshwater lake basin. Some have connected this incident with legendary accounts of the great flood encountered in several different religious traditions. Although most of the sea is quite deep, the northwestern section of the sea is relatively shallow, and provides a flourishing ecosystem for red algae and animals dependent on the algae as a food source. Although the Black Sea ecosystem was generally quite strong, the recent introduction of alien species such as the Rapana snail has devastated some native populations.

Shipping, industry, and especially tourism have transformed the Black Sea coastal region with large numbers of artificial structures to protect beaches from erosion, causing the buildup of pollution and toxins. During the 1960s, the advent of the Green Revolution in agriculture led to the massive inflow of fertilizers into the sea, creating an overabundance of nutrients and crowding out of native red algae, the foundation of the Black Sea's ecosystem.

Tons of plant and animal life washed up onto the shores as the sea became starved of oxygen. The introduction of the alien comb jelly in the 1980s, which ate fish larvae, led to a massive decline in fish. The fall of the Soviet Union led to a respite in fertilizer and waste dumping into the Black Sea, leading to a partial recovery of the red algae habitat. Nevertheless, the recent development of oil fields and pipelines may lead to serious negative, environmental consequences for the region.

SEE ALSO: Biological Oxygen Demand; Mediterranean Sea; Oceans.

BIBLIOGRAPHY. Black Sea Environmental Programme Coordination Unit, www.dominet.com (cited February 2007); A. Gunes-Ayata, ed., *Black Sea Politics* (IB Tauris, 2005); Laurence Mee, "Can the Marine and Coastal Environment of the Black Sea Be Protected?" *Politics of the Black Sea*, T. Aybak (ed.), (IB Tauris, 2001).

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Blaut, James (1921–2000)

JAMES M. BLAUT was an historian and geographer. His intellectual contribution was centered on what he considered to be the Eurocentrism of much existing thought, and which has come to be accepted as the best available explanation of the past. This Eurocentrism was initially expounded by Max Weber and has been restated by subsequent historians of repute, including modern exponents such as Jared Diamond and David Landes. Blaut challenged the exceptionalist view of European expansion and the so-called European Miracle, which ascribed the massive expansion of European interests and power to superior ideology, technology, and cultural expression.

In *The Colonizer's Model of the World,* Blaut argued that the transformation of the global economy between 1492-1688 could be explained by the comparative proximity of European states to the Americas and the resources they provided, which subsequently enabled colonial states to accumulate surpluses to fuel their further colonization of Africa and Asia.

The subsequent work, *Eight Eurocentric Historians,* further developed his arguments that the reality of the past had been, and was continuing to be, distorted by historians. The result of this distortion was to malign the actions and histories of developing world people and institutions who are considered to be necessarily inferior to the colonists. This way of thinking is linked to the World Systems Theory of History and the Structural Dependency view of economic history. Blaut died before he was due to write and publish the third part of his projected trilogy to complete his argument. However, he did foreshadow in papers such as "The Theory of Cultural Racism" the ways in which he believed that Eurocentrism had become embedded in modern thought patterns:

> …the dominant racist theory of the early 19th century was a biblical argument, grounded in religion; the dominant racist theory of the period from about 1850 to 1950 was a biological argument, grounded in natural science; the racist theory of today is mainly a historical argument, grounded in the idea of culture history or simply culture.

Today's racism is "cultural racism." In other words, the sense of European superiority, which had been obtained through geographical accident and capitalist accumulation, was justified first by those who believed that following Christian beliefs in some prescribed way were privileged by God over other people; this belief was succeeded by biological and scientific arguments purporting to show the mental superiority of Caucasians (a school of thought that still occasionally recurs) and then by the belief that one culture offered benefits to its people above others. In the 1970s, some speculated that since so many Catholic countries were controlled by dictators, then Catholicism may be culturally inferior to Protestantism. At the beginning of the 21st century, similar arguments are made about Islamic cultures.

BIBLIOGRAPHY. James M. Blaut, *Eight Eurocentric Historians* (The Guilford Press, 2000); James M. Blaut, *The Colonizer's Model of the World: Geographical Diffusionism and Eurocentric History* (The Guilford Press, 1993); James M. Blaut, "The Cultural Theory of Racism," *Antipode: A Radical Journal of Geography* (Vol.23, pp.289-99, 1992).

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Blizzards

BLIZZARDS ARE THE most severe winter storm, with blowing snow, high winds, and low temperatures. Different countries have different classification systems for blizzards. The U.S. National Weather Service categorizes a blizzard as a winter storm with sustained winds or frequent gusts of 35 miles per hour or greater, and enough falling or blowing snow to frequently reduce visibility to less than a quarter of a mile. Temperatures are 20 degrees F or lower. These conditions prevail for at least three hours. A "severe" blizzard has winds of 45 miles per hour or greater and temperatures at 10 degrees F or below.

Blizzards are caused by extra-tropical storms that originate outside the tropics and dominate the weather in the mid-latitudes of the world from autumn to spring. A mid-latitude cyclone, an area of low atmospheric pressure surrounded by winds that blow counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere, is at the center of these storms. Cyclones are large-scale rotating weather systems that pull cold air toward the equator from the poles and carry warmer, humid air in the direction of the polar regions. The clash between these warm and cold air masses produces precipitation along a wide front. In winter, this can generate freezing rain, heavy snowfall, and blizzards. The normal lifetime of a winter cyclone is about three to five days, and generally tends to move across continents and oceans from west to east.

A significant proportion of the world's population live in the mid-latitude regions, which can expect blizzards in winter along with the severe disruption and economic loss they may cause. A wide range of countries in the Northern Hemisphere may experience blizzards, from Canada to northern regions of Europe and Asia. In the Southern Hemisphere, recent blizzards have occurred in the Chilean Andes, southern Peru, and Patagonia in Argentina. Both Arctic and Antarctic regions experience intensely cold blizzards.

In the United States, about 60 million people live in areas with a high risk of snowstorms. From 1960 to 2000, there were 438 blizzards in the United States, or an average of just over ten blizzards a year. On average, a blizzard event affected an area of over 150,000 square kilometers and over 2.4 million people. The highest incidence of blizzards occurred in the blizzard zone of North Dakota, South Dakota, and western Minnesota.

Blizzards create several risks. Blowing and drifting snow can create whiteouts, in which it is impossible to distinguish ground from air, making aviation and land transportation extremely hazardous. Cold temperatures combined with strong winds also create severe wind chills, which can result in frostbite or hypothermia. Power outages may occur, and livestock may die due to heavy snow and high winds. The deadliest blizzard in the world in the 20th century occurred in Iran in February 1972, when a week-long storm caused approximately 4,000 fatalities.

Some observers have predicted that the greater moisture in the atmosphere caused by global warming will intensify the number and strength of blizzards. However, the polar air masses, which are the second ingredient in making a blizzard, are not likely to become colder due to global warming. A recent study shows that blizzards are a less common occurrence on the Canadian prairies during the past 45 years. This may be an early indicator of a reduc-

Captain Oates

Many people associate going into a blizzard with the remark by Captain Oates in 1912: "I am just going outside and may be some time." This immortal phrase was recorded in the diary of a fellow expedition member of Captain Lawrence Edward Grace Oates.

Oates, who had served in the Second Anglo-Boer War as an officer in the Dragoons, wanted to go on the Terra Nova Expedition in 1910, which was organized by Robert Falcon Scott with the intention of being the first men to reach the South Pole. He was good at handling horses, and Scott initially liked him, although they were later to have bitter arguments over the management of the expedition.

When the party of five men reached the South Pole, they found that the Norwegian Roald Amundsen had beaten them to it. Oates by this time was suffering from scurvy and also aggravations to an old war wound. On their way back from the South Pole, the five men found themselves in serious trouble, and having difficulties in reaching their supply dumps. One of the party, Edgar Evans, died, and Oates was suffering from frostbite. On the night of March 17, 1912, when the four were trapped in a tent and supplies were low—they did not realize that they were only eleven miles from the next supply dump—Oates, on his 32nd birthday, uttered his famous remark and went out of the tent into the blizzard and died. Unfortunately, the other three men were trapped in their tent during the blizzard, and they perished soon afterward.

Oates's body was never found; it lies somewhere under a deep burial of snow and ice.

tion in the number of Northern Hemisphere mid-latitude cyclones due to global warming.

SEE ALSO: Climate, Arctic and Subarctic; Climate, Continental.

BIBLIOGRAPHY. Michael Allaby, *Blizzards* (Facts On File, 2004); Jeffrey O. Rosenfeld, *Eye of the Storm: Inside the World's Deadliest Hurricanes, Tornadoes, and Blizzards* (Plenum Press, 1999); R. M. Schwartz, T. W. Schmidlin, "Climatology of Blizzards in the Conterminous United States, 1959-2000," *Journal of Climate* (v.15, 2002).

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Body, Human

THE HUMAN BODY is a very complex set of systems that can withstand enormous challenges as well as accomplish dramatic feats. It can be described chemically, biologically, physically, and in terms of its functions. Chemically, the body is mostly water with additional elements including calcium, nitrogen, oxygen, sodium chloride, iron, phosphorus, potassium, trace minerals, and carbon. The human body is composed of a number of organic compounds that include carbohydrates, lipids, nucleic acids, and proteins.

The carbohydrates supply energy to the body's cells. The body is maintained by energy derived from chemical reactions with carbohydrates. Lipids are fats that store energy for future use. Some lipids are the material used by the body to make the living cells of the body. Nucleic acids supply cells with instructions to perform their jobs. Proteins also serve as building blocks for cells. Some proteins are enzymes, which perform a variety of functions such as speeding chemical reactions within the body.

Biologically, the human body is composed of cells, which is the basic unit of living things. Cells are mostly composed of proteins and nucleic acids in addition to water. The cells in the human body perform many functions such as providing food and oxygen, eliminating wastes, defending against disease organisms, and regulating body temperature. They stimulate growth and other activities as well. Each cell, such at blood cells, muscle cells, or brain cells, have unique features.

There are four major kinds of tissue cells. Connective tissue cells join together various parts of the body and also provide support. Most of the connective tissues, such as those attaching bones to muscles, are very strong and can withstand rugged use. The elastic connective tissues attach muscles to bones, or in the case of cartilage, support bones and act as support for motion.

Muscle tissue is fibrous and threadlike, and can contract or stretch in actions that enable a variety of motions, such as work or play. Nervous tissue transmits electro-chemical impulses that act as signals to the brain, muscles, sensory organs, and to other parts of the body. The epithelial tissue covers the body with skin and orifices such as the mouth and throat with a lining. The epithelial tissues protect the body from invasive organisms or from harmful substances.

Some of the tissues in the human body are organized into organs, which perform specialized functions. Groups of organs create networks to perform major functions in the body, such as the digestive system and the nervous system. Organs are composed of two or more types of tissue. The heart is an organ composed of muscle tissue, nervous tissue, and connective tissue.

The human body can be compared to a complex process organized into systems. The major systems include the skeletal, muscular, nervous, respiratory, circulatory, digestive, lymphatic, urinary, endocrine, reproductive, and epidermis (integumentary).

The skeletal system is the body's framework. It supports the body, protects its vital organs, and enables it to do activities. The skeletal system is composed of 206 bones. Marrow forms the inside of bones and serves as an intricate microstructure fed by the blood. Bones also make red blood cells.

The muscular system consists of 600 muscles of three types that enable the body to move. Skeletal muscles are attached to the bone and are voluntary, meaning they can usually be controlled by the mind. The body's internal organs have smooth muscles which, unlike skeletal muscles, do not have striations. Smooth muscles are involuntary muscles; they move automatically. Cardiac muscles in the heart are like both smooth and skeletal muscles. They have striations, but operate like smooth muscles with continuous, automatic, rhythmic actions. The heart beats, on average, 70-80 times per minute.

The respiratory system supplies oxygen to the body and removes carbon dioxide, which is a waste gas produced by respiration. The respiratory system includes the trachea (windpipe) and the lungs. Oxygen is needed by the cells of the body to release the energy supplied by food.

The circulatory system is composed of the heart, blood vessels, blood, and the lymphatic system. The heart is a four-chambered hollow muscle that pumps blood throughout the body. The right side receives the oxygen-poor blood and sends it to the lungs. The lungs then return blood to two chambers in the left side of the heart, which then send the oxygen-rich blood out to the brain and the body. The lymphatic system uses lymph, a milky liquid drawn from watery fluids collected around cells. Taken from blood vessels, lymph move slowly into the lymph system running throughout the body. The lymph collects wastes from cell activities, carries nutrients, and delivers white blood cells to various parts of the body. The thymus gland in the upper chest and the spleen are the main glands involved in the lymph system.

Another system that cleanses the body is the urinary system. The kidneys are the pair of organs that do most of the work in the urinary system; they are composed of millions of tiny filtering *nephrons* that filter salt, urea, and other wastes and water to be removed in the form of urine.

The glands in the endocrine system regulate growth, reproduction, digestion, and other hormonal functions. The major glands are the pineal gland, the hypothalamus, pituitary gland, thyroid gland, adrenal gland, the pancreas, the ovaries or testes, and the placenta during pregnancy. The body produces over 50 hormones that act as messengers to stimulate certain tissues.

The nervous system manages the activities of the other systems with chemical messages. These are

The human body is a very complex set of systems that can withstand enormous challenges as well as accomplish dramatic feats. It can be described chemically, biologically, physically, and in terms of its functions.

transmitted through nerve cells (neurons). The central nervous system, the brain and spinal cord, controls the actions of the body. It receives information from the peripheral nervous system, which is composed of the eyes, ears, nose and other sense organs. The autonomic nervous system communicates messages from the brain's subconscious to the involuntary muscles and to other automatic bodily functions.

The digestive system enables food and water to be used for the health of the body. Food taken into the mouth is passed down the esophagus into the stomach, where it is converted into *chime*. This thick liquid passes into the first part of the small intestines, where enzymes from the liver and the pancreas finish the digestion. The second part of the small intestines absorbs substances that can be used by the body. The remainder is passed to the large intestines, which extract water and minerals. What is left is eventually expelled as waste.

The reproductive system ensures the continuation of the species by bringing together the male sperm and the egg for growth in the uterus to produce a baby. Human gestation is nine months.

The skin or integumentary system has three layers. The outer layer, the epidermis, is tough and constantly shedding dead cells as new ones are replaced every several weeks. The skin protects the body from invasive bacteria, viruses, chemicals, and the sun. The middle layer is the dermis. It regulates body temperature; sweat glands are part of the dermis layer. The third later contains subcutaneous tissues that provide storage for fat, act as a cushion, and aid in the retention of heat.

SEE ALSO: Antibiotics; Birth Control; Carbon Dioxide; Chromosomes; Cloning; Disease; Food; Health; Malnutrition; Oxygen; Sex; Sexually Transmitted Diseases; Vaccination; Waste, Human; Water.

BIBLIOGRAPHY. Anne M. Agur, *Grant's Atlas of Anatomy* (Lippincott Williams & Wilkins, 2004); Ann Baggaley, Jim Hamilton, and Jane Perimutter, *Human Body* (DK Publishing, Inc., 2001); Deni Brown, *The Visual Dictionary of the Human Body (Eyewitness Visual Dictionary Series),* (DK Publishing, 1991); Carmine D. D. Clemente, *Anatomy: A Regional Atlas of the Human Body* (Lippincott Williams & Wilkins, 2006); Barbara Janson Cohen and Jason James Taylor, *Memmler's The Human Body in Health and Disease* (Lippincott Williams & Wilkins, 2005); Henry Gray, *Gray's Anatomy* (Barnes & Noble, 2000); Barbara Herlihy and Nancy K. Maebius, *Human Body in Health and Illness* (Elsevier Health Sciences, 2002); Armand Marie Leroi, *Mutants: On Genetic Variety and the Human Body* (Penguin Group, 2004); Joseph E. Muscolino, *The Muscular System Manual: The Skeletal Muscles of the Human Body* (Elsevier Health Sciences, 2004); Johannes W. Rohen, Chihira Jokochi, and Elke Lutien-Drecoll, *Color Atlas of Anatomy: A Photographic Study of the Human Body* (Lippincott Williams & Wilkins, 2006); Gary A. Thibodeau, *Anatomy and Physiology* (Times Mirror/Mosby College Publishing, 1987); Gerard J. Tortora and Bryan H. Derrickson, *Principles of Anatomy and Physiology with Brief Atlas* (John Wiley & Sons, 2005); Funk & Wagnalls, *Atlas of the Body* (Rand McNally & Company, 1980).

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Bolivia

THE HISTORY OF Bolivia has been one of resource extraction by outside powers, revolution, and countercoups. As a result of persistent instability and exploitation, the nation is one of the poorest and least developed in Latin America. Some 64 percent of the 8,857,870 live in poverty. Life expectancy (65.5 years) is low and the fertility rate is high (2.94 children per woman). With a per capita income of $2,700, Bolivia is ranked 164th of 232 nations in world incomes. The United Nations Development Project (UNDP) Human Development Reports rank Bolivia 113th of 232 countries on general quality-of-life issues. Although Bolivia is rich in natural resources, including tin, natural gas, petroleum, zinc, tungsten, antimony, silver, iron, lead, gold, timber, and hydropower, the benefits of resource development have predominantly flowed to a handful of corporations and important ruling families. Prices have been volatile for many resources, making sustained investment difficult. The controversial move to nationalize valuable natural gas fields is welcomed by most Bolivians as a effort to keep a higher share of profits in-country, though it is seen by foreign investors and free-trade advocates as serious error. Consequently, foreign aid is essential to Bolivia's economic survival.

Over 60 percent of the population lives in urban areas. Elsewhere, desperation often propels farmers into the business of illicit drugs. Currently, Bolivia is the third largest cultivator of coca in the world, and the number of hectares under cultivation increases regularly. Farming and raising livestock are often left to women and small children, who manage farms while males migrate to cities to seek employment. Overburdened and overworked, environmental protection is not a high priority for Bolivian farm women. Since the land is used year-round in order to survive, massive soil degradation occurs. Consequently, more land is needed to grow the same amount of crops. This practice, in turn, contributes to perpetual land shortage. Livestock, particularly goats that browse on trees and shrubs, also cause considerable environmental damage, stripping the land of essential vegetation.

Although landlocked, Bolivia has 8,817 square kilometers (14,190 square miles) of inland water, including Lake Titicaca. Located along the borders of Bolivia and Peru, Lake Titicaca is the world's highest navigable lake (6,122 kilometers [3,805 miles]). It is also the largest lake in South America (9,064 square kilometers [5,632 square miles]). Elevations in Bolivia vary from 145 kilometers (90 miles) at Rio Paraguay to 10,526 kilometers (6,542 miles) at Nevado Sajama. The climate varies according to altitude, ranging from humid and topical in the lowlands to cold and semiarid in the highlands. The terrain is also varied. The Andes Mountains are rugged with a highland plateau that gives way to hills. The Amazon Basin is made up of lowland plains. During March and April, northeastern Bolivia is prone to flooding. Droughts are also a threat. In 1983, for instance, a drought began that lasted into the 1990s, forcing many Bolivians from their homes.

A FRAGILE ENVIRONMENT

Much of Bolivia's environment is fragile. Forests have been stripped for their high-value timber, and slash-and-burn tactics have been employed to clear land. Such practices have also led to widespread deforestation and substantial soil erosion. Due to industrial pollution, Bolivia also suffers from a lack of fresh water for drinking, cooking, and irrigation. Some 28 percent of Bolivians have no sustained access to fresh drinking water, and 55 percent lack access to improved sanitation.

Other environmental problems include loss of biodiversity and desertification. The Bolivian government has protected 13.4 percent of the country's biologically diverse areas, such as the Chimán Forest and the Santa Cruz White and Black Rivers Wildlife Reserve. Of 316 endemic mammal species, 24 species are endangered, and 28 of the 504 endemic bird species are threatened with extinction. In 2006, a study at Yale University ranked Bolivia 71st of 132 nations on environmental performance. While Bolivia's ranking was above the relevant income group average, it was considerably lower than the average for the relevant geographic group. Bolivia's lowest scores were in the areas of air quality and environmental health.

Bolivia's current environmental policy is chiefly concerned with sustainable development. Policies are designed to ensure a healthier environment for all living things while promoting the economic growth that is essential to fighting poverty. Key objectives have been identified as improving environmental management, more responsible use of resources, forests, and ecosystems, and improving and monitoring environmental quality. The Institutional Network of Environmental Quality has been established to promote environmental quality, and the Unit of Social and Policy Analysis has been charged with evaluating and monitoring the rules and policies of the Strategy for Sustainable Development.

Bolivia has participated in the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands. The government has signed but not ratified the Environmental Modification, Marine Life Conservation, and Ozone Layer Protection agreements.

SEE ALSO: Cocaine; Deforestation; Land Degradation; Livestock; Poverty; Soil Erosion; Titicaca, Lake.

BIBLIOGRAPHY. James Aranibar, "Bolivia, Economic Performance and Social Issues from the 80's up to Date," www.nssd.net (cited April 2006); C.A. Bowers and Frédérique Apffel-Marglin, eds., *Rethinking Freire Globalization and the Environmental Crisis* (Lawrence Erlbaum, 2005); CIA, "Bolivia," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental* (ABC-CLIO, 2004); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); UNDP, "Human Development Reports: Bolivia," www.hdr.undp.org (cited April 2006); World Bank, "Bolivia," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Boll Weevil

IN 1892, NEAR Brownsville, Texas, a small beetle, identified by local agricultural authorities as the Boll Weevil, or *Anthonomus grandis,* made its first appearance in the United States. For the next century, the tiny insect would radically alter the South's agricultural economy by attacking the region's major crop—cotton. Many believe that the weevil was one of the most important agents of social change in the South, second only to the Civil War. The beetle's destructive wrath, coupled with a backwards agricultural system known as sharecropping, impoverished the southern states and prompted Franklin D. Roosevelt during the 1930s to label the South as the "nation's number one economic problem."

Although the boll weevil is indigenous to Mexico and Central America, it is an invasive species in the United States. At the time of its arrival, most of the South's agricultural lands were cultivated in cotton. Over the next 30 years, the ravenous beetle migrated eastward. By 1915, it was bearing down on Georgia. At the time of the beetle's entry into Georgia, approximately 5.2 million acres of the state's land was cultivated in cotton. The weevil's impact on the state could be observed eight years later when it was reported that only 2.6 million acres were devoted to cotton. The decline in cultivated acreage corresponded with a drastic reduction in yield. In 1914, for example, Georgia produced 2.8 million bales of cotton. By 1923, these numbers had been reduced to 600,000 bales, primarily due to the weevil. The story was the same across the Cotton Belt. In 1907, Mississippi produced 191,790 bales of cotton. Within only five years of the weevil's arrival, Mississippi farmers could barely generate 30,000 bales. During the height of the Great Depression in the 1930s, the South's estimates of damage due to the insect exceeded $200,000 annually. In 1950, the Cotton Belt set a historical record with losses topping over $750 million. By the end of the 20th century, the weevil had cost the region's cotton farmers an estimated $22 billion in losses and control efforts.

In order to survive, the boll weevil must have access to cotton. Adult weevils impact young cotton bolls (or squares) by feeding upon them and using them as a place to deposit their eggs. Actually, the damage done by feeding is minimal. It is the larval stage of the insect that is most devastating to cotton. Male weevils, after locating a cotton field, release a special pheromone to attract females. Thus, the presence of cotton is necessary to ensure the insect's propagation. Upon mating, females seek out a cotton boll in which to deposit an egg. Meanwhile, both males and females use their long snout to puncture the bolls and feed.

After mating, the female lays an egg (usually one per boll) in an abandoned feeding tube and covers it with a dark, sticky substance known as frass. Within the week, the egg hatches and a small, legless larva, or grub, emerges. For the next few days, the larva consumes the boll's internal tissues, after which it enters a pupation stage that lasts for about a week. At the end of the pupation period, an adult weevil emerges from the boll and immediately begins to seek out cotton and a mate.

The damaged boll yellows, withers, and drops. The entire life cycle (egg, larva, pupa, and adult) requires around three weeks to complete. A typical season may produce as many as eight to ten generations of weevils. To ensure the survival of the species, adult weevils over-winter in or adjacent to cotton fields, only to reemerge in the spring.

For most of the 20th century, the fight against the boll weevil produced only limited results. The struggle compelled many farmers to give up cotton and pursue other cash crops, like peanuts, tobacco, and vegetables. During the 1970s, however, scientists discovered ways to attack the insect through its own biology by developing pheromone lures and detection traps. The use of chemicals, particularly Malathion, has also been effective. Cultural practices, too, like the destruction of cotton stalks after harvest to deprive weevils of a winter habitat, have also been successful.

WINNING THE BATTLE

Today, cotton-producing states participate in the Boll Weevil Eradication Program (BWEP), which was first tried in North Carolina during the late 1970s. Basically, BWEP applies a three-pronged approach to weevil eradication: the spraying of Malathion, the use of pheromone lures and traps, and the destruction of cotton stalks. The early successes with the program prompted other states to participate. BWEP has had enormous success in eliminating the weevil from several states and some, like Georgia, Alabama, South Carolina, and North Carolina have declared themselves free of the insect. BWEP also boasts an environmental benefit. With the eradication of the weevil, the need for insecticides is greatly reduced, allowing farmers to rely more heavily on beneficial insects to control cotton pests.

SEE ALSO: Cotton; Insects; Invasive Species; Pesticides.

BIBLIOGRAPHY. P.B. Haney, W.J. Lewis, and W.R. Lambert, "Cotton Production and the Boll Weevil in Georgia: History, Cost of Control, and Benefits of Eradication," Georgia Agricultural Experiment Station, *Research Bulletin* (No. 428, November, 1996); J. Kim Kaplan, "We Don't Cotton to Boll Weevil 'Round Here Anymore," *Agricultural Research* (February 2003); John Leland, *Aliens in the Backyard: Plant and Animal Imports into America* (University of South Carolina Press, 2005); Phillip M. Roberts, "Boll Weevil," *The New Georgia Encyclopedia* (Georgia Humanities Council, 2004–2006); U.S. Department of Agriculture, "Boll Weevil Eradication," Aphis Factsheet, November 2001.

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Bookchin, Murray (1921–2006)

MURRAY BOOKCHIN (1921–2006) is best known as the founding figure of social ecology, a political and philosophical approach to radical environmentalism. As the author of dozens of books and countless articles, as a prolific public speaker, and as the founder of the Institute for Social Ecology, Bookchin's sphere of influence encompassed green political theory and environmental activism internationally.

Raised in the New York City in the 1930s, Bookchin grew up amongst radical politics and the labor movement; these working-class roots continued to inform his politics and philosophy for years to come. From the 1950s forward, Bookchin worked to bring together the cohesive political vision of the traditional Left with the new concerns of ecology, toxics, and biodiversity. His contribution mainly took the form of an immense body of writing, but he was also an active figure in grassroots anti-war, anti-nuclear, and environmental social movements since the 1960s. His influence was particularly important for various European Green parties, as well as the anti-nuclear movement known as the American Clamshell Alliance. Even during the retirement period before his death, Bookchin continued to write prolifically.

BOOKCHIN'S MAJOR WORKS

Bookchin's first major work, *Our Synthetic Environment* (1962), published under the pseudonym Lewis Herber, outlined a comprehensive critique of industrial capitalism's relation to the natural world. While Rachel Carson's *Silent Spring*, published at the same time, is often credited with sparking the nascent ecology movement in the United States, it was Bookchin's work that provided the seminal ideas that would eventually become radical ecology. *Post-Scarcity Anarchism* and *The Modern Crisis*, among other works, served as responses to the way the traditional Left movements in the United States had attempted to understand ecology and natural value. Bookchin emphasizes that the destruction of the natural environment stems from the same political and economic systems that oppress the working class, the developing world, and so on.

These ideas are developed further in *The Ecology of Freedom* and *The Philosophy of Social Ecology*, where Bookchin laid out the teleological philosophy behind social ecology. He argued that human sociality emerges directly from evolution's tendency toward increasing complexity and consciousness. In the context of Bookchin's leftist politics, this argument suggests that an objective basis for a free and just society can be found in nature itself. In practical terms, Bookchin advocated an approach to political organization he called *libertarian municipalism*.

As described in *From Urbanization to Cities and Remaking Society: Pathways to a Green Future*, this approach is based on a radical decentralization of power, allowing citizens direct access to all forms of political decision-making. Bookchin modeled this strategy on classic Greek democratic forms and New England town meetings, updated with an understanding of global environmental problems and appropriate technologies like solar energy and public transportation.

Since the 1980s, Bookchin frequently became entangled in sectarian controversies with other leftists and radical ecologists. In particular, he has taken a hard line against the philosophy and practice of deep ecology, associated with earth spirituality and the militant biocentric environmentalism of groups like Earth First! While these debates generated significant bitterness and divisiveness, Bookchin's ideas remain an important legacy for green political theory and practice.

SEE ALSO: Biocentrism; Earth First!; Social Ecology.

BIBLIOGRAPHY. Janet Biehl, ed. *The Murray Bookchin Reader* (Cassell, 1997); Murray Bookchin, *Anarchism, Marxism, and the Future of the Left: Interviews and Essays* (AK Press, 1999); Steve Chase, ed. *Defending the Earth: A Dialogue Between Murray Bookchin and Dave Foreman* (South End Press, 1991); Ulrike Heider, *Anarchism: Left, Right and Green* (City Lights, 1994).

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Boreal Forest

IN CONVENTIONAL GEOGRAPHIC terms, the boreal forest is a terrestrial biome encircling nearly the entire subarctic. In North America, the boreal forest lies predominantly within Canada, where it occupies a contiguous zone from the province of Newfoundland to the Mackenzie River delta in the Northwest Territories, extending as far south as central Ontario and Québec. Significant portions of boreal forest are also found in central Alaska. In Europe and North Asia, the boreal forest—or taiga forest—is equally impressive in size, spanning northern Scandinavia, northern Russia and Siberia, and the Kamchatka Peninsula. Although frequently represented as a vast wilderness, millions of people reside in the boreal forest. In Canada alone, just fewer than 4 million people are estimated to reside within the boreal forest, including well over 500 hundred First Nations communities and several large resource-dependent municipalities. The taiga in Eurasia is also very heavily populated.

RICH IN NATURAL RESOURCES

The boreal forest consists of mainly coniferous tree species, including fir, spruce, and tamarack. There are also deciduous tree species, such as trembling aspen and poplar, and large expanses of peat bog, especially in the northern latitudes. Sizeable herds of woodland caribou (reindeer in Eurasia) migrate throughout the boreal forest, as do large populations of black bears, grizzly bears, and timber wolves. Recent estimates suggest that in North America alone, over 4 billion migratory landbirds inhabit the boreal forest at the height of the summer breeding season. Topographically, the boreal forest varies from flat, lowland expanses in central and northern Canada and the Siberian lowland, to mountainous regions in western Canada and west-central Russia.

The boreal forest is among the world's most important sources of natural resources, and for this reason has become an object of environmental concern over the last few decades. Since roughly the early 1990s, environmental and conservation organizations have argued that excessive industrial resource extraction throughout the boreal forest is having a detrimental effect on the forest's capacity to deliver environmental services such as biodiversity, potable water and carbon storage. In 1997, these concerns were given additional gravitas when the World Resources Institute declared that the boreal forest comprises 50 percent of the world's remaining "frontier forest" and urged governments, civil society and industry to collectively halt the pace of boreal forest destruction. Subsequently, many North American and European conservation organizations began drawing public attention to the boreal forest through media campaigns and consensus-building activities. Similarly, many indigenous peoples' groups—including the Sámi people, the Lubicon Cree, James Bay Cree, and Deh Cho First Nations—have argued that excessive resource extraction in the boreal forest poses a significant threat to their cultural survival, since such activities are frequently carried out on their traditional territories and often infringe on their legal rights.

One noteworthy feature of boreal forest politics is that the forest is represented politically in different terms depending on the region in question. In Canada, many conservation groups recognize the importance of the Canadian boreal forest's carbon storage capacity, echoing the Intergovernmental Panel on Climate Change, which says that the global boreal forest contains 25 percent of the world's terrestrial carbon. They also place heavy emphasis on the protection of mammalian and avian biodiversity. In seeking some degree of boreal forest conservation, these groups have embraced an anthropocentric ideology that places an economic value on the ecosystem goods and services provided by the boreal forest. According to one recent estimate, the total value of ecosystem goods and services supplied by Canada's boreal forest in 2002 was $93.2 billion, while the total value of carbon stored in the boreal forest was valued at $3.7 trillion. These groups hope that policymakers will factor these figures into long-term land use planning decisions that affect the boreal forest, and as such, contribute to ecologically benign future development. In Canada, this approach to boreal forest conservation has resulted in an environmental political culture that emphasizes consensus building among numerous stakeholder groups. The Canadian Boreal Initiative, for instance, is currently brokering a social consensus that brings together First Nations, conservation groups and industry to negotiate a sustainable future for the boreal forest.

In Europe and North Asia, environmental groups articulate the taiga forest in somewhat different terms. While such "green developmentalism" is an important goal for many of these groups, they argue that taiga conservation cannot be implemented without addressing the underlying causes of taiga deforestation, such as illegal forest activity and government corruption. These groups seek to ensure that taiga forest products imported into the European Union conform to the highest environmental, social and governance standards.

SEE ALSO: Canada; First Nations; Forests; Russia

BIBLIOGRAPHY. Mark Anielski and Sara Wilson, *Counting Canada's Natural Capital: Assessing the Real Value of Canada's Boreal Ecosystems* (Canadian Boreal Initiative and Pembina Institute, 2005); Peter Blancher, *The Importance of Canada's Boreal Forest to Landbirds* (Canadian Boreal Initiative and Boreal Songbird Initiative, 2003); Dirk Bryant, Daniel Nielsen, and Laura Tangley, *The Last Frontier Forests: Ecosystems and Economies on the Edge* (World Resources Institute, 1997); Philip J. Burton, Christian Messier, Daniel W. Smith and Wiktor L. Adamowicz, (eds.), *Towards the Sustainable Management of the Boreal Forest* (National Research Council of Canada, 2003); David J. Henry, *Canada's Boreal Forest* (Smithsonian Institution Press, 2002).

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Boserup, Ester (1910–99)

ESTER BOSERUP WAS a Danish economist who studied economic and agricultural development. Her most notable work is *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (1965). Boserup presented her work as a "framework for a dynamic analysis embracing all types of primitive agriculture." She posited the theory that instead of agricultural output determining population size, population pressure was a precondition for the emergence and development of agricultural innovation and intensification, primarily among subsistence and peasant producers. Boserup described how societies with moderate population growth can increase agricultural productivity by investing additional labor and applying innovations to their farming systems, such as digging irrigation channels or building terraces. Her theory that population pressure stimulates agricultural innovations directly contradicted Thomas Malthus (1766–1834). Malthus, an English political economist, argued that increased food production triggered population growth, and that population growth would always outpace the food supply because population grows geometrically while the food supply grows linearly. Thus, population growth would outstrip agricultural output, eventually resulting in famine and population crash. This cycle was labeled the "Malthusian catastrophe."

CHALLENGING MALTHUS

Malthus's theory held sway for over a century until Ester Boserup's provocative thesis challenged his ideas. Drawing on Boserup's work, social scientists intensified their research into agricultural change. Anthropologists and geographers, most notably those studying swidden agriculture (closely related to shifting cultivation), sought evidence to test Boserup's thesis. Many scientists found that at low population densities, swidden agriculture was the most efficient way to produce food, in terms of workload and productivity. Following Boserup's model, it was demonstrated that with population growth, the swidden fallowing periods often became too short, fields became less fertile, and the workload increased, while productivity decreased. At this point, rather than collapsing into famine, societies developed ways to intensify agricultural production through innovation. In many cases, the innovations that supported increased populations came in the form of inputs, such as fertilizers, pesticides, and high-yielding crop varieties, technologies that Malthus could not have imagined in 18th-century England.

Many of the current debates on population and the environment trace their intellectual roots to Malthus or Boserup. For neo-Malthusians like Paul Erlich, author of *The Population Bomb* (1968), societies become mired in a cycle of high population growth, resulting in an inability to produce enough food. Ecological degradation inevitably follows this scenario. Boserup provided an alternative viewpoint in the current population–environment debate by arguing that population growth may stimulate agricultural intensification, thereby suggesting that population growth can ultimately have a benign or possibly even a positive effect on the environment.

Although Boserup's theory is generally considered oversimplified and too general, it has been supported by research on agricultural societies that are not fully integrated into market economies. However, in some of the world's poorest regions, such as sub-Saharan Africa, population pressures have outstripped food production, resulting in famines. Boserup's theory was not fully developed and cannot explain these contradictions. Geographers such as David Carr who examine the evolution of thought on population–environment theories believe that further research is necessary to understand under what conditions population pressure will lead to agricultural intensification, and whether or not this intensification will result in more or less environmental degradation.

SEE ALSO: Farming Systems; Malthus, Thomas; Malthusianism; Population; Shifting Cultivation.

BIBLIOGRAPHY. Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (G. Allen and Unwin, 1965); S. Brush and B.L. Turner II, eds., *Comparative Farming Systems* (Guilford Press, 1987); David L. Carr, "Proximate Population Factors and Deforestation in Tropical Agricultural Frontiers," *Population and Environment* (v.25/6, 2004); Paul Erlich, *The Population Bomb* (Buccaneer Books, 1995 [1968]); D. Grigg, "Ester Boserup's Theory of Agricultural Change: A Critical Review," *Progress in Human Geography* (v.3/1, 1979); Thomas Malthus, *An Essay on the Principle of Population* (Oxford, 1999 [1798]); B.L. Turner II, Robert Hanham, and Anthony Portataro, "Population Pressure and Agricultural Intensity," *Annals of the Association of American Geographers* (v.67/3, 1977).

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Bosnia and Herzegovina

IN 1992, BOSNIA and Herzegovina declared independence when the former Federation of Yugoslavia broke up into smaller nations. The move was followed by an extended period of ethnic conflicts among the new countries. Peace efforts in 1994 led to the creation of the Federation of Bosnia and Herzegovina. With a total land area of 51,129 square kilometers, Bosnia and Herzegovina supports a population of 4,025,476 people.

Most areas experience hot summers and cold winters; but in higher elevations, the summers are short and cool while the winters are severe. Rain is frequent along the 20 kilometers of Adriatic coastline. The most common environmental problems include air pollution from the numerous metallurgical plants, a shortage of urban waste disposal sites, deforestation through illegal logging, water shortages, and destruction of the infrastructure. Destructive earthquakes are not uncommon. Protracted war and conflict has also left hazards behind, including an estimated 1,000,000 land mines that dot the landscape.

Bosnia and Herzegovina is rich in natural resources that include coal, iron ore, bauxite, copper, lead, zinc, chromite, cobalt, manganese, nickel, clay, gypsum, salt, sand, and hydropower. With over 40 percent of the land area of Bosnia and Herzegovina forested, the nation has the third-largest forest reserve in Europe. However, large areas of forests are steadily being lost to illegal logging and other forms of uncontrolled exploitation. Such disturbances to the environment have led to massive landslides that have changed the course of the Bosna River and to soil erosion and fire destruction. Little is being done to counteract this destruction because of a weak infrastructure, even though the forests of Bosnia and Herzegovina are home to the majority of the 72 species of mammals that are endemic to the area. As a result, 10 species are threatened with extinction. Likewise, three species of the 206 bird species endemic to the area are threatened.

Despite potential for growth, Bosnia and Herzegovina is the second poorest nation among the former Yugoslav countries, outranked only by Macedonia. Agricultural output contributes 14.2 percent of the Gross Domestic Product, but farms tend to

Stari Most

The Stari Most ("Old Bridge") across the river Neretva in Mostar, Bosnia, was built between 1557 and 1568 by the Turks after having been commissioned by Suleiman the Magnificent to replace a wooden suspension bridge. The first span of the stone bridge collapsed, and the Sultan told Mimar Hayruddin, the architect and a student of the famous architect Sinan, that he would lose his head if the next span also collapsed. As no time limit was given, the architect decided to stall. However, the architect was worried that the new span might collapse when the scaffolding was removed, so he fled and was found digging his own grave when the locals went to look for him. On its completion, the bridge was said to have been the largest single span arch bridge.

The bridge is 4 meters wide, 30 meters long, and 24 meters above the river. It did not have any foundations, but has abutments made from limestone, which are against the cliffs on either side of the river. There has been some academic debate over how the scaffolding across the river was erected in the first place, how it was possible to have the tenelija stone transported from one bank of the river to the other, and how the scaffolding survived during the long period before it was removed.

The bridge remained one of the most famous sites of Bosnia-Herzegovina, appearing on many postcards from the 1890s onward. Each year men jumped from the bridge into the cold Neretva River, and tourists visited it regularly from the 1930s. During the war in Bosnia-Herzegovina from 1992–1995, Croat militia were keen on taking control of Mostar and blew up the bridge with artillery fire in order to split the Bosnian-held left bank from territory they held on the right bank. The bridge was rebuilt in 2004 and reopened on July 22, 2004, looking much like its predecessor but strengthened with a reinforced concrete core.

be small and inefficient. Therefore, most food is imported. With a 45.5 percent unemployment rate and a poverty rate of 25 percent, environmentalism often takes a back seat to economic concerns. At present, around 44.4 percent of the population is urbanized, but that percentage is expected to rise over the next decade. Two percent of the population lacks access to safe drinking water, and seven percent lack access to improved sanitation. The United Nations Development Project (UNDP) Human Development Reports rank Bosnia and Herzegovina 68th in quality-of-life indicators.

Because of its recent history of strife, Bosnia and Herzegovina is still establishing institutions, and the country is only slowly finding its path to a consciousness of environmentalism. This is reflected in the lack of a legal framework to regulate the use and protection of natural resources. Additionally, the government lacks funding for programs that promote environmental responsibility and for oversight. Bosnia and Herzegovina has no water treatment plants, and waste treatment plants are inefficient.

The drafting of environmental laws is now underway, and some international groups have stepped in to promote environmentalism. For instance, Project Highlight, sponsored by PM, a multinational project and construction management company, is working with the Ministries of Environment on developing environmental policies that are cost effective and in enacting environmental legislation that meets European Union standards. PM is also involved in raising public awareness, training officials, and providing technical support for environmental policies and programs. For its part, the government of Bosnia and Herzegovina has announced its commitment to the environment through participation in the following international agreements: Air Pollution, Biodiversity, Climate Change, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, and Wetlands.

SEE ALSO: Deforestation; Earthquakes; Soil Erosion; Wars.

BIBLIOGRAPHY. "Bosnia and Herzegovina: State of the Environment 1998, www.enrin.grida.no (cited March 2006); CIA, "Bosnia and Herzegovina," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Jurg Klarer et al., eds., *Source Book on Economic Instruments* (Sofia Initiative on Economic Instruments, 1999); One World, "Bosnia and Herzegovina," www.uk.oneworld.net (cited March 2006); PM, "Bosnia and Herzegovina," www.pmg.ie (cited March 2006); UNDP, "Human Development Reports: Bosnia and Herzegovina," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Bosnia and Herzegovina," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006); Ilda Zornic, "Loggers Destroying Bosnia's Forests," 12 January 2005, www.armeniatree.org (cited March 2006).

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Botany

BOTANY IS THE study of plants. Botanists study all aspects of plants, including their environment and how they grow. It is closely associated with agriculture, horticulture, and pharmacology. Botany is one of the oldest of sciences. From early human history, people have gathered plants for medicine or food. Folklore in the earliest of human societies was passed on for generations. Medicine men or women practiced the development of remedies for diseases and injuries, as well as intoxicants. With the development of farming about 12,000 years ago, horticultural plant knowledge also began to move toward a body of knowledge. Ancient civilizations of the Egyptians, Indians, and Babylonians coined names for the plants they knew. The Greeks added descriptions to plant names. Aristotle, his student Theophrastus (*An Inquiry into Plants*), and Galen the physician gave descriptions to the names. Aristotle sought for the unique form or idea that is found in each plant. This basis would eventually aid the development of taxonomy of plants.

There are hundreds of thousands of plants around the world. They vary widely, even when related.

Because of this variation, it was necessary to develop a standardized nomenclature to aid a precise science. Latin, the language of scholarship until the 20th century, was used for the taxonomy to assign a universal name to plants with different common names or national names in the many European languages. The use of Latin, a dead language, prevents changes in names that would occur in a living language, thereby creating lasting scientific precision. The scientific naming has a fixed pattern in which the first name identifies the genus to which a plant belongs. The second name is the species name, which denominates precisely in which one of the subgroups it is a member. Each genus is a unique class with each of its species also a unique group. The commonly named orange tree has a scientific name of *Citrus sinensis*, of which naval and Valencia oranges are varieties. Field guides for a particular region may include common names to aid in identification.

Other features of plants not only aid it identification and naming, but also are studied in order to understand the nature and possible uses of plants. These features of plants studied by botanists include plant physiology, cytology and histology; morphology; genetics; pathology; plant ecology; and economic botany.

Physiology in botany is the study of plant survival activities, such as how plants make and use food, how the cells of a plant enable it to grow, how the plant reproduces, and how the plant is influenced by heat, light, and moisture. The way that plants metabolize materials as food in order to grow is a central part of botany. For example, trees breathe in carbon dioxide and exhale oxygen, which in turn is breathed by humans and animals. Photosynthesis is the process used by plants to make green chlorophyll, which animals and humans eat.

Botanists also study how plants make chemicals. Alfalfa, clover, peanuts, and other plants produce nitrogen compounds that aid plant growth and ultimately also fertilize the soil. Their symbiotic relationship with Rhizobia bacteria are similar to other types of symbiotic relationships plants have. Histology is the study of the different kinds of cells and how they are arranged in different plants, and cytology focuses on the specific nature of plant cells.

Plants range from single-cell, very complex arrangements of cells into soft green leaves, seaweed, or into very hard tropical trees like mahogany. Cytology and histology are subdisciplines of plant morphology, which is the study of the form and structure of plants. Morphology is organized around the taxonomy of plants. This part of botany seeks to understand how a plant grows and lives. The goal is to place new plants into an organized taxonomy.

Many gardeners seek to breed a flower with a unique beauty, new color, or some other characteristic.

Plant genetics focuses on the laws of genetic reproduction to describe how plants transmit their characteristics to their offspring. Many gardeners seek to breed a rose that may be an ideal beauty, or a flower with a new color or some other characteristic. University botanists may be seeking to selectively breed a more productive type of tomato or corn plant using genetic knowledge of each plant.

Plant pathology has a number of causes. The most damaging pathogens are viruses, bacteria, fungi, and molds. Other causes may be exhaustion of the soil or weather. Plant pathogens may also be toxic to humans if the infected plants are eaten. To prevent crop loss, plant pathology includes the study of ways to fight or prevent plant diseases. Genetics may be used to develop strains of plants resistant to infection, or medicinal fungicides or other treatments may be used. Some botanists seek to apply their knowledge to all segments of agriculture. They specialize in making rapid, accurate, and scientifically sound diagnoses and management strategies for all types of plant health problems.

Plant ecology studies the relationship between plants and their spatial location. Also important to plant ecology are studies of how plants grow (or do not grow) together in different climates or regions such as mountains, deserts, swamps, seashores, river bottoms, or under the sea. Knowledge of plant ecology can be very helpful in aiding recovery of the natural health of an area. For example, the nutria (*Myocastor coypus*), a large fur-bearing rodent that has become an invasive species in Louisiana, Maryland, and elsewhere, destroy wide areas of marshland by eating the roots of marsh grasses. Promoting the marsh grass recovery is important, because the marshes are vital sea life breeding areas.

Economic botany is the application of botanical knowledge. It involves research to adapt plants to human use for food, fertilizer, medicine, or for other benefits such as grass on golf courses. It also seeks to develop practical knowledge of all aspects of plants. Botany is also related to many other sciences such as soil science, chemistry, geography, mathematics, and physics. All the sciences and businesses that use botanical knowledge benefit from pure botanical research.

SEE ALSO: Drugs; Ecology; Food; Genetically Modified Organisms (GMOs); Plants.

BIBLIOGRAPHY. R.L. Bonnet and G.D. Keen, *Botany: 49 Science Fair Projects* (Tab Books, 1989); T.J. Elpel, *Botany in a Day: The Patterns Method of Plant Identification* (HOPS Press, LLC, 2004); W.H. Lewis, *Medical Botany: Plants Affecting Man's Health* (John Wiley & Sons, 1977); Randy Moore, *Botany* (Wm. C. Brown, 1995); Murray Nabors, *Introduction to Botany* (Benjamin Cummings, 2003); William Stearn, *Botanical Latin* (Timber Press, Inc., 2004); K.M. Van de Graff and J.L. Crawley, *Photographic Atlas for the Botany Laboratory* (Morton Publishing Company, 2004).

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Botkin, Daniel B.

THE ECOLOGIST DANIEL B. Botkin has worked and published on forest and wildlife ecology for many decades, and developed one of the first computer simulation models in ecology. His best known work is *Discordant Harmonies: A New Ecology for the 21st Century* (1990). Botkin forcefully argues against the myth of the balance of nature, which he claims has permeated environmental thinking since antiquity. Illustrated by many case studies, Botkin shows that this balance has never existed, and that "wherever we seek to find constancy we discover change." It is not only impossible to preserve unchanging "natural" landscapes, but attempts to do so can actually have disastrous consequences. Thus at Tsavo National Park in Kenya, the elephant population first grew to completely destroy the existing tree population, then collapsed itself after a devastating drought.

Botkin does not argue that all environmental management should be abandoned, or that all environmental change is desirable. Rather, "the key to a new but wise management of nature is to accept changes that are natural in kind and in frequency, to pick out the melodies from the noise." This, he believes, will be possible through more careful data collection and more sophisticated analysis and modeling that take complexity into account.

Disequilibrium ideas are further explored in all of Botkin's subsequent writings, including historical studies of Lewis, Clark, and Thoreau's nature observations as well as a series of consultancy reports. They also influence his thinking on climate change. While deeply concerned about the effects of climate change on biodiversity, Botkin has pointed out that predictions about these effects may be misleading if based on assumptions of otherwise stable conditions.

Botkin's accessible writing and many other activities have played a key role in spreading disequilibrium ecology beyond the science of ecology, amongst both social scientists concerned with the environment and environmental management practitioners. In the social sciences, where popular equilibrium thinking has been quite persistent, many different authors are beginning to draw on Botkin and new ecology ideas, in particular in political ecology and environmental history. In environmental management, there are several hurdles that make the translation of disequilibrium theory into practice difficult. For one, conservation continues to be dominated by territorial approaches, the preservation of whole landscapes, which hinder a radical reorientation. If there is no longer a given "natural" landscape, decisions over what should be preserved become even more political. Moreover, there is, in most places, simply not the kind of long-term data available that would be necessary for proper disequilibrium management—in fact, as Botkin himself has frequently pointed out, there is often astonishingly little ecological data altogether used in environmental management.

Having said this, Botkin's suggestions for a different kind of ecological science and management are now widely discussed in the conservation world and have been integrated into practice in some instances. One example is the adoption of let-burn policies on natural fire disturbances, in which Botkin's work has been very influential. Another is Botkin's own study on salmon in Oregon, which led to the adoption of a different management approach.

SEE ALSO: Climax Communities; Disequilibrium; Equilibrium.

BIBLIOGRAPHY. D. Botkin, *Discordant Harmonies. A New Ecology for the 21st Century* (Oxford University Press, 1990); D. Botkin, *Our Natural History: The Lessons of Lewis and Clark* (Putnam, 1995); D. Botkin, *No Man's Garden: Thoreau and A New Vision for Civilization and Nature* (Shearwater Books, 2000); Lindsey Gillson and Katherine J. Willis, "As Earth's Testimonies Tell: Wilderness Conservation in a Changing World," *Ecology Letters* (v.7, 1998); Ian Scoones, "New Ecology and the Social Sciences: What Prospects for a Fruitful Engagement?" *Annual Review of Anthropology* (v.28, 1999).

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Botswana

THE REPUBLIC OF Botswana is located in southern Africa, between South Africa, Namibia, Zimbabwe, and Zambia. Botswana covers 600,370 square kilometers (231,803 square miles), equivalent to an area twice the size of Arizona. Formerly the British protectorate of Bechuanaland, Botswana adopted its new name upon independence on September 30, 1966. The country is named after the dominant ethnic group, the Tswana. Botswana has a population of 1,765,000 people, with 195,000 living in Gaborone, the capital city.

Botswana is the oldest democracy in Africa, with four decades of civilian leadership, a pluriform multiparty system, progressive social policies, and significant capital investment. As one of the Frontline States, Botswana played an influential role in countering the former apartheid government of South Africa.

Botswana has one of the most dynamic economies in Africa, characterized by the most rapid growth in per capita income in the world since 1966. The economy is strong, with one of the highest credit ratings of any African country. Botswana has a proven record of good economic governance and is ranked the least corrupt country in Africa. The economy is dominated by the mining sector, with Botswana being the largest exporter of gemstone diamonds in the world. Other minerals, including copper, nickel, salt, soda, ash, and potash, are also extracted. Livestock production is also an important part of the economy, as Botswana is the largest exporter of beef to the European community. Only 0.6 percent of the land in Botswana is farmed, and major crops include sorghum, maize, millet, and groundnuts. Another source of revenue is tourism, which is a growing sector due to the abundant number of large game that are protected in parks and reserves that cover 15 percent of the country.

Botswana has the second-highest rate of HIV/AIDS infection in the world (after Swaziland) with 37.5 percent of the total population infected. This has resulted in a decline in the average life expectancy to 33.7 years (the lowest in the world) as well as a nonexistent growth rate in population. However, Botswana also has one of Africa's most progressive and comprehensive programs for dealing with the disease. While English is the official language, there are several local dialects reflecting various ethnic groups, including Setswana (spoken by the Tswana, who make up 79 percent of the population), Kalanga (11 percent), and Basarwa (3 percent). Half of the country has indigenous religious beliefs, while 30 percent are Christian, and the remaining 20 percent observe other religions. Literacy rate is 80 percent.

GREAT WILDERNESS AREAS

Two of Africa's great wildernesses, the Kalahari Desert and the Okavango Delta, are found in Botswana. The Kalahari covers nearly 70 percent of the country. While Botswana is landlocked, 2.5 percent of the country is covered in water with most of it in the Okavango Delta, the world's largest inland delta. In addition to the desert and delta, there is a large saltpan in the north (the Makgadikgadi) while the rest of the country is covered in rolling hills of grasslands and savanna. These diverse habitats are one reason for the rich fauna in the country, including the Blue Wildebeest and antelope. Three environmental issues facing the country are desertification, overgrazing, and limited sources of fresh water.

SEE ALSO: Desertification; Kalahari Desert; Overgrazing.

BIBLIOGRAPHY. Central Intelligence Agency, *The World Factbook*, (Central Intelligence Agency, 2006); Economist Intelligence Unit (EIU). *Country Report: Botswana*; (EIU, 2006); John F. McCoy, *Geo-data: The World Geographical Encyclopedia* (Thomson-Gale, 2003).

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Bovine Growth Hormone

BOVINE GROWTH HORMONE (also referred to as recombinant bovine growth hormone, rbGH, or recombinant bovine somatotropin, rbST) is a genetically engineered version of a hormone that occurs naturally in cows. When injected into cows, it can increase milk production by between 15 and 25 percent. Consumer organizations, animal welfare groups, environmental groups, and small farmers' organizations have opposed the use of bovine growth hormone due to its potential threats to food safety, cow health, and the economic viability of small farms.

The Monsanto corporation began experimenting with rbGH in the 1980s. Their rbGH product, Prosilac, was approved by the U.S. Food and Drug Administration for commercial sale and use on November 5, 1993. But the approval process and subsequent use of rbGH have been surrounded by controversy. Studies have shown that the use of rbGH can cause a number of health problems in cows including lameness, diminished fertility, and an increased risk of mastitis (udder inflammation). Mastitis is usually treated with antibiotics, which can make their way into dairy products, thus increasing health risks for consumers. Concerns have also been raised about the relationship between rbGH use and increases in another hormone found in cows, insulin growth factor or IGF-1, which, while naturally found in milk and beneficial to human health, has also been linked to certain forms of cancer. Scientific reports have yielded conflicting conclusions about the broader health impacts of rbGH use.

Consumer organizations such as the Center for Food Safety and the Organic Consumers Association have charged that there was inadequate testing of the drug prior to its approval and that health consequences, including cancer risks, have been underestimated. Some charge that Monsanto used political influence to usher through the approval of the growth hormone in the United States, and that the corporation covered up evidence of its dangers. A major controversy erupted, and a series of lawsuits were filed over a Fox News report on bovine growth hormone (BGH) that Monsanto sought to suppress.

Political conflicts have also erupted over the labeling of products made from cows treated with

BGH. In an industry victory in 1997, a federal court struck down a Vermont law that required labeling for dairy products made with milk from BGH-treated cows. Voluntary labeling is still allowed in most states, and some dairy producers indicate on labels that their products were produced from cows that have not been treated with the hormone.

Resistance to BGH and genetic engineering in general has been even stronger in Europe and Canada than in the United States. The European Union placed a moratorium on the use and marketing of rbST in 1990, and in 1999 imposed a permanent ban. Health agencies in Europe and Canada place more weight on the evidence suggesting human health risks of the growth hormone. Public opinion in Europe is also strongly against genetically modified products. The United States sought to overturn the European ban for the purposes of marketing U.S. goods. However, when Codex, an international organization that sets food standards, failed to reach consensus on the safety of BST in 1999, the United States backed off on its efforts to force these goods onto the European market.

Concern about the implications of the use of growth hormones for small farms is also significant in Europe and America. There is no shortage of milk, thus increased production resulting from the use of synthetic hormones threatens to lower milk prices and harm small producers. Resistance to rBGH has been particularly strong in dairy farm states such as Wisconsin and Vermont.

There is no shortage of milk, so increased production due to synthetic hormones threatens to lower milk prices.

SEE ALSO: Agriculture; Animal Rights; Cattle.

BIBLIOGRAPHY. Andy Coghlan, "Milk Hormone Faces Growing Opposition," *New Scientist* (January 23, 1999); Diane Gershon, "Prospects for Growth Hormone Turn Sour," *Nature* (v.364/6438, 1993); Deana Grobe and Robin Douthitt, "Consumer Risk Perception Profiles Regarding Recombinant Bovine Growth Hormone (rbGH)," *Journal of Consumer Affairs* (v.33/2, 1999); Kevin Edson Jones, "Constructing rBST in Canada: Biotechnology, Instability and the Management of Nature," *Canadian Journal of Sociology* (v25/3, 2000); U.S. Food and Drug Administration, Center for Veterinary Medicine, "Report on the Food and Drug Administration's Review of the Safety of Recombinant Bovine Somatotropin," www.fda.gov (cited April 2006).

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Bovine Spongiform Encephalopathy

BOVINE SPONGIFORM ENCEPHALOPATHY (BSE) is a communicable, chronic, degenerative, and fatal disease that predominantly affects the central nervous system of cattle. Affected animals' brain tissue becomes increasingly damaged by lesions of sponge-like holes that commonly cause animals to exhibit behavioral symptoms such as dementia, aggression, lack of balance, and excessive salivation. As a result, BSE has become more popularly known as "mad cow disease." During the early 1990s, a "mad cow" epidemic emerged in the United Kingdom (UK) and then spread throughout Europe, decimating beef industries in affected nations and terrifying populaces. While it is believed that the disease has presently leveled off considerably due to stricter livestock testing and policy changes designed to limit BSE's contagious viability, new cases of BSE continue to appear in nations previously unaffected by the disease, such as the United States.

BSE is one of a class of brain diseases classified as Transmissible Spongiform Encephalopathies (TSEs) that are contracted by human and non-human animals. Non-human TSEs also include Chronic Wasting Disease in deer and elk, Transmissible Mink Encephalopathy, Feline Spongiform Encephalopathy, and Scrapie found in goats and sheep. Human TSEs include Kuru, Gerstmann-Straussler-Scheinker Syndrome, Fatal Familial Insomnia, and Creutzfeldt-Jakob disease. Notably, in 1996, a new variant of Creutzfeldt-Jakob disease (vCJD) was diagnosed, and while it has never been proven that BSE directly causes vCJD, many experts now believe that vCJD results when BSE crosses the species barrier and achieves human transmission. Unlike many other infectious diseases that are transmitted by virus or bacteria, TSEs are believed to be caused by misshapen, self-replicating body proteins called prions, and TSEs are spread through contact with prion-infected tissue or fluids, particularly through consumption. Unlike most bacteria and viruses, however, prions are believed to survive normal refrigeration and cooking procedures. Thus, it is believed that vCJD generally occurs after persons have eaten meat infected with BSE.

PROPAGATION AND ORIGINS

BSE has been greatly propagated due to the widespread adoption of controversial factory farm feeding practices, in which slaughterhouse waste by-products, often described as "meat and bone meal" (MBM), are incorporated into cattle feed as a protein additive in order to generate weight gain in livestock. This practice resulted in the mass propagation of the disease when MBM from infected herds was utilized as feed. Technically, such feeding practices have existed since the early 20th century, but it is only over the last few decades with the rise of factory farms as agro-industry standards that MBM feeding became truly ubiquitous for millions of animals. Thus, while it is possible that BSE has been transferred between individual animals for some time via MBM, it is only since the 1970s that agricultural conditions have existed that would allow for the development of a BSE epidemic on national and global levels.

The origins of BSE remain mysterious. One leading theory purports that BSE originated when sheep infected with Scrapie were fed to cattle, which were in turn rendered and then fed to other cattle, thereby resulting in a mutated BSE prion. However, a competing theory claims that the disease developed spontaneously. The British government, for instance, maintains that BSE arose spontaneously in a small number of UK cattle sometime during the 1970s. Those favoring the theory of spontaneous origin also point to the discovery in Italy during 2003, and in countries such as France and the United States, of an apparently new form of BSE-causing prion. The disease associated with this prion has been named Bovine Amyloidotic Spongiform Encephalopathy (BASE), but scientists note that, except for the different mutations between the BASE and BSE prions, the two diseases are largely equivalent in terms of their prognosis. This has led some to believe that BASE is a spontaneous strain of BSE that developed outside of the United Kingdom.

While BSE has been discovered in some 35 countries, it is perhaps most closely linked to the UK. Authorities in the UK first officially identified BSE during 1986. Over the next 15 years, more than 180,000 animals contracted the disease, and billions of dollars in damage was done to the British cattle industry as international bans on the importation of British beef products ensued. The resulting public alarm led to a mass cull of over four million head of asymptomatic cattle in an attempt to ensure safety, and in 1988 the British government became the first of many nations to ban the use of ruminant proteins in the manufacture of animal feed. A year later, they enacted a ban of specified bovine offals, such as ruminant brain, spinal, and intestinal meat, for human consumption. By 1993, the worst of the epidemic was over in the UK, but the export of British cattle and MBM had begun to seed BSE in many other countries. Then, beginning in 1995, the first of about 160 people began to die of vCJD, and studies began to predict the emergence over time of thousands of additional cases. As the British government had repeatedly promoted the safety and quality of British beef throughout the preceding decade's crisis, sometimes in opposition to its own scientific findings, critics charged that the government consciously put public health in jeopardy in order to stabilize the large economic losses suffered by the beef industry.

TESTING AND PREVENTION

In the United States, consumer groups argue that the government uses inaccurate tests and small testing samples, as well as lax MBM regulation policies and enforcement practices. Stanley Prusiner, who won a Nobel Prize in 1997 for his work on BSE, has called for U.S. testing to mirror standards achieved by Japan and the European Union (EU). Japan tests all cattle slaughtered for human consumption and every suspect farm animal, totaling some 1.2 million cattle annually at a cost of over $30 million. Likewise, the EU tests all slaughtered cattle older than 30 months and all nonambulatory livestock older than two years, involving more than 10 million animals annually at a yearly cost of $300 million. Meanwhile, the United States seeks only random testing of sick and nonambulatory cattle, which would involve a mere 20,000 animals at a cost of around $500,000 per year. Considering that monetary losses to a nation's beef industry often run into the billions when BSE is discovered, stringent testing standards may prove prudent. Many nations may lack the political will to create such policy, though, especially when BSE and vCJD epidemics no longer dominate the headlines. Still, the disease continues to evolve, and the conditions that gave rise to an epidemic may continue to exist.

SEE ALSO: Bovine Growth Hormone; Cattle; Chronic Wasting Disease; Disease; Ranchers; Transmissible Spongiform Encephalopathies.

BIBLIOGRAPHY. Paul Brown, et al., "Bovine Spongiform Encephalopathy and Variant Creutzfeldt-Jakob Disease: Background, Evolution, and Current Concerns," *Emerging Infectious Diseases* (v.7/1, 2001); Sheldon Rampton and John Stauber, *Mad Cow U.S.A.* (Common Courage Press, 2004); Peter Smith and Ray Bradley, "Bovine Spongiform Encephalopathy and its Epidemiology," *British Medical Journal* (v.66/1, 2003); Maxime Schwartz, *How the Cows Turned Mad* (University of California Press, 2003); Patrick Van Zwanenberg and Erik Millstone, "BSE, A Paradigm of Policy Failure," *Political Quarterly* (v.74/1, 2003).

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Braudel, Fernand (1902–85)

FRENCH HISTORIAN Fernand Braudel taught in Algeria and Brazil, and from 1937 at the École Practique d'Hautes Études of Paris. In 1947 he entered as faculty in the College de France and became one of the most relevant figures of the so-called French Annales School of History, named for the journal *Annales d'Histoire Économique et Sociale,* continuing the tradition pioneered by Marc Bloch and Lucien Febvre, who together founded the journal in 1929.

Braudel's most important work is *The Mediterranean and the Mediterranean World in the Age of Philip II* (first published in French in 1949 and considerably expanded in the second edition of 1966). *The Mediterranean* (written while Braudel was in a German prisoner-of-war camp) offers an innovative view of history articulated in three movements, characterized by different evolutionary rhythms. First, in what he called the *Longue Durée,* was the history of the slowly unfolding relationships between the humans and their geographical environment. This part owed much to the world on French regional geography of Vidal de la Blache that had come to Braudel through the work of Lucien Febvre and was profusely illustrated by maps. On top of this "geohistory," Braudel placed an economic and social history of people and their relationships (mostly based on circulation and not on production), and finally, he situated political history, in which individual figures acquired more protagonism. Braudel thus reunited Vidal de la Blache with Durkheim and Weber, and with the more conventional history of great individuals.

The first part of *The Mediterranean* offers a prime example of a classical interpretation of the geography of this sea and its peoples, emphasizing the common elements (physical and human) of a

Mediterranean environment, especially the relationships between mountains, valleys, islands, and the people inhabiting them. Braudel shows how on some occasions, the Mediterranean islands are insular, but on others, they open up to foreign influence and actively participate in the progress of commerce and politics.

Braudel's approach and that of the Annales School in general had wide appeal because it represented a well-articulated alternative to historical materialism. In fact, Braudel was highly critical of Marx and Marxist historians, whom he defined as determinists. For Marx, Braudel would say that history is flat, whereas for Braudel, history has a temporal and geographical thickness. However, Braudel always refused to enter into the study of economic relationships.

Between 1967 and 1969, Braudel published another ambitious work, the three-volume *Material Civilization, Economy and Capitalism: 15–18th Centuries*. The first volume, *The Structure of Everyday Life,* focused on demography and the conditions of livelihood. The second centered upon *The Wheels of Commerce* and the third on *The Perspective of the World,* or the time in which Europe unified the world to its profit. The concept of the world economy was later developed by Braudel's disciple Immanuel Wallerstein. His final work was *The Identity of France* (published posthumously in three volumes). The first volume, titled *History and Environment,* uses again the geohistorical approach of *The Mediterranean,* and geography is brought in to explain the French identity.

SEE ALSO: Geography; Historical Materialism; Marx, Karl.

BIBLIOGRAPHY. Felipe Fernandez-Armesto, *Civilizations: Culture, Ambition, and the Transformation of Nature* (Simon & Schuster, 2002); John A. Marino (ed.), *Early Modern History and the Social Sciences: Testing the Limits of Braudel's Mediterranean* (Truman State University Press, 2002); Immanuel Maurice Wallerstein, *End of the World as We Know It: Social Science for the Twenty-First Century* (University of Minnesota Press, 2001).

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Brazil

BRAZIL IS THE largest country in South America, covering an area of 8.5 million square kilometers and with a population of approximately 170 million people, according to the 2000 census. Brazil encompasses several distinct biomes, notably some 4 million square kilometers of the Amazon basin, as well as the Atlantic forest (which once covered some 1.4 million square kilometers) and the Pantanal, the world's largest interior wetland (110,000 square kilometers).

Human occupation in what is now Brazil appears to have begun at least 11,500 years ago, based on pottery shards found in the Amazon. Estimates of the indigenous population of Brazil upon European contact in 1500 have ranged widely, and recent estimates have been higher, up to 5 million. The higher estimates are based on growing evidence of greater pre-Columbian environmental alterations than previously recognized.

The Portuguese discovery of Brazil led to colonization efforts beginning in the 16th century. This led to a series of boom-bust economic cycles, each featuring a specific natural resource exported to Europe by the colonizers. The first product was Brazilwood, used for dye; this went into decline by 1600. Sugar plantations had emerged along the Atlantic coast by then, and this stimulated forest clearing and conflicts and enslavement of indigenous peoples. In the late 19th century, coffee became the preeminent export product.

Consequently, railways spread across São Paulo and other states of southern Brazil, enabling expansion of the agricultural frontier. This facilitated forest clearing in the Brazilian interior, which provided fuelwood for coastal Brazilian industry in the early 20th century. Interior colonization and incipient industrialization thus greatly reduced Brazil's indigenous population, as well as the Atlantic forest.

After World War II, new medical technologies facilitated population growth by reducing mortality, prompting rural-urban migration and the expansion of an industrial workforce. Brazil's urban populations, especially in its largest cities, grew rapidly. This proceeded via unplanned construction of new housing in the peripheries of many towns, resulting in considerable pollution via untreated disposal of raw human waste as well as accumulation or burning of garbage. A notable exception to this pattern is the city of Curitiba, which beginning in the 1960s planned its urban expansion via zoning measures and waste management.

Brazil's military took control of the government in 1964 and embarked on policies of "authoritarian capitalism" that paired repression of labor unions with incentives for industrial development and frontier expansion into the Amazon. Brazil's economic growth accelerated in the late 1960s, called The Brazilian Miracle, but industrial pollution also rapidly increased. The industrial town of Cubatão subsequently became infamous for its extremely polluted air and water, as well as its high rates of cancer and birth defects.

By the late 1970s, economic growth slowed and Brazil's financial status worsened, eventually leading to democratic elections in the 1980s. However, growing environmental problems were overshadowed by Brazil's economic crisis. Civilian politicians focused primarily on national development rather than environmental protection. Large projects, such as the Carajás iron mine in the Amazon and the hydroelectric dam at Iguaú Falls, were given priority.

Nonetheless, 1988 proved to be a bellwether year, as demonstrations and lobbying in the national capital of Brasília led to recognition of environmental patrimony and indigenous rights in Brazil's new constitution. On Christmas day that year, the rubber tapper Chico Mendes was assassinated by ranchers for defending the forest, ending a year of record deforestation and burning in the Amazon, which placed the deforestation issue before the international community. Brazil's government responded with the "Our Nature" program and voiced concerns about foreign intervention in the Amazon as a threat to Brazil's national sovereignty.

By the early 1990s, environmental issues gained more attention. Brazilian environmental organizations had proliferated, including SOS Atlantic Forest, and Brazil created a new Ministry of the Environment. In response to land conflicts in the Amazon, Brazil also instituted the concept of "extractive reserves," where communities earn livelihoods via sustainable use of forest products, rather than clearing forest for agriculture.

Bertha Lutz

Bertha Maria Júlia Lutz (1894–1976) was a prominent Brazilian zoologist and scientist, as well as a feminist and campaigner for women's rights in Brazil. Her father, Adolfo Lutz (1855–1940), originally from Switzerland, was a pioneer of tropical medicine. Settling in Sao Paulo, he worked as a microbiologist and specialized in the link between sanitation and epidemics, especially the plague, malaria, and yellow fever, and became head of the Bacteriological Institute of Sao Paulo. Bertha Lutz studied at the University of Paris (Sorbonne), and became intensely interested in amphibians. She later gave her name to a frog: Paratelmatobius lutzii ("Lutz Rapids Frog"). In 1919, having returned to Brazil, she started work at the Museu Nacional in Rio de Janeiro, then the capital of Brazil. She became the second woman to hold a job in the Brazilian public service, and later became a naturalist at the Botany section of the museum.

From her time in Paris, Bertha Lutz had been heavily influenced by French and British feminist ideas, and started agitating for the women's right to vote in Brazil, attending several international meetings, notably the Pan-American Conference on Women in 1922. Women were allowed to vote from 1932, and Lutz was briefly a member of parliament. With the death of her father in 1940, Bertha decided to work on cataloguing his papers, and spent the next 30 years of her life working on this, publishing several papers. In 1948 she was a signatory to the United Nations' Universal Declaration of Human Rights, one of only four women who signed it. The Bertha Lutz Foundation was established in her honor; its symbol is a green butterfly.

In 1992, Brazil hosted the United Nations Conference on Environment and Development in Rio de Janeiro. This conference led to drafting of international conventions on climate, biodiversity, and numerous other environmental issues of global concern. This in turn led to formulation of "Agenda 21," Brazil's response to the conventions drafted at "Rio-92." Brazil has since signed and ratified nearly all of these conventions, including the Kyoto Protocol on Climate Change.

Consequently, Brazilian environmental law progressed considerably during the 1990s. However, implementation of many of those laws has been inadequate, largely due to their complexity and the lack of resources allocated to the Ministry of Environment. Deforestation in both the Amazon and Atlantic forests has continued, accelerating somewhat since 2000. Air pollution in metropolitan São Paulo also worsened, leading to restrictions on the use of automobiles to certain days of the week. While Brazil has been less dependent than many countries on fossil fuels, its network of hydroelectric dams has generated environmental problems and public protest, and prompted Brazil to develop fossil fuel energy sources. Biodiversity is high but not adequately documented in Brazil, prompting the expansion of a system of national parks, forests, and biological and indigenous reserves. However, they require more resources for enforcement of conservation regulations, for there remains considerable trade in illegal wildlife and timber from Brazil.

Brazil's environmental record in the new millennium is mixed. Basic sanitation in urban areas, including waste disposal and water treatment, have both improved. Large Brazilian companies are increasingly adopting international standards of conduct and environmental quality, due in part to international demand for corporate accountability. But tensions between Ministries over questions of development and the environment have led the government to favor continued expansion of soybeans and other agricultural exports into the Amazon and other fragile environments, in order to help Brazil pay its national debt via economic growth.

SEE ALSO: Amazon River Basin; Biodiversity; Rubber.

BIBLIOGRAPHY. Clovis de Vasconcelo De Cavalcanti, ed., *Environment, Sustainable Development and Public Policies: Building Sustainability in Brazil* (Edward Elgar Publishing, 2000); Uma J. Lele, Syed Arif Husain, Virgilio Viana, Adalberto Verissimo, and Stephen Vosti, *Brazil: Forests in the Balance: Challenges of Conservation with Development* (World Bank Publications, 2000); Jan Rocha, *Brazil in Focus: A Guide to the People, Politics and Culture* (Latin America Bureau, 2000).

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Brockovich, Erin (1960–)

WHEN ERIN ELIZABETH Pattee was growing up in Kansas, she seemed an unlikely prospect for becoming a high-profile advocate for victims of industrial poisoning. She suffered from a learning disability, panic attacks, anorexia, and low self-esteem. Nevertheless, she developed the strong sense of right and wrong that gave her the motivation to become the voice for silenced and exploited victims. In 1991, as a broke, divorced parent recovering from an automobile accident, Brockovich became a receptionist in the law office of Masry and Vititoe in Westlake Village, CA.

By chance, she was asked to open a file on a pro bono real estate case involving Pacific Gas and Electric (PG&E). Brockovich noticed that the file contained the result of blood tests performed on residents of Hinkley, California, and asked permission to pursue the case. This move changed her life.

As Erin Brockovich pursued the story behind mysterious illnesses in Hinkley, she discovered that PG&E had released more than 370 million gallons of Chromium VI in the water of Hinkley over a 30-year period. Studies have shown that repeated exposure to high levels of Chromium VI may cause headaches and nosebleeds. Acute toxicity from Chromium VI may also lead to allergic contact dermatitis, skin ulcers, nasal rhinitis, liver damage, edema, nephritis, and various pulmonary conditions and cancers.

In 1962, the Public Health Service established a cap of 50 UG/L in drinking water. By 1975, the Environmental Protection Agency (EPA) had mandated that cap through the National Interim Primary Drinking Water Regulations. The samples that Brockovich took from Hinkley contained Chromium VI at 10 times the acceptable level. In 1976, Congress passed the Resource Conservation and Recovery Act (PL 94-580), which provided the EPA with the authority to identify hazardous wastes such as those containing chromium and to establish standards for generating and transporting hazardous materials.

Residents of Hinkley had not only drunk the chromium-polluted water; they had also swam and bathed in it and irrigated their crops with it. As a result, they suffered from the classic symptoms of chromium poisoning. Brochovich's lack of professional position and authority allowed her to become friends with the residents of the small town and win their trust. Using unorthodox methods, she also gained access to files that irrevocably incriminated PG&E in the contamination.

When 634 residents of Hinkley hired Masry and Vititoe to handle their suit against PG&E, the law firm paid Brochovich's friend, George Halibee, to serve as her nanny so that she could devote more time to the case. Ultimately, Erin Brockovich and Ed Masry were able to assemble such overwhelming evidence against PG&E that after four years of arbitration, the company agreed to pay $333 million to the victims. It was the largest settlement in a direct lawsuit in American history. Masry and Vititoe paid Brockovich a bonus of $2.5 million for her work on the case.

In 2000, Steven Soderbergh brought Brockovich's story to the public in the motion picture *Erin Brockovich*, with Julia Roberts in the title role. Brockovich was paid $30,000 for the rights to her life story, and Roberts won an Academy Award for Best Actress for her portrayal of the blowsy, feisty Brockovich. She has continued to serve as an environmental activist in her position as director of environmental research at Masry and Vititoe. In 2001, Brockovich published the inspirational *New York Times* best-seller, *Take It from Me: Life's a Struggle, but You Can Win*. Brockovich also hosts *Final Justice* for Lifetime Television.

SEE ALSO: Environmental Protection Agency; Groundwater; Resource Conservation and Recovery Act; Water Quality.

BIBLIOGRAPHY. Erin Brockovich and Marc Eliot, *Take It from Me: Life's a Struggle, but You Can Win* (McGraw-Hill, 2002); Mitchell D. Cohen and Max Costa, "Chromium," in Morton Lippmann, ed., *Environmental Toxicants: Human Exposures and Their Health Effects* (John Wiley & Sons, 2000); "Erin Brockovich (*Anderson v. Pacific Gas and Electric*)," www.lawbuzz.com (cited March 2006); *Intimate Portrait: Erin Brockovich*, Lifetime Television (originally aired 2003); Sidney A. Katz and Harry Salem, *The Biological and Environmental Chemistry of Chromium* (VCH, 1994); Law Offices of Vititoe and Associates, www.vititoe.com (cited March 2006).

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Brower, David (1912–2000)

DAVID BROWER (1912-2000) was an environmentalist who lived the phrase "In the beginning was the act!" He battled fiercely for the protection of the earth and he had a profound influence on America's wilderness areas. Brower's credits in environmental protection and advocacy are legendary in their volume and significance. He worked on the creation of national parks in the Pacific Northwest, Alaska, and New England. Along with other staunch environmentalists, he was instrumental in blocking the building of dams in Dinosaur National Park, the Grand Canyon, and Canada's Yukon Territory. Brower's own words portray the man and his passion: "Polite conservationists leave no mark save the scars upon the Earth that could have been prevented had they stood their ground."

David Brower served as executive director of the Sierra Club from 1952 to 1969, where he continued to serve in various capacities until 1998, two years before his death at the age of 88. In 1982, David Brower founded the Earth Island Institute (EII), an organization dedicated to the conversation, preservation, and restoration of the environment. The EII provides support for enterprising environmentalists to develop projects and to support them in the implementation of their work. EII environmentalists have been active in projects worldwide to protect the fast-disappearing rainforests, promote organic and sustainable agriculture, the reduction of pollution in the world's oceans, and the development of environmental programs to protect urban areas. The latter effort resulted in the formation of the Urban Habitat project, addressing environmental issue in metropolitan areas.

BATTLES AND COMPROMISES

Brower's battle over Glen Canyon Dam in 1956 was perhaps one of the defining moments (and setbacks) of the preservation movement in the United States. Following a rafting trip down the Colorado river with Floyd Dominy, the chief dam builder of the Bureau of Reclamation, Brower struck a deal to allow the flooding of Glen Canyon in exchange for preservation of the Green River in northern Utah. These events are recorded in detail in John McPhee's classic book, *Encounters with the Archdruid*. Brower lived to regret the decision, but the struggle helped to place the Sierra Club in the public consciousness and fueled Brower's no-compromise work in his later years.

Up to his death in 2000, Brower remained active in nature preservation. In Lake Baikal in Siberia, for example, he led teams of scientists in search of ways to protect Lake Baikal and ensure its full restoration during the 1980s and 1990s. On three occasions (1978, 1979, 1998), Brower was nominated for the Nobel Peace Prize for his profound accomplishments in stewardship of the global environment. He received the coveted Blue Planet Prize in 1998, a highly prestigious award given each year by the Asahi Glass Foundation. David Brower had a profound influence on the environmental and conservation movements in the United States and globally.

SEE ALSO: Baikal, Lake; Grand Canyon; Sierra Club.

BIBLIOGRAPHY. David Brower, *For Earth's Sake: The Life and Times of David Brower* (Peregrine Smith Books, 1990); David Brower, *Let the Mountains Talk, Let the Rivers Run: A Call to Those Who Would Save the Earth* (HarperCollins West, 1996); David Brower, *Not Man Apart: Lines from Robinson Jeffers* (Sierra Club, 1969); J. McPhee, *Encounters with the Archdruid* (New York, Ferrar, Strauss, and Giroux, 1971).

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Brownfields Properties

BROWNFIELDS PROPERTIES, DEFINED as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" exist in virtually every urban and rural community across the United States and internationally. Although the exact number of brownfields properties in the United States is unknown, the U.S. Environmental Protection Agency (EPA) estimates more than 450,000 sites exist, ranging in size from less than one acre to several thousand acres.

Brownfields properties may be abandoned, vacant, or underutilized, ranging in size, form, and degree of contamination with former uses such as gas stations, manufacturing plants, dry cleaning facilities, railroads, and residential buildings with asbestos. Some sites have low to moderate levels of contamination. In the United States, properties classified as Superfund sites contain higher levels of environmental contamination, pose significantly greater health and safety risks, and require more extensive remediation. As of February 2006, more than 1,200 contaminated properties in the United States were listed on the EPA's Superfund National Priorities List.

Brownfields can have negative economic and societal impacts on communities. In addition to the actual or potential health and safety ramifications, brownfields are often considered eyesores due to deteriorated structures, vandalism, and lack of grounds maintenance. These properties reduce property values of surrounding real estate. Many local public officials, however, now see beyond brownfields as liabilities and recognize them as potential assets in comprehensive local development strategies.

Likewise, in the United States, state government agencies regularly work with local officials through a variety of rehabilitation and redevelopment programs. The National Governors Association stated: "There is a compelling economic case for state spending on brownfields. A dollar of state spending produces about 10 times to 100 times more dollars in economic benefits. Expanding the mission of brownfields justifies greater state spending."

Remediation and redevelopment of brownfields properties results in benefits such as job creation,

Brownfields are often considered eyesores due to deteriorated structures and vandalism.

tax revenue increases, neighborhood revitalization, crime reduction, environmental improvement, and urban sprawl reduction. In many industrialized nations, brownfields redevelopment is considered a vital component to sustainable development. A study by George Washington University for the U.S. Council of Environmental Quality shows that one acre of redeveloped brownfields property saves 4.5 acres of greenfields property—undeveloped lands outside of core urban areas that can be preserved from the offset of development. Likewise, rehabilitation and redevelopment of brownfields sites can create substantial employment and return to state or city investment. A 1999 study by the Council for Urban Economic Development (CUED), for instance, shows that $1 invested by the public sector in brownfields redevelopment generated $3.41 in private investment. In 2005, an Illinois study of 37 brownfields projects reported that every $1 invested by the city resulted in $4.17 in private investment and 66 jobs created or retained.

Many environmental remediation methods exist, and the specific process used depends on several factors: type and location of contamination, concentration of the contaminant, planned future use of the property, and cleanup standards required by regulatory programs. For instance, property planned for residential use requires higher cleanup standards than property intended for industrial or commercial uses.

Remediation techniques take several forms: physical, chemical, biological, thermal, solidification/stabilization, encapsulation, and monitoring. Innovative techniques including in-place oxidation, bioremediation, and phytoremediation are becoming more common. These methods involve the use of agents, live organisms, or plants to decompose, degrade, or otherwise transform the state of the hazardous material, rendering it less harmful or eliminating it completely. On-site (in situ) treatments such as these are less disruptive to the environment and avoid the risks associated with the removal and transportation of contaminants to waste disposal locations (ex situ or off-site remediation). Increasing attention is being paid to incorporating brownfields properties into environment-friendly programs in cities located in the industrialized world. Innovative, environmentally sound practices were implemented in the remediation and site redevelopment of Chicago's highly acclaimed Center for Green Technology, constructed on a former brownfields site.

Brownfields site preparation, planning, assessment, cleanup, and redevelopment is facilitated through assorted federal, state, and local level initiatives. The level of assistance offered through brownfields policies and programs varies widely among industrialized nations. In the United States, at the federal level, the financial and technical assistance for brownfields is offered mainly through Environmental Protection Agency (EPA) assessment and cleanup programs, and the Housing and Urban Development (HUD) Brownfields Economic Development Initiative (BEDI).

Other U.S. federal programs, however, also fund brownfields rehabilitation and redevelopment projects that fit within specific program guidelines. State and local governments offer direct financial assistance such as loans and grants, and indirect assistance through various financial tools such as tax abatements, credits and refunds, low-cost environmental insurance, infrastructure upgrades, job training, and tax increment financing. Brownfields redevelopment projects can involve public investment, private investment, or a combination of the two.

Despite the availability of programs and resources to encourage remediation and redevelopment, many brownfields sites remain undeveloped for several reasons, including shortage of funds, potential liability, and environmental regulations. Contamination can exist in the soil, surface water, groundwater, and/or structures. The extent of contamination, related costs, and resources are often not known until the project is well under way. Potential stakeholders are often reluctant to initiate the redevelopment process because of uncertainty associated with brownfields. By contrast, previously undeveloped land, or greenfields, located on the periphery of development, are often more attractive to developers because of lower risks and costs.

SEE ALSO: Environmental Protection Agency; Superfund Sites.

BIBLIOGRAPHY. Ed Gilliland, *Brownfields Redevelopment: Performance Evaluation* (Council for Urban Economic Development, 1999); National Governors Association, *New Mission for Brownfields: Attacking Sprawl by Revitalizing Older Communities* (2000); U.S. Congress, "Small Business Liability Relief and Brownfields Revitalization Act," Public Law 107-118 (H.R. 2869), 2001, www.epa.gov (cited April 2006); U.S. Environmental Protection Agency, "Brownfields Cleanup and Redevelopment: About Brownfields," 2006, www.epa.gov (cited April 2006); U.S. Environmental Protection Agency, "NPL Site Totals by Status and Milestone," 2006, www.epa.gov (cited April 2006); Norman Walzer and Gisele F. Hamm, *Brownfield Investments and Outcomes* (Illinois Environmental Protection Agency, 2005); White House Council on Environmental Quality, "Over 1,000 to Be Trained for Environmental Jobs in Brownfields Communities Nationwide" (CEQ E-Notes, 2004).

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Brucellosis

BRUCELLOSIS, WHICH PRIMARILY affects mammals such as deer and elk, cattle, pigs, dogs, sheep, and goats, is an infectious disease caused by Brucella bacteria. Human cases of brucellosis are rare, but are more common in places where public health efforts are limited; unpasteurized milk and dairy products account for the most common route of infection.

Brucella abortis, a strain of the bacteria that generally affects cattle and bison, causes decreases in milk production and spontaneous abortions in infected individuals. In the United States, this is the most common agent causing brucellosis infections. Transmission of the bacteria is typically accomplished through direct exposure to infected animals, although cases of contamination through affected food and water sources have been documented. Contemporary losses to farmers, in the form of decreased milk production and aborted fetuses, are estimated at less than $1 million annually, compared to $400 million in 1952.

CONTROL AND PREVENTION

Prior to 1934, control of brucellosis in the United States was limited to individual herds and livestock owners. Since the mid-1930s, the Cooperative State Federal Brucellosis Eradication Program has eliminated occurrence of brucellosis in 44 states, with the other six states charting infection rates of less than 0.25 percent. Yellowstone National Park (YNP), which is comprised of land in Montana, Wyoming, and Idaho, is home to the last remaining free-range bison herds in North America, some of which carry brucellosis; about 50 percent of Yellowstone bison are estimated to carry the brucella abortis bacteria. Reintroduction of brucellosis from free-range herds could enormously economic impact the livestock industry, and potentially jeopardize export markets for American beef.

Because brucellosis prevention was historically focused on private herds nationwide, the YNP bison herds were controlled through border control activities and shot upon leaving the park. Problems arose during the winter of 1996–97, when record snowfalls limited forage for YNP bison. Some 1,079 bison that departed YNP in search of food were shot or sent to slaughter, while an additional 1,300 bison starved to death within the park. The winter of 2005 saw another 900 bison shot or slaughtered by the National Park Service. Concerns with this style of management include a potential reduction in genetic diversity and population viability of YNP bison. Environmental groups discount the theoretical risk to domestic livestock posed by bison and elk, and suggest that less heavy-handed management of wildlife in the YNP area could still protect livestock health.

Current management plans focus on managing a free-range bison herd, while also attempting to control brucellosis. To this end, a strain RB51 vaccine is being tested for use in bison, although delivery of the vaccine is often difficult, and would have to be delivered ballistically or to bison captured outside the YNP boundary. Another delivery option under study is microcapsules of oral vaccine that could be distributed in feeding areas in the park. If the YNP bison and elk herds were to become brucellosis-free, they could presumably be allowed unfettered access to the North American continent once again.

SEE ALSO: Bison; Cattle; Livestock; Yellowstone National Park.

BIBLIOGRAPHY. D.S. Davis and P.H. Elzer, "Brucella Vaccines in Wildlife," *Veterinary Microbiology* (v.90, 2002); K. Kleiner, "Oh Give Me a Home," *New Scientist* (v.162/2190, 1999); United States Department of Agriculture, Animal and Plant Health Inspection Services, www.aphis.usda.gov (cited November 2006); United States Department of Health and Human Services, Centers for Disease Control and Prevention, www.cdc.gov (cited November 2006).

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Brundtland Report

THE BRUNDTLAND REPORT, *Our Common Future*, is so named for having been authored (in 1987) by a United Nations (UN) commission chaired by the former prime minister of Norway, Gro Harlem Brundtland. The United Nations established the World Commission on Environment and Development, and charged it with articulating a long-term vision for development to the year 2000 and beyond that would afford avenues of cooperation among countries at differing stages of economic and social development. One broad aim of the commission was to reconcile two fundamental political dilemmas posed by development that had taken hold by the mid-late 1980s: one emanating from the tension between economic development and environmental preservation, and the other embodying the disparate states, rates and priorities of development in the global north vs. south.

In presenting its proposal for bridging the two gaps (between environment and development, and between developed and developing countries), the Brundtland Commission tapped the concept of sustainable development. Sustainable development had previously been defined and recommended by the former International Union for the Conservation of Nature (IUCN) in its *World Conservation Strategy,* published in 1980. It was a trajectory for developing countries that would enable them to avoid the environmental costs incurred by developed nations in the course of their own processes of industrialization and economic development. This vision of sustainable development focused primarily on the concept of inter-generational equity; in other words, the focus was on preserving the environment for the future in order to enable future generations to meet their own development needs. The Brundtland Commission, while reiterating the IUCN's general linking of environment and development, also placed a stronger emphasis on the needs of developing nations and on concerns of poverty alleviation and equity, particularly intra-generational equity. *Our Common Future* defined sustainable development as a process that:

> …meets the needs of the present without compromising the ability of future generations to meet their own needs… It contains within it two key concepts: the concept of 'needs,' in particular, the essential needs of the world's poor, to which overriding priority should be given, and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

The commission thus laid out an alternative vision for sustainable development, tying inter-generational equity predicated on sustaining the environment for future generations, to intra-generational equity that hinged on poverty alleviation and reducing the gap between developed and developing nations. In other words, it linked economic development to environmental conservation as well as social justice. The report implied that sustainable development could be achieved by changing the quality rather than the quantitative aspects of development; in so doing, it diverged fundamentally from the former Limits to Growth model popularized in the 1970s by environmentalists in the developed world. In most interpretations of the concept of sustainable development as defined by the Brundtland Report, disproportionate emphasis continues to be placed on inter-generational equity (environment–development goals) at the expense of the intra-generational equity (development–social justice goals).

SPHERE OF INFLUENCE

The Brundtland report's timeliness in addressing these political schisms on development partly explains the visibility and influence it has come to wield in development and policy arenas. Perhaps the greatest reason for its success on the international stage, however, lies in what is also its fundamental weakness: its ambiguity in defining sustainable development, and its concomitant inability (or unwillingness) to specify how such development could be attained. The challenges of realizing the tripartite goals of economic development, social justice, and environmental conservation outlined by the Brundtland Commission are complex and manifold, and nowhere as palpable as in the developing world. In the spaces allowed by the concept's ambiguity, however, could be accommodated the panoply of perspectives from the developed world, focusing on *environmental* sustainability; and from the governments of the lesser developed nations, concentrating on sustaining their *economic development* and the reduction of poverty. The common ground that the Brundtland Commission cleared in 1987 laid the foundation for the subsequent conference of nations at Rio de Janeiro's Earth Summit in 1992, a forum where both developed and developing nations converged to further discuss their visions, priorities and specific agendas for national and international environment–development issues. After Rio de Janeiro, the discourse on sustainable development switched to a discussion of rights rather than needs, and has come to reflect several parallel trains rather than a consensus. The report continues to be the source of lively debate over the definitions and principles of sustainable development, and has generated the development of numerous indicator variables capturing sustainability from the social as well as environmental sciences.

SEE ALSO: Sustainability; Sustainable Development; United Nations.

BIBLIOGRAPHY. I. Moffatt, "On Measuring Sustainable Development Indicators," *International Journal of Sustainable Development & World Ecology* (v.1, 1994); M. Purvis and A. Grainger, (eds.), *Exploring Sustainable Development: Geographical Perspectives* (Earthscan, 2004); World Commission on Environment and Development, *Our Common Future* (Oxford University Press, 1987).

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Bt (Bacillus thuringiensis)

BACILLUS THURINGIENSIS (BT) is a bacterium that naturally occurs in soil and on both wild and domesticated plant species. Some varieties of this bacterium produce a protein that acts as a natural insecticide, toxic to certain classes of insect larvae, including moth and butterfly as well as some varieties of beetle and fly larvae. As a result, Bt is a natural insecticide used in traditional agricultural production systems, as well as applied in higher-intensity modern agriculture, usually sprayed directly on crops. In the latter form, the bacterium is a product marketed as an insecticide under numerous trade names. Because the toxins break down quickly when exposed to ultraviolet light and other environmental factors, Bt is considered an attractive, organic, and environmentally friendly form of pesticide, especially when

Some varieties of Bt produce a protein that acts as a natural insecticide, toxic to certain insect larvae.

compared to more persistent compounds that have the tendency to bioaccumulate (such as chlorinated hydrocarbons), and nerve-based substances (e.g., organophosphates).

Far more controversially, Bt toxins have become widely used in transgenic crops, where genetic modification creates new crop plant breeds (especially corn, cotton, and potatoes) that produce Bt. Critics warn that although Bt itself is a relatively safe insecticide, the new breeds present human and environmental risks. Specifically, they raise concerns about human health exposure, resistance of insect species over time, and the possible transfer of the gene through crosspollination to wild relatives that may result in the creation of new, especially persistent super-weeds, whose new genetic advantages make them immune to healthy predation by pests.

Industry has responded by suggesting that since commerical Bt is already safely applied, the new genetic applications pose a minimal risk. While it is true that the scientific evidence on Bt as applied in spray form is well developed, the broader ecosystemic effects of the Bt transgene are essentially unknown. Nevertheless, the acreage of Bt crops has expanded rapidly in the last several years, making Bt crop acreage roughly one fifth of the global total of transgenic crops, demonstrating a violation of the precautionary principle.

SEE ALSO: Genetically Modified Organisms; Genetics and Genetic Engineering; Precautionary Principle.

BIBLIOGRAPHY. Kim Kaplan, "Bt Corn: Less Insect Damage, Lower Mycotoxin Levels, Healthier Corn," Agricultural Research Service website, www.ars.usda.gov (cited April 2000); Matthew Metz, *Bacillus thuringiensis: A Cornerstone of Modern Agriculture,* (Haworth Press, 2003); Rajeev K. Upadhyay and Rajeev K. Upadhyay, ed., *Advances in Microbial Control of Insect Pests* (Kluwer Academic Publishers, 2003).

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BT Toxoid

BT TOXOID IS shorthand for *Botulinum* toxoid (BT) vaccine. It has been used for over 25 years to protect industry and laboratory workers from occupational exposure. The BT toxoid vaccine immunizes against *Clostridium botulinum* bacteria toxin. Vaccines use the toxin produced by *Clostridium botulinum* bacteria to stimulate the body's production of antibodies or antitoxins against the threat of infection by the bacteria. Pharmaceutical companies have found ways to nullify the highly toxic poisons produced by the disease. The toxin protein is treated with either chemicals or heat to neutralize its poisonous property. These methods allow toxoids to be administered in large quantities to quickly stimulate immunization; however, adverse reactions have occurred in a number of those receiving it.

Botulinum neurotoxis (BT) is a protein produced by the soil bacteria *Clostridium botulinum*. The bacteria are rod-shaped and flourish best in anaerobic conditions. The spores of the bacteria survive in a dormant condition until they are exposed to conditions favorable to growth. There are seven different strains of the *Clostridium botulinum* bacteria; each strain produces a different toxin. The letters A through G identify the seven known kinds of BT. Four of these strains (A, B, E, and F) cause human botulism. The toxicity of BT is very high. An average adult can be killed by 70 one-millionths of a gram. Contracting botulism can cause serious paralysis because the *Clostridium botulinum* bacteria's toxin, botulin, is a nerve toxin.

There are three main type of botulism. All can be fatal and must be treated as a medical emergency. Eating food contaminated with *Clostridium botulinum* bacteria causes foodborne botulism. This form of botulism is very dangerous because it can affect a large number of people; however, only a quarter of cases each year are this form of botulism. Toxins produced in a wound infected with *Clostridium botulinum* bacteria cause wound botulism. This form of botulism is a danger for farm workers and combat soldiers, and produces a few cases each year. Infant botulism develops in an underdeveloped baby's intestines, where the toxins are released. Honey contaminated with *Clostridium botulinum* bacteria is the most common cause of infant botulism. Isolated cases of aerosol botulism have occurred among researchers. This condition is rare and also unnatural.

When a botulism infection occurs, the first symptoms occur within less than one to two days. In more severe cases, vision may be doubled or blurred, speech slurred, breathing will be shallow, and swallowing will be difficult with the mouth dry. The effects of the toxin move from the upper to the lower extremities in the body symmetrically. The toxin reduces muscles reflexes, paralyzes the limbs, and in deadly cases, destroys the nerves that fire the diaphragm and the muscles required for breathing. *Clostridium botulinum* has also attracted the attention of governments and terrorists for its potential as a biological weapon. Aum Shinrikyo, the Japanese terrorist group, tried to use a weaponized aerosol botulinun toxin on three separate occasions with little success. For some years until the First Gulf War in 1991, Iraq had a biological weapons program that included botulism.

SEE ALSO: Biotechnology; Disease; Vaccination.

BIBLIOGRAPHY. Chris Bell and Alex Kyriakides, *Clostridium Botulinum: A Practical Approach to the Organism and Its Control in Foods* (Blackwell Science, Inc., 2000); Daniel Farb, *Bioterrorism Botulinum: For Healthcare Workers and Public Officers (Allied Health, Nurses, Doctors, Public Health Workers, EMS Workers, Other Emergency, Safety, Fire, Police, and Disaster Planning and Response Personnel) and the Public* (University of Health Care, 2004); Thomas V. Inglesby, Donald A. Henderson, and Tara O'Toole, *Bioterrorism: Guidelines for Medical and Public Health Management* (American Medical Association, 2002); Marcus Naumann, *Handbook of Botulinum Toxin Treatment* (Blackwell Science, Inc., 2002).

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Buffalo Commons

IN THE DECEMBER 1987 issue of *Planning* magazine, Deborah Popper, a geography graduate student at Rutgers University, and Frank Popper, chair of the Rutgers urban studies department, published an article proposing that the U.S. Great Plains be transformed into the world's largest historic preservation region. The Poppers suggested that the vast area be called the Buffalo Commons, and that the federal government would inherit the task of bringing the region back to its 19th-century condition. The Poppers proposed that an extensive area of the Great Plains be taken out of the private property category as part of roughly 20 million acres of native grassland. Initially, landowners in the Great Plains spoke out harshly against the Popper's ideas. There was the belief among residents that their land would simply be taken from them by federal mandate.

However, this was not the idea. In one plan, farmers and landowners would enter into contracts with federal agencies and be compensated for their estimated financial loss over a 15-year period. The landowner agreed to the planting of native grasses for the transition to the new era.

The Poppers contended that modern human settlement and agriculture on the Great Plains were not environmentally sustainable. The Dust Bowl era saw thousands of settlers leave the region as the winds blew away what little topsoil existed. John Steinbeck's *The Grapes of Wrath* is a vivid account of the drought's devastation. As a result of this natural disaster and the aridity of the region, the Great Plains lost over a third of its population between the 1920s and the 1980s. As late as the 2000 census, some counties registered population densities below two people per square mile, a figure used by Frederick Jackson Turner in 1983 to proclaim the end of the frontier era. Declining population densities in the Great Plains belie Turner's pronouncement. Along with low population densities and remote communities comes a paucity of essential services, such as full-service hospitals and shopping centers. Schools in the Great Plains regions are either closing or yielding to consolidation with other districts. The loss of a school in a small community can spell its demise. The smaller the community, the greater the influence of the school. It may very well be the largest employer in the community, and will open its doors to community members during after-school hours.

Water availability in the Great Plains is also a serious problem. The region relies to a large degree on the vast Ogallala Aquifer, an extensive underground source of fresh water extending from Texas north to South Dakota. The aquifer at its highest volume was estimated to hold an amount of water equal to that of Lake Michigan. Over the years, the level of water has declined dramatically as more and more wells have been put in place and the amount of water taken out of the ground has far exceeded that gained through natural recharge. Adding to the problem, recharge occurs primarily at the northern terminus of the aquifer in an arid area. Thousands of farms in the Great Plains have ceased operations because of the inability to reach the lowered water level of the aquifer.

Invoking the frontier notion has given rise to the acceptance in the U.S. House of Representatives of a formal definition of a *frontier county:* one that has a critically low population density, does not have medical facilities readily available, and is significantly distanced from other essential services. Hundreds of counties, primarily in the western United States, are officially classified as frontier counties. As provocative as the Popper's initial proposals seemed, it appears that the era of the Buffalo Commons may occur in some parts of the Great Plains in a de facto sense, and not as a federal program.

SEE ALSO: Dust Bowl, U.S.; Great Plains; Ogallala Aquifer; United States.

BIBLIOGRAPHY. Daniel Licht, *Ecology and Economics of the Great Plains* (University of Nebraska Press, 1997); Anne Matthews, *Where the Buffalo Roam: the Storm over the Revolutionary Plan to Restore America's Great Plains* (Grove Press, 1992); D.E. and F.J. Popper, "The Great Plains: From Dust to Dust," *Planning* (December 1987); Richard S. Wheeler, *The Buffalo Commons* (Forge, 1998).

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Buffer Areas

BUFFER AREAS SURROUND or abut core protected areas. The activities that take place in buffer areas depend largely upon local circumstances and national or international legislation. Buffer areas may be privately owned or owned by governments, and in some cases, ownership is a combination of the two. Buffer areas, like the core zone, may be otherwise recognized through international treaties. The level of protection may, however, be less in the buffer area than in the core zone. Buffer areas may also be referred to as buffer zones or managed-use areas.

If the core zone's purpose is to protect the environment through restricting human use of the area, more wide-ranging activities may occur in the buffer area. These activities need to be of low impact upon the core area. Some examples are ecotourism, low-impact recreation, environmental education, and research.

The core zone and buffer area often occur as part of the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Man and Biosphere Reserves, which had strict concentric zonation in its original design. At the center of the zonation was the core zone, which, as stated, was a place where the natural ecosystems were protected and monitored. Surrounding the core zone was the buffer area, which was intended to shield the core zone from wider human impacts.

ORIGINS OF BUFFER MODELS

The original model conceived in the 1970s intended that the buffer area would comprise two separate areas. The inner buffer area was to be strictly limited in terms of public access, with the main activities to be education and research. In the outer buffer area, wider-ranging activities such as recreation could take place. Later, in the 1980s, the outer buffer area was renamed the *transition zone*. Subsequently, this outer zone has sometimes been called an *area of cooperation*. Agriculture, settlement, and other activities that sustainably develop the area may occur in the area of cooperation.

In fact, the original concentric design for the core, buffer, and transition areas has not always been followed, and this in some ways reflects the flexibility of the biosphere reserve concept. For instance, the Gouraya Biosphere Reserve in Algeria is a national park by the same name. It contains uplands, one wetland, and a marine area. The forests and marine areas contain important flora and fauna. The core zone is strictly protected. There are two buffer areas that abut the core zones in order to protect them from the activities in the transition area. The transition area comprises about 4.7 square miles (1157.6 hectares), with the two buffer areas totaling 0.6 square miles (162.7 hectares) and the core zone comprising 2.6 square miles (680.2 hectares).

Buffer areas can on occasion be absent from a biosphere reserve. Such is the case in the Taï Biosphere Reserve in the southwest Côte d'Ivoire. This primary tropical forest has a core area of 2,007.8 square miles (520,000 hectares) with a transition area of 386 square miles (100,000 hectares). 160,000 people were counted as living within the core zone of the biosphere reserve in 1998. This shows how flexible the biosphere reserve concept is in its application as the original ideal model depicted the core zone as being devoid of human occupation. Yet there are problems within this biosphere reserve include logging, farming, poaching, and illegal gold mining. Given these activities and the human settlements, this biosphere reserve's core zone is followed directly by a transition zone, with no buffer zone.

SEE ALSO: Biosphere; Biosphere Reserves; Conservation; Man and the Biosphere Program (UNESCO).

BIBLIOGRAPHY. Michel Batisse, "Developing and Focusing the Biosphere Reserve Concept," *Environmental Conservation* (v.9/2, 1986); R.P. Neumann, "Primitive Ideas: Protected Area Buffer Zones and the Politics of Land in Africa," *Development and Change* (28(3): 559-582); J. Sanford Rikoon and Theresa L. Goedeke, *Anti-Environmentalism and Citizen Opposition to the Ozark Man and the Biosphere Reserve* (Edwin Mellon Press, 2000); United Kingdom Man and Biosphere program, www.defra.gov.uk (cited December 2006); United Nations Environmental, Scientific, and Cultural Organization (UNESCO), www.unesco.org (cited December 2006).

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Bulgaria

FROM 1946 TO 1990, Bulgaria was part of the Soviet bloc of nations. After the breakup of the bloc, Bulgaria held its first multiparty election of the post–World War II era and began its transformation into a market economy. This nation of 7,450,349 people covers 110,910 square kilometers, with the Black Sea forming its eastern border. Because of the temperate climate, Bulgarian summers are dry and winters are cold and damp. Bulgarian industry utilizes large deposits of coal, copper, and zinc. Other natural resources include bauxite, lead, timber, and arable land. The mountainous terrain makes the country vulnerable to landslides, and earthquakes are a constant threat.

Environmentally, Bulgaria faces problems with air pollution caused by industrial emissions and with rivers polluted by raw sewage, detergents, and heavy metals. Additionally, Bulgarian forests have been damaged by air pollution and acid rain, and the soil has been contaminated by heavy metals and other industrial wastes. Around 4.5 percent of Bulgaria's land area is protected. Among the 81 species of mammals endemic to the country, 14 species are threatened, as are 10 species of the 248 endemic bird species. A study conducted by Yale University in 2006 ranked Bulgaria 50th of 132 countries on environmental performance; however, Bulgaria outranks most other countries in its income and geographic groups. Concerning overall quality-of-life issues, The United Nations Development Project (UNDP) Human Development Reports rank Bulgaria 55th.

ENVIRONMENTAL PROS AND CONS

Bulgaria's labor force is heavily dependent on services (56.3 percent) and industry (32.7 percent). And while almost 70 percent of the population lives in urban areas and only 11 percent of the labor force is engaged in agriculture, the per capita income of $9,000, unemployment rate of 11.5 percent, and poverty rate of 13.4 percent mean that backyard gardening, canning, and informal urban agriculture are crucial components of livelihoods throughout the country. All Bulgarians have access to safe drinking water and improved sanitation.

Indiscriminate usage of pesticides in the past continues to create environmental problems for Bulgaria. In 1996, for instance, an inventory revealed that large quantities of organochlorine pesticides, which have been banned by the government, are still stockpiled. High concentrations of hydrocarbons (HCBs) have been found in the Danube, Dnieper, and Dniester Rivers. HCB residues dropped extensively in Bulgaria between the 1970s and the 1990s. On the other hand, lindane continued to show up in the Bulgarian waters of the Danube. Pollution has also been found in estuaries in areas of Bulgaria where oil production refineries are located.

Offering a more positive view of Bulgaria's environment than that presented by the Regional Environmental Center, the Bulgarian Council of Ministers has identified Bulgaria's environmental strengths as low air, water, and soil pollution, overall cleanliness, rich biological diversity, legislation and programs to promote environmentalism, a high percent of nuclear power use, and a well developed pollution monitoring system. Nevertheless, the study also identified environmental weaknesses in Bulgaria that include a shortage of funding for environmental programs, water shortages, inefficient water usage, high noise pollution, high levels of transportation pollution, a lack of administrative oversight capacity, persistent "hot spots" of pollution in large cities, and continued problems of waste disposal.

Local governments have been given responsibility for dealing with pollution in their own areas, and Bulgaria has pledged a commitment to global environmentalism by participating in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution—Sulfur 85, Air Pollution–Volatile Organic Compounds, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands. Bulgaria has ratified but not signed the agreement on Air Pollution–Sulfur 94.

SEE ALSO: Acid Rain; Pesticides; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. CIA, "Bulgaria," *The World Factbook,* www.cia.gov (cited March 2006); Glenn E. Curtis, *Bulgaria: A Country Study* (Federal Research Division, Library of Congress, 1993); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Republic of Bulgaria, Council of Ministers, *National Strategy for the Environment and Action Plan 2000–06* (Ministry of Environment and Water, 2001); UNDP, "Human Development Reports: Bulgaria," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Bulgaria," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 En-

vironmental Performance Index," www.yale.edu (cited March 2006).

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Bullard, Robert

ROBERT BULLARD IS an activist and academic who has been one of the leading voices of the environmental justice movement. While working as an environmental sociologist in the 1970s, Bullard wrote a study called "Solid Waste Sites and the Black Houston Community" that identified a systematic pattern of siting garbage dumps in black neighborhoods. His research documenting the unjust connection between toxic siting and communities of color led to the first lawsuit (*Bean v. Southwestern Waste Management*) that used civil rights law to challenge environmental discrimination.

Bullard documented this research in *Dumping in Dixie: Race, Class, and Environmental Quality* (1990), which is widely regarded as the first book to fully articulate the concept of environmental justice. In *Dumping in Dixie,* Bullard reports that African Americans in the South bear a disproportionate burden in the siting of hazardous-waste landfills and incinerators, lead smelters, petrochemical plants, and many other toxic facilities. Bullard's study, in conjunction with a 1987 report issued by the Commission for Racial Justice of the United Church of Christ, proved to be crucial documents for establishing the momentum of the environmental justice movement. His later research extends to include all people of color, as well as working-class and low-income communities that are disproportionately affected by garbage and pollution, going beyond individual cases to demonstrate the institutional racism that propels this type of inequality.

Bullard was an instrumental planner of the First National People of Color Environmental Leadership Summit in 1991, which brought together a network of grassroots activists concerned with environment justice. This summit not only drafted organizing principles of the modern environmental justice movement, but also identified a new kind of environmental politics that challenged environmentalism to become more than a white, upper-middle-class movement. Later, Bullard was influential in working with the Clinton Administration to enact an executive order that required all federal agencies to consider environmental justice in their programs. In Bullard's 2003 book, *Just Sustainabilities: Development in an Unequal World,* he argues that social equity must be addressed in all decisions of economics and environment for any true sustainability to be achieved.

CURRENT RESEARCH

Bullard's current research focuses on how U.S. government response to emergencies (including flood, drought, hurricane, and accidents) has consistently endangered the health and welfare of African Americans. He states, for example, that the inadequate response to Hurricane Katrina in Louisiana fits a historical pattern of institutional racism. He argues that the response to Hurricane Katrina was not an aberration, nor was it solely due to the incompetence on the part of a particular agency or administration. Rather, natural disasters are made worse by the way society differentiates between race and class. He also extends this logic globally, suggesting that the framework of the environmental justice movement can resonate across many environmental and social issues facing developing countries.

For the past 25 years, Bullard has maintained a leading role in advocating for environmental justice. His academic research and dedicated activism have significantly influenced the environmental movement by introducing class and race into the analysis of how environment and society interact. Bullard is currently the director of the Environmental Justice Resource Center at Clark Atlanta University.

SEE ALSO: Clinton Administration; Development; Justice; Landfills; United Church of Christ–Commission for Racial Justice; Waste Incineration.

BIBLIOGRAPHY. Robert Bullard, *Dumping in Dixie: Race, Class, and Environmental Quality,* 3rd ed. (Westview Press, 2000); Robert Bullard, *Just Sustainabilities: Development in an Unequal World* (MIT Press, 2003); Gregory Dicum, "Justice in Time: Meet Robert Bullard, the Father of Environmental Justice," *Grist Magazine* (March 14, 2006), www.grist.org (cited May 2006); Robert Gottlieb, *Forcing the Spring: The Transformation of the American Environmental Movement* (Island Press, 1993); Richard Hofrichter, ed., *Toxic Struggles: The Theory and Practice of Environmental Justice* (New Society Publishers, 1993); Jim Motavalli, "Dr. Robert Bullard: Some People Don't Have the 'Complexion for Protection,'" *E Magazine* (July/Aug 1998), www.emagazine.com (cited May 2006).

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Bureau of Land Management, (U.S.)

FOUR FEDERAL AGENCIES administer most of the 671.8 million acres of land in the United States owned by the federal government (as of 2004, 29.6 percent of the total): the Bureau of Land Management (BLM), the National Park Service, the Fish and Wildlife Service in the Department of the Interior, and the Forest Service in the Department of Agriculture. The BLM manages the largest proportion, 261.5 million acres (12.5 percent of the total land in the United States) and is responsible for managing subsurface mineral resources on an additional 300 million acres. Most of the lands the BLM manages are located in ten western states and Alaska and are dominated by rangelands and deserts and, in Alaska, by forests, high mountains, and arctic tundra. The BLM manages a wide variety of resources and uses, including energy and minerals; timber; forage; wild horse and burro populations; fish and wildlife habitat; wilderness areas; archaeological, paleontological, and historical sites; and other natural heritage values.

The BLM came into its role almost by default. In the late 19th century, the creation of the first national parks and forests reserves signaled a shift from a congressional policy of transferring the ownership of lands from public to federal. Formed last among the land management units, the BLM came to manage land unclaimed—and considered less valuable—by the Parks and Forest Service. The BLM was created in 1946 through the merger of two agencies: the General Land Office and the Grazing Service. The General Land Office was created by Congress in 1812 to oversee the survey and disposal of public domain lands ceded to the federal government by the 13 original colonies or acquired through treaty or purchase. The Grazing Service, initially known as the Division of Grazing, was established in accordance with the 1934 Taylor Grazing Act to manage those public domain lands deemed chiefly valuable for grazing, pending their final disposal. This act delegated much decision-making power to local grazing boards, and the Grazing Service was intended to resemble more of a temporary custodian of the public rangelands than a powerful agency. Its existence was characterized by conflict with the Forest Service over control of grazing on the public domain and with Congress and the western cattle industry over the setting of grazing fees. In addition, because it was formed through an executive reorganization, the BLM operated on insecure foundations and under a maze of confusing and sometimes conflicting regulations, until 1976 when Congress passed the Federal Land Policy and Management Act (FLPMA), sometimes called the BLM Organic Act. The BLM is still hampered by these initial weaknesses and a per-acre budget much lower than the other federal land management agencies.

EQUIPPING THE BLM

FLPMA declared that the public lands would be retained in federal ownership; superceded and rationalized many existing public land laws and regulations; officially gave authority and direction for managing the public lands to the BLM; and gave the agency its multiple-use, sustained-yield mandate. It eliminated the grazing boards and set up a system of federal grazing regulations, 43 CFR 4100, to provide uniform guidance for administration of grazing on the public lands exclusive of Alaska; this strengthened BLM's ability to regulate grazing and placed greater emphasis on maintaining or improving the ecological health of public rangelands. It also directed the BLM to inventory the lands it managed for wilderness characteristics, as the 1964 Wilderness Act had directed the National Park Service and the Forest Service. With this mandate, the BLM was finally equipped to manage the public lands. Even so, controversy follows agency management decisions, especially in ongoing debates about the role of grazing on public lands versus conservation, recreation, and other land uses. Critics continue to argue that the agency remains subject to "capture" by narrow interests, though the increasingly enlarged mandate of BLM has made such controversies more complex and multi-sided.

The BLM has organized into a Washington office with a politically appointed director and 12 state offices, each with a state director. Each state is organized into field offices, whose managers report to the state directors. In 2001, the BLM created a National Landscape Conservation System to administer the national monuments, National Conservation Areas, Wilderness Areas, Wilderness Study Areas, National Historic Trails, and Wild and Scenic Rivers under its jurisdiction.

BIBLIOGRAPHY. Bureau of Land Management, www.blm.gov(cited May 2006); J.N. Clarke and D. C. McCool, *Staking Out The Terrain: Power And Performance Among Natural Resource Agencies*, (Albany, State University of New York Press, 1996); Debra Donohue, *The Western Range Revisited: Removing Livestock from Public Lands to Conserve Native Biodiversity* (University of Oklahoma Press, 1999); Christopher McGrory Klyza, *Who Controls the Public Lands? Mining, Forestry, and Grazing Policies, 1870–1990* (The University of North Carolina Press, 1996); Karen R. Merrill, *Public Lands and Political Meaning: Ranchers, the Government, and the Property Between Them* (University of California Press, 2002); Carol Hardy Vincent, *Federal Land Management Agencies: Background on Land and Resources Management, Congressional Research Service Report RL32393* (Library of Congress, 2004).

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Bureau of Reclamation (U.S.)

IN THE LATE 19th century, insufficient rainfall caused western settlers in the United States to use irrigation for farming, and pressure escalated for the federal government to create and manage irrigation and reservoir storage projects. The U.S. Congress was already investing in the nation's growing infrastructure: Roads, navigable rivers, harbors, canals, and railroads were being built, maintained, and/or developed. Westerners especially needed the government to invest in regional irrigation projects, and this movement showed its strength when irrigation platforms were debated during the presidential election in 1900. It was therefore only two years later that the Bureau of U.S. Reclamation Service would be created.

In 1924, Congress authorized the building of the Hoover Dam in Boulder Canyon, Nevada, using federal funding.

On July 17, 1902, Congress passed the Reclamation Act, which required that water users repay construction costs from which they received benefits, and was created to study the need for and institute water development projects in federal lands across the western states. Secretary of the Interior Ethan Allen Hitchcock then established the U.S. Reclamation Service within the U.S. Geological Survey (USGS) to operate solely on the revenue from federal land sales, but since Texas had no federal land, it was not included in any reclamation projects until 1906, when Congress passed a special act to include it. In 1903, the Roosevelt Dam and the Salt River Project was the first major project under this new Act, and ultimately made Phoenix, Arizona, a thriving agricultural and urban site.

In 1907, the Secretary of the Interior separated the Reclamation Service from the USGS, and created an independent bureau within the Department of the Interior with Frederick Haynes Newell appointed as its first director. These first years have been called the Irrigation Age; however, many of the bureau's early water projects were fraught with problems—land was purchased that was unfeasible for irrigation; many early settlers were inexperienced in the use of irrigation; some lands were over-irrigated, requiring expensive drainage plans; irrigation customers were unable to repay their loans from exorbitant preparation and construction costs; settlements were abandoned; shady land dealings and speculation created an atmosphere of mistrust; and many projects were created in farmlands only suitable for low-value crops.

In 1923, the agency was renamed the Bureau of Reclamation, and one year later, Congress authorized building of the Hoover Dam in Boulder Canyon, Nevada. This monumental project required large appropriations; and for the first time, the Bureau began to receive substantial federal funding, but only after a lengthy public debate about supporting public power versus its private-sector creation and supervision. Called the Multi-Purpose Era, huge projects followed one after another including Boulder Dam, the Columbia Basin, the Colorado–Big Thompson, and the California Central Valley Projects. These largest water facilities started during the Great Depression and lasted until the decades after World War II. From 1941–47, civilian public service labor was used for extensive western water projects that had been interrupted by the war.

GRASSROOTS OPPOSITION

The last major construction projects occurred in the 1960s, when the American environmental movement gained influence to develop considerable grassroots groups opposed to the water development projects. In 1976, when the Teton Dam failed as it was filled for the first time, it barely tarnished the Bureau's international status; however, it was America's growing environmental movement, in addition to President Carter's criticism of water projects, that many believe most affected the Bureau of Reclamation's direction and planned projects across the western United States. During the late 1980s, the bureau reorganized all plans for projects planned up to 40 years before stating that "the arid West essentially has been reclaimed."

The Bureau of Reclamation is now a division of the U.S. Department of the Interior, and administers and oversees all water development projects in the western United States (180 projects in 17 western states) and provides agricultural, household, and industrial water to about one-third of the population in that region. In 1992, roughly 5 percent of western lands were irrigated, and the bureau supplied water to about 20 percent of the region, or about nine million acres. Also, dams constructed by the Bureau of Reclamation are major electricity generators, with 56 power plants online, generating 35,000 megawatt hours of electricity in 1996.

SEE ALSO: Dams; Department of the Interior; Hoover Dam; Hydropower; Water Demand.

BIBLIOGRAPHY. David P. Billington and Donald C. Jackson, *Big Dams of the New Deal Era: A Confluence of Engineering and Politics* (University of Oklahoma Press, 2006); J.N. Clarke and D.C. McCool, *Staking Out The Terrain: Power And Performance Among Natural Resource Agencies* (Albany, State University of New York Press, 1996); William D. Rowley, *Bureau of Reclamation: Origins and Growth to 1945* (United States Dept. of the Interior, 2006).

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Burkina Faso

BURKINA FASO IS a landlocked country in West Africa, north of Ghana, Togo, and Côte D'Ivoire, formerly known as Haute Volta (Upper Volta). Despite its relative international obscurity, it is known for three things: its people, particularly its rural population's struggle against poverty in a sometimes harsh and unyielding physical milieu; a legacy of recent political populism; and the presence of extensive and sometimes innovative international development assistance. Most of the country lies in the Sahelian and Sudano-Sahelian climatic zone. It is wetter and thus more productive in the south than the north, where rainfed cropping gives way to herding. A unimodal rainfall pattern allows the cultivation of dryland crops, particularly millet and sorghum, on ferruginous and sandy soils in summer. Sugar and cotton are also grown, primarily in the wetter southwest.

Population growth is rapid in Burkina (to approximately 13 million in 2006), and parts of the rural hinterland have median densities (50 persons/square kilometer) and intensive cultivation systems. Some 90% are primarily engaged in subsistence farming or herding, and urban growth is concentrated in Ouagadougou (the capital) and Bobo-Dioulassou. The primary exports, gold, cotton, and livestock, are vulnerable to price fluctuations. The country lacks reserves of natural resources and imports its fuel, some food, and other essentials. It is one of the world's poorest five countries with a Gross National Income per capita of approximately $350 per year.

HISTORY OF THE REGION

This region was occupied by hunter-gathers for at least 12,000 years, and was first farmed 5,000 years ago. The Mossi people, warrior-farmers from northern Ghana, conquered and intermingled with indigenous inhabitants since at least the 1400s, establishing several kingdoms. Several other ethnic groups are found in the west, and Fulani herders to the north. Burkina became a colony of France in 1896, and through several colonial configurations, the administration used forced and voluntary labor for work on plantations and other projects across its regional territories, because other economic options were so limited. The country achieved independence peacefully in 1960.

From 1983–87, Burkina was led by Capt. Thomas Sankara, one of Africa's most charismatic leaders. Sankara challenged gender inequality, nepotism, the power of chiefs and pervasive post-colonial domination by France, and launched major campaigns to provide rural health care and infrastructure. Blaise Compaoré, who has ruled since 1987 before and after national elections, has overseen the embrace of neoliberalism, privatization, and less-discriminate aid flows. Decentralization is also being pursued.

Despite persistent drought, Burkina's farmers are masters of their milieu. They have adapted to climatic uncertainties through intensive micro-management of soil, water, labor, and crop varieties. Unpredictable conditions means livelihood diversification is the norm: the "bricolage" of locally-based and more distant activities, the latter including a significant economic migration stream to the West African coast and beyond. Migration to the plantation and urban economy of Côte D'Ivoire has traditionally been huge, but has fallen since 2001 with the xenophobia that preceded civil war in that country.

Major famines across the Sahel in the 1970s and 1980s were sparked by a succession of poor rainy seasons, and magnified by poor institutional capacity. Strong international humanitarian support to Burkina dates from this period. It has included numerous bilateral and nongovernmental programs, including assistance for health, food security, and sustainable production. For example, there has been great innovation in soil and water conservation supported by Oxfam, GTZ, Six-S and other organizations. Semi-permeable rock bunds (walls), built by locals across contours in hundreds of communities, captured summer rains on slopes and increased infiltration rates and crop yields. This "miracle" conservation strategy attracted international attention and support, because its success depended on a combination of appropriate technology, Sankariste local communitarianism, and social cohesiveness among Mossi and other peoples.

SEE ALSO: Appropriate Technology; France; Poverty.

BIBLIOGRAPHY. P. Englebert, *Burkina Faso: Unsteady Statehood in West Africa* (Westview Press, 1999); L. Engberg-Pedersen, *Endangering Development: Politics, Projects and Environment in Burkina Faso* (Westport, CN & London: Praeger, 2003); S. Hagberg, Poverty in Burkina Faso: Representations and Realities, (Uppsala: Uppsala Universitet, 2002); Jeune Afrique, *2001 Burkina Faso Atlas*. (Paris: Editions Jeune Afrique).

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Burundi

IN THE EARLY 1990s, the Republic of Burundi experienced the assassination of its first democratically elected president after only 100 days in office. The ethnic conflict between the Hutu majority (85 percent) and the Tutsi minority (14 percent) that followed the assassination lasted for almost 12 years and led to the deaths of 200,000 Burundians. Hundreds of thousands more fled to other areas in Burundi and to neighboring countries, chiefly Tanzania. In 2003, international groups engineered a peace agreement; and in 2005, the Hutu elected a new president. However, rebel groups continue to threaten political and economic stability.

With a per capita income of only $600, Burundi is the sixth poorest country in the world. Nearly 70 percent of the population lives in extreme poverty. Income is unevenly distributed, with the richest 10 percent of the population holding almost a third of all resources and the poorest 10 percent sharing 1.8 percent of income. Burundi's largely undeveloped natural resources include nickel, uranium, rare earth oxides, peat, cobalt, copper, platinum, vanadium, hydropower, niobium, tantalum, gold, tin, tungsten, kaolin, and limestone. More than 35 percent of Burundi is arable, and 93.6 percent of the workforce is engaged in subsistence agriculture. Together, tea and coffee exports furnish 90 percent of Burundi's foreign exchange revenues. Depressed prices on these markets in recent years have led to declining revenue and efforts at increasingly intensive cultivation.

Burundi, which is situated at the crest of the Nile-Congo watershed in central Africa, shares borders with the Democratic Republic of the Congo, Rwanda, and Tanzania. The climate of Burundi is equatorial, and altitudes vary from 772 meters at Lake Tanganyika along the western border to 2,670 meters at Heha in west central Burundi. The mostly moderate temperatures vary according to altitude. Around 150 centimeters of rain falls on Burundi during the wet seasons that occur between February and May and between September and November. Most of Burundi's terrain is hilly and mountainous, with interspersing plains and a plateau in the east. Burundi experiences both flooding and drought, and landslides are common.

With one out of every 10 adults in Burundi living with HIV/AIDS, the country is experiencing a major health crisis. Some 25,000 individuals had died of this disease by 2003. Around 21 percent of Burundians lack sustained access to safe drinking water, and 64 percent lack access to improved sanitation. Consequently, the population faces a very high risk of contracting food and waterborne diseases such as bacterial diarrhea, hepatitis A, typhoid fever, and malaria, a vectorborne disease. High incidences of disease result in low life expectancy (50.81 years), population growth (3.7 percent), high infant mortality (63.13 deaths per 1,000 live births), and death rates (4.22/1,000). Burundian women bear an average of 6.8 children. Since only one of every two children attends school and only 45.2 percent of females and 58.8 percent of males are literate, it is extremely difficult to disseminate essential information on health and the environment.

CRIPPLED ENVIRONMENT

Soil erosion is accelerating in Burundi in response to overgrazing and the encroachment of agricultural development into marginal lands. The loss of large areas of forest for fuel use has produced an annual deforestation rate of 9 percent. Because of declining rainfall and the destruction of forests, water catchments, and ecosystems, northeastern Burundi, where many refuges fled during the civil war, is experiencing major food shortages. This destruction motivated by attempts to survive has spread to the Murehe Nature Reserve, depleting the bamboo and aquatic grasses and threatening biodiversity. Of 107 endemic mammal species, six are threatened, as are seven of 145 bird species. While laws have been enacted to prevent illegal hunting and poaching, they are rarely enforced.

In 2006, scientists at Yale University ranked Burundi 108 of 132 countries in environmental performance, slightly above the comparable geographic and income groups. The lowest scores were received in the areas of environmental health, biodiversity and habitat, and production of natural resources. The Ministry for Land, Environment, and Tourism is responsible for implementing environmental laws in Burundi, which focus on sustainable development and eradicating poverty. The Burundi government participates in the following international environmental agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, and Ozone Layer Protection. The Law of the Sea agreement has been signed but was never ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome; Coffee; Famine; Infant Mortality Rate; Life Expectancy; Poverty.

BIBLIOGRAPHY. CIA, "Burundi," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); IRIN, "Burundi: Environmental Causes behind Food Shortages in Northern Kirundo," www.irinnews.org (cited May 2006); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); UNDP, "Human Development Reports: Burundi," www.hdr.undp.org (cited May 2006); World Bank, "Burundi," *Little Green Data Book,* www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Bush, George H. W. Administration

ON NOVEMBER 15, 1990, President George H. W. Bush signed amendments of the Clear Air Act—an act written by congressional Democrats—into law, and declared in the East Wing of the White House that "polluters must pay." While campaigning against democrat Michael Dukakis of Massachusetts, Bush accused his opponent of being lax on pollution in Boston Harbor, declaring that Dukakis delayed and caused the harbor to get "dirtier and dirtier." President Bush also declared in 1988, "I am an environmentalist; always have been and always will be." Bush claimed he would aggressively enforce environmental laws and standards. In many ways, Bush realized this campaign promise. Recognizing their vital, long-term importance in sustainable development, he created a "no net loss" policy toward wetlands and development that required the protection of wetlands or the creation of new ones. President Bush attended the Rio Environmental Summit in Brazil in 1992, but did not ultimately sign its final provisions. The famous summit introduced the term *sustainable development* into common speech, which means creating conditions for economic development that do not leave developing countries worse off environmentally than when they began.

HESITATIONS ON POLICY

Even as he strongly advocated for environmental protections and seemed to have a personal interest in the environment, President Bush also had reservations about the possible negative consequences of environmental policies that could be implemented too quickly. He claimed in 1992, "We cannot keep some of the extremes of the environmental movement happy because I believe that a sound environment can go hand-in-hand with reasonable growth." President Bush was particularly concerned about how strict environmental provisions might affect jobs, especially in the lumber industries of the northwest where "40,000 people could be thrown out of work." When asked about the environment in a presidential debate, he refused to "burden the automobile industry with the kind of costs the Europeans wanted us to put on the industry." He also mentioned the American families who would be affected by overly protective policies toward the Spotted Owl, a symbol of the environmental movement as well as popular resistance to some environmental policies that affected jobs. Bush seemed determined to protect the environment in principle; but he was wary of the political consequences of signing international agreements and enforcing policies that might—in the short term—risk the jobs of American voters.

SEE ALSO: Clear Air Act; Rio Declaration on Environment and Development; Timber Industry.

BIBLIOGRAPHY: R. Barilleaux and M. Rozell, *Power and Prudence: The Presidency of George H. W. Bush* (Texas A and M University Press, 2004); Marc Davis, *George H. W. Bush* (Compass Point Book, 2002); Richard Himelfarb and Rosanna Perotti, eds., *Principle Over Politics?: The Domestic Policy of the George H. W. Bush Presidency* (Greenwood Publishing Group, 2004).

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Bush, George W. Administration

WHILE IT IS far too early to judge the legacy of a sitting president, many have called George W. Bush the weakest environmental president in history; even Republicans have criticized President Bush for his environmental record. In addition, much of the public does not support Bush's environmental initiatives. A USA Today/CNN/Gallup poll taken in 2004 found those who disapprove of Bush's environmental record had risen to 45 percent. Another 2004 poll found 65 percent of Americans did not believe the Bush administration would make environmental progress in the next term.

In keeping with the governing philosophy of the administration, several controversial policies of the administration have sought to reconcile environmental protection with issues of economic growth. Specifically, the Bush administration has pushed to open the Arctic National Wildlife Refuge (ANWR) for oil and gas development, asserting the minimal risk that modern extraction represents to native wildlife and stressing the problem of dependence on foreign oil. Critics suggest that the artic ecosystem is especially fragile and that the limited reserves in ANWR represent a limited benefit for the risk. The administration has also advanced a forest fire control policy for National Forests, the Healthy Forests Restoration Act of 2003 (or Healthy Forests Initiative), which seeks to thin forest stands through contracts to private timber companies. Critics maintain that these efforts at "thinning" represent unwarranted subsidized access for loggers to pristine forest areas that do not represent a serious fire hazard.

The administration also has withdrawn United States support, committed under the previous administration, for the Kyoto Protocol, an international attempt to reduce greenhouse gas emissions. The administration argues that, as currently written, Kyoto exempts large countries like China and India from immediate action, producing an unfair trade advantage for these growing industrial powers. Critics maintain that lack of leadership on this crucial problem further marginalizes the United States in key issues of global governance.

The Bush administration has also sought to exempt the Department of Defense, one of the nation's worst polluters, from critical environmental laws. The Natural Resources Defense Council (NRDC) released their report of Bush's first term in 2004, citing over 150 destructive policy actions in just the previous year. They claimed the worst offenses to be the amount of toxic releases from industrial facilities, worsened mercury contamination, sewage contamination, and air pollution. Equally controversial, on the inauguration day of his first term, President Bush mandated that all federal agencies halt pending regulations established by the Clinton administration, including at least a dozen regulations dealing with the environment.

President Bush has also made a number of controversial decisions in filling key environmental positions. These include the posting of a former timber lobbyist to Undersecretary for Natural Resources and Environment with the Department of Agriculture; a former lobbyist for power companies and major electricity users to the post of Chairman for the Council on Environmental Quality (CEQ); an attorney who formerly represented mining interests to Assistant Secretary for Land and Minerals Management; and an attorney who previously represented clients in cases against the Environmental Protection Agency (EPA) regarding chemical and air pollution to the helm of the administration's overhaul of the Clean Air Act, governing industrial plants pollution controls.

The Bush administration defends their record. They cite continued progress in regard to access to clean water, cleanup of hazardous wastes, land conservation and stewardship, increased aid and cooperation for conservation efforts, improving air quality, and addressing global climate change.

A nondiesel road rule is aimed at reducing air pollution from diesel-powered bulldozers, tractors, boats, and other off-road engines.

Nevertheless, the administration's strategies for managing their environmental image point to continued problems. Critics point to euphemistic names for policies that slacken regulatory authority in ways that make them more appealing, such as "Healthy Forests Initiative." The final evaluation of the administration's environmental record will be judged in the future, but current controversy remains pronounced.

SEE ALSO: Arctic National Wildlife Refuge; Clean Air Act; Clinton Administration; Kyoto Protocol; Natural Resources Defense Council

BIBLIOGRAPHY. Council on Environmental Quality homepage, www.whitehouse.gov/ceq (cited May 2006); Robert Devine, *Bush versus the Environment* (Anchor Books, 2004); Robert F. Kennedy Jr., *Crimes against Nature: How George W. Bush and His Corporate Pals are Hijacking our Democracy* (HarperCollins, 2004);"The Bush Record," Natural Resources Defense Council (NRDC), www.nrdc.org/bushrecord (cited May 2006).

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Butterfly Effect

THE *BUTTERFLY EFFECT* is colloquial language used to describe the idea within chaos theory called *sensitive dependence on initial conditions*. This principle became the cornerstone to the science of chaos theory. Scientists interested in the butterfly effect and chaos theory are concerned about initial conditions, determinism, uncertainty of measurement, dynamic instabilities, manifestations of chaos, and perceiving new order.

It is because of the constant butterfly effect that the world's weather forecasts remain very imperfect. They are accurate for a few days, but beyond six or seven they become speculative. This is the butterfly effect in action. Tiny pieces of weather cascade into bigger and bigger effects. Likewise, mistakes and uncertainties in calculations create false assertions that, when expanded millions of times, result in false predictions.

Chaos theory, originating within mathematics and meteorology, posits that all systems, including complex and seemingly chaotic ones, are determined by underlying order, and tiny movements in a system can build to large events (the butterfly effect). The term *chaos theory*, however, can be misleading because the theory attempts to describe phenomena that appear to be random, periodic, and chaotic, but actually evolve in complex systems and interactions among systems according to exact and predictable rules.

Chaos theory is sometimes presented as esoteric knowledge, but many researchers illustrate the principles with very simple examples like swinging pendulums, bouncing balls, and pinball machines. Slightly different inputs can determine very different results.

Chaos theory posits that even tiny movements in a system can build to large events (the butterfly effect).

Chaos theory is both a challenge to and an extension of the deterministic view of science. Determinism is historically a central belief in modern science. Newton thought scientists could know the future of the physical universe by measuring initial conditions and applying the physical laws determining its development. Newtonian science assumes that more precise measurements of a phenomenon will yield more accurate predictions about future events. The assumption was that an inability to make accurate predictions was related to problems in making accurate enough measurements. Discoveries in astronomical science, however, reveal that tiny errors in the measurement of initial states yield large and unpredictable outcomes. Two or more nearly identical states can yield vastly different outcomes. Even if measurements could be made thousands of times more accurately, the uncertainty of the outcome doesn't decrease along with the refined starting measurement.

Edward Lorenz arrived at his chaos observations during his attempts to to create better meteorological predictions with early computers, which had the capacity to conduct vast mathematical problems with slight iterations. He observed in his models that changing the values in numeric systems at the level of the thousandths decimal led to different weather phenomena after many iterations. Slight differences in initial conditions created large differences in outcome. At the time, it was not believed such small differences were significant. Yet, the instruments used to measure weather were not even as accurate as Lorenz's hypothetical models. Because perfect measurements of initial conditions, especially in large systems with many variables, are impossible, predictability is extremely problematic.

Initial conditions are also problematic to define, because one researcher's initial conditions may be another's conditions of midstream. Additionally, measuring initial conditions in any given moment will not give a full picture of the current processes, directions, and causes of the initial condition.

Sensitive dependence is also empirically difficult to measure, as it implies more than a relationship between two states. It implies that there are deterministic, dynamical systems. Dynamical systems have moments of near balance and instability, and small influences can have large consequences. Initial differences of one unit may increase a hundred times in one system and a million times in another, and the variable of time will differentiate systems even more.

Chaos theory maintains that things that appear chaotic are actually not chaotic at all. The central goal in chaos theory is development of a science and perception that can detect a pattern in a seemingly chaotic system. According to James Gleick, author of *Chaos: Making a New Science*, chaos theory is "a revolution not of technology, like the laser revolution or the computer revolution, but a revolution of ideas." Chaos is actually orderly disorder, and the task is to perceive the order.

Many physicists claim chaos theory is about a description of process rather than a being or state. Chaos theory breaks across academic disciplines because it is interested in the holistic nature of systems. Mathematicians, physicists, chemists, biologists, ecologists, and economists are all interested in irregularity. Advocates of chaos theory say chaos theory and the recognition of the butterfly effect have turned back the reductionistic trend in science. The environmentally oriented philosophy known as deep ecology embraces the butterfly effect as it illustrates well the fragile dynamic relationship between seemingly disparate elements.

SEE ALSO: Chaos Theory; Deep Ecology.

BIBLIOGRAPHY. James Gleick, *Chaos: Making a New Science* (Viking, 1997); Nina Hall, *Exploring Chaos: A Guide to the New Science of Disorder* (W.W. Norton, 1991); L. Douglas Kiel and Euel W. Elliott, *Chaos Theory in the Social Sciences: Foundations and Applications* (University of Michigan Press, 1997); Edward N. Lorenz, *The Essence of Chaos* (University of Washington Press, 1993); Garnett P. Williams, *Chaos Theory Tamed* (National Academies Press, 1997).

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Cacao

PRECOLONIAL MAYAS OF Central America described cocoa, the main ingredient of chocolate, cocoa butter, and cocoa powder, as the "food of the gods." But since the early to mid-19th century, when Europeans developed milk chocolate and solid chocolate, cocoa has certainly become a culinary delight for humans. Cacao (*Theobroma cacao*) is the tree that produces the cocoa beans from which cocoa is derived. The crop's origin is the Amazon Basin, and today 75 percent of cacao is cultivated in broadly similar humid lowland tropical forest environments, within 8 degrees of the equator.

SWEEPING CHANGES IN PRODUCTION

The history of cacao production for markets is a history of remarkable changes—socioeconomic, cultural, and ecological. Globally, cacao production levels tell a story of change that shows a historical trend of significantly rising output. The collective output of the four largest producers of cocoa beans—Côte d'Ivoire, Ghana, Indonesia, and Brazil (in order of rank from the largest producer)—expanded in recent decades by over 650 percent, from 381, 000 metric tons in 1951 to 2,889,774 metric tons in 2005 (which is 81 percent of the 2005 global cocoa bean output of 3,552,586 metric tons). Nationally, cocoa products have made sizeable contributions to government tax revenues, foreign exchange earnings, national income, and employment. For instance, in Ghana, the cocoa economy has established itself as a major component of the national economy since the late 19th century, when cocoa exports began. While the relative economic contributions of cocoa have declined as Ghana's economic activities have expanded, the cocoa sector remains important, contributing a fifth of total export income of about $1.9 billion in 2001. The 23 percent of rural households involved in cacao production are the source of 83 percent of Ghana's cocoa income.

The story of change associated with cacao production is also a local story. Locally, the commercial production of cacao has been historically a vehicle of modernization and social change that brought increased trade and other economic activities, as well as greater access to transportation and formal education. Also, social differentiation and gender relations in cacao producing societies have been influenced by access to income and wealth from cocoa sales. In West Africa, a region that produces over 70 percent of global cocoa beans, cacao production

The impact of cacao production has been global, from indulgence in chocolate to the impact on biodiversity.

increasingly drew rural dwellers into commercial activity that transformed relations of production, changed land and labor relations, and modified processes of access to land and labor. Within the rural settings where cacao is produced, land transactions have become more commercialized and land rights more exclusive (to provide land tenure security for cacao farmers), compared to pre–cacao production customary practices and rights. Changes have also occurred in the types of labor employed by the rural cacao farmers. For instance, the use of hired labor increased with cacao production, but so did problems of labor motivation and control in this labor-intensive enterprise. And since 2000, a more troubling observation in Côte d'Ivoire is the reemergence of an early 20th-century practice of increasing use of forced child labor on cacao plantations. As in all capitalist enterprises, keeping costs of labor and other cacao production costs low is a key to profit making. And keeping costs of production low at all levels of the cocoa supply chain—from the cultivation of cacao to its manufacture into other value-added cocoa products—is what ultimately translates into the cheap chocolate consumed in ever larger quantities in Europe and North America.

IMPACT ON ENVIRONMENT

The impacts of changes in the environment–society relations associated with cacao production are garnering increased attention. Cacao production marks a shift in the way societies managed their environment. Prior to the introduction of export crops, the bush fallow/shifting cultivation agroforestry system of agriculture, involving the recycling of land between cultivation and forest fallow, had little permanent effects on farmlands. The soils and forest vegetation had enough time to regenerate after a short period of cropping. Also, the scale of ecological disturbance was small, as much of the production was for subsistence.

The fact that cacao trees are widely cultivated under the shade cover of natural indigenous canopy trees that are left standing as farms are made, or cultivated under a planted canopy of trees, would intuitively suggest that the ecological impacts of cacao production in tropical forests would be minimal. However, cacao production simplifies a complex ecosystem. The under-story vegetation of forests is drastically suppressed, and the density of the upper-story canopy trees is severely altered to make room for cacao trees. And an increasing number of farmers are completely eliminating shade trees on monospecies cacao farms to boost their yields in high-chemical input farms. Biodiversity is thus endangered and threatened over time, and so are a variety of ecological processes, whose absence depletes soil nutrients and increase pests and fungal and viral diseases on cacao farms. A further environmental issue is the use of agrochemicals to sustain short-run cacao yields and its implications for environmental contamination and human health.

Declining yields (often after 20 to 25 years of cultivation) in the old cacao producing frontiers, as soils decline in fertility and as cacao pests and diseases proliferate, make production unsustainable and have led to the search for richer soils and exploitation of new forests, in a cycle of destruction in which the biotic and edaphic components of the environment deteriorate over time. In just 20 years (1984–2004), the size of the area from which cocoa beans were harvested within tropical forests increased by 2.2 to 7 million hectares, and much of this 47 percent increase came from the four leading cocoa bean producers, particularly from Indonesia.

The impact of cacao production has been truly global in scope; from the global indulgence in chocolate treats to the role of cacao production as a major threat to global biodiversity. Cacao production has yet another potential global impact: the potential of ameliorating biodiversity decline and global warming through well-managed cacao farms that grow cacao under a wide variety of planted shade vegetation species and that retain an array of natural vegetation life forms in the tropical forests.

SEE ALSO: Agroforestry; Biodiversity; Cash Crops; Shifting Cultivation; Sustainability.

BIBLIOGRAPHY. Sara Berry, *No Condition Is Permanent* (University of Wisconsin Press, 1993); FAO, FAOSTAT database, "World Crop and Livestock Statistics 1948–85," www.fao.org (cited April 2006); Ghana Statistical Service, *Ghana Living Standards Survey: A Report of the Fourth Round (GLSS 4)* (Ghana Statistical Service, 2000); Institute of Statistical, Social and Economic Research (ISSER), *The State of the Ghanaian Economy* (ISSER, various years); Robert Rice and Russell Greenberg, "Cacao Cultivation and the Conservation of Biological Diversity," *Ambio* (v.29/3, 2000); Elliot Schrage and Anthony Ewing, "The Cocoa Industry and Child Labor," *Journal of Corporate Citizenship* (v.18, 2005).

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Cadastral Maps

CADASTRAL MAPS ARE maps of properties. They identify plot boundaries, and so generally are very large-scale (covering a relatively small area in great detail), and identify the owner(s) and/or user(s) of each property, usually by linking plots on a map to a written register that records ownership and use, and often other details such as the area of the plot. Before maps were used for these purposes, written registers recorded each plot's owner(s) and/or user(s), and a description of plot location and boundaries. The change from written to mapped cadasters started about 1570 and continued primarily through 1900, in tandem with a move to capitalist property relations and market-orientated agriculture. England was an early leader, probably because capitalist economic relations emerged so early there. Sometimes the written textual descriptions remained the authoritative legal documents proving ownership, the maps being merely descriptive accompaniments. Cadastral maps, called *estate maps*, record the property owned in one area by one person, family, or body such as a college. Such maps usually remained in manuscript, being of interest to only a few people who commissioned the maps to help them manage their estates.

Publicly commissioned cadastral maps record the plots of all the property owners and/or users in one administrative unit, and may be commissioned by government at all levels. Publicly commissioned cadastral mapping, which was practiced by the Romans at least as early as the second century B.C.E., began again in the early 17th century in the Netherlands and Sweden and continues today. The public authority might order such mapping for several reasons: to impose taxation, to reallocate land, as an inventory of national resources, to distribute plots on land to be settled, or as a public legal record to aid property transactions. Such projects almost invariably aroused opposition, either for the general reason that they absorbed time, personnel, and money that others thought might be better spent elsewhere, or from those who would suffer from the particular measure being effected by the maps. Nobles resented taxation surveys, which threatened their traditional immunity from taxation; peasants resented land redistribution schemes, which threatened their precarious livelihoods; and local people resented imperial surveys, which would allow central authorities more control over their lives. Publicly commissioned cadastral mapping did not always represent a threat: some of the earliest occurred in polder areas of the Netherlands, where people knew they must work together to raise money for dikes to keep their lands dry.

Because each publicly commissioned cadastral map was used by relatively few people, they generally remained in manuscript and in government archives. A few, such as those advertising plots for sale in newly laid out towns, were printed. Between the private estate maps and the publicly commissioned cadastral maps lie maps of crown estates (land over which the crown, or later in some countries the state, has rights, but which may include plots of land held by others). Where the estate in question was small and the purpose of the map was land management, the maps often resemble estate maps. There are many beautiful examples of such maps, made for display by the prince and perhaps showing his hunting grounds. Where such estates covered huge tracts of land or had many tenants, they resemble government cadastral maps and could have a connected purpose, because the more money raised by the crown through effective administration of crown estates, the less pressure for taxation to fund government. Government cadastral maps gradually changed from being used to effect one particular measure to being a body of information useful for a variety of government needs. Cadastral maps today are mostly publicly commissioned, and many use geographical information systems accurately and comprehensively to record information for many purposes.

SEE ALSO: Ecomanagerialism; Land Use Policy and Planning; Maps.

BIBLIOGRAPHY. Roger J.P. Kain and Elizabeth Baigent, *The Cadastral Map in the Service of the State: A History of Property Mapping* (University of Chicago Press, 1992); David Buisseret, ed., *Rural Images: Maps in the Old and New Worlds* (University of Chicago Press, 1996).

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Cairo Guidelines on Waste Trading (UN)

THE UNITED NATIONS Environment Program (UNEP) adopted the Cairo Guidelines and Principles for the Environmentally Sound Management of Hazardous Wastes, or Cairo Guidelines on Waste Trading, in 1987. The guidelines dealt with the nature and transport of hazardous wastes, primarily by sea, and the informed consent to be given by states through whose territory the waste passed and the prior notification that states were to receive. These guidelines were necessary to regulate the increasing flows of such wastes and their often-toxic nature. Maritime trade had also become an almost entirely globalized industry with regulations almost impossible to enforce. Concern had been raised in 1981 at the Ad Hoc Meeting of Senior Government Officials Expert in Environmental Law that was held in Montevideo, and gave rise to an Ad Hoc Working Group that provided the guidelines that were ultimately adopted.

The process of negotiation was controversial because of the unclear nature of what exactly defines waste and other technical issues. However, the continuing stream of problematic shipping accidents galvanized the discussions. Even so, a variety of political arguments meant that it took several years before ratification could take place, even though it required the signatures of only 20 countries. One of the most significant areas of controversy focused on the nature of the guidelines, which provided a basis for continued transportation of waste and not the complete ban preferred by many interests. Ultimately, the guidelines were ratified as the Basel Convention in 1987.

Some conflict has centered on what qualifies as hazardous waste. Since regulations inevitably add some cost to transportation of such items and by protecting people from them and their effects, commercial firms seek ways to minimize those costs. As a result, they have lobbied to have different categories of hazardous waste downgraded in status. The importance of the Cairo Guidelines has been to provide a reasonably comprehensive set of regulations that serve as a legal basis for all aspects of a complex, widely distributed industry with significant implications for the environment. Even so, this listing approach is problematic; it is difficult to create a fully comprehensive listing that is up to date with the latest technologies and techniques for dealing with hazards.

SEE ALSO: Basel Convention; Hazards; Waste, Human; Waste, Nuclear; Waste, Solid; Wastewater.

BIBLIOGRAPHY. Philippe Sands, *Principles of International Environmental Law* (Cambridge University Press, 2003); Han-Nhien Q. Vu, "The Law of Treaties and the Export of Hazardous Waste," *UCLA Journal of Environmental Law and Policy* (v.12, 1994).

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Cambodia

THROUGHOUT MOST OF its recent history, Cambodia has been beset by political strife. After gaining independence from France in 1953, the country was dragged by global politics into a period of profound violence. In 1975, the Communist Khmer Rouge captured Phnom Penh and evacuated all cities and towns, causing the deaths of around 1.5 million Cambodians through execution, starvation, and hardship. Cambodia fared somewhat better during the 10-year Vietnamese occupation that followed. In 1991, the Paris Peace Accords led to a ceasefire and eventually to free elections. However, the long years of political strife left Cambodia struggling economically and environmentally.

Bordering on the Gulf of Thailand, Cambodia has a coastline of 443 kilometers. The climate is tropical with seasonal variations. The rainy season generally lasts from May to November and is followed by a five-month dry season. Monsoons are common between June and November, and flooding and occasional droughts threaten the stability of life. Though the government created flood protection sleeves, many migrants have made their homes in these structures, limiting ability to control water flow. Most of the terrain is flat with interspersing paddies and forests. In the southwest and north, the land is mountainous. Cambodia's most distinct geographic features and the ones perhaps most important to its history, are the Mekong River and Tonle Sap, a lake in the western part of the country. During the dry season, the Tonle Sap drains to the Mekong. But this flow is reversed on an enormous scale during the rainy season, which increases the size of the lake by more than three times, ensuring a flow of fresh water into the Mekong delta to support agriculture,

Land Mines

During the war in Cambodia from December 1978 until the Paris International Conference on Cambodia in October 1991, millions of landmines were laid by various military factions. The government, the Vietnamese-backed People's Republic of Kampuchea (P.R.K.), planted many mines around their friendly bases and villages to prevent surprise attacks. The resistance groups, the hard-line Maoist Khmer Rouge, and the pro-Western Non-Communist Resistance of the right-wing Khmer People's National Liberation Front and the royalist F.U.N.C.I.N.P.E.C. also laid mines around P.R.K. bases to prevent attack. Many are long-lasting plastic mines; and because they are light, during the monsoons many float to new places.

During the war, many thousands of people have been maimed each year, and it is estimated that there were some 40,000 victims of land mines in Cambodia, with the mines still claiming 40 to 50 victims each month. There are now many groups clearing mines in known trouble spots, with the Cambodian government agency, the Cambodian Mine Action Centre (C.M.A.C.), operating with support from foreign countries. In addition, the Hazardous Areas Life (Support) Organization (H.A.L.O.) and the British-funded Mines Advisory Group (M.A.G.) are both active, the latter being involved in the training of many Cambodians in mine clearance.

Many of the areas in Siem Reap province, around the temples of Angkor—the major tourist attractions in the country—have been cleared, but other regions along the Thai-Cambodian border, where much of the fighting from 1978 until 1991 took place, are still littered with hundreds of thousands of unexploded mines. Most areas thought to have unexploded mines are marked, with education programs to rural families and children helping reduce the toll.

and producing a unique and enormous fishery that supplies most of the country's protein. Other natural resources include oil and gas, timber, gemstones, small deposits of iron ore, manganese, phosphates, and the potential for developing hydropower.

In 1999, an agreement with the United States and a guaranteed quota of textile imports paved the way for economic growth, but competition has since slowed economic recovery. Three-fourths of the workforce is involved in subsistence farming. Forty percent of the population lives below the poverty line, and one-third of Cambodians are chronically undernourished. Rice, the staple food for most Cambodians, is often destroyed by flooding and drought. The per capita income of $2,100 places Cambodia 173rd in world incomes.

PRESSING ENVIRONMENTAL ISSUES

Cambodia's population of 13,600,000 people is threatened by a number of health factors, including a high HIV/AIDS rate (2.6 percent) that produces lower life expectancy (59.29 years), growth rates (1.81 percent), high infant mortality (68.78 deaths per 1,000 live births), and death rates (8.97 deaths/1,000 population). It is difficult to disseminate health and environmental information because of educational deficiencies. Eighty percent of the population lives in rural areas where there is a serious lack of potable water; around 66 percent of Cambodians do not have access to safe drinking water. Only 16 percent of the total population has access to improved sanitation. Consequently, food and waterborne diseases are common, including cholera, bacterial and protozoal diarrhea, hepatitis A, and typhoid fever. Some locations are also vulnerable to vectorborne diseases such as dengue fever, malaria, and Japanese encephalitis. The United Nations Development Program (UNDP) Human Development Reports rank Cambodia 130th of 232 nations in overall quality of life.

One of Cambodia's most pressing environmental problems is waste management. Domestic and industrial effluents and solid wastes have cause extensive pollution of surface and groundwater. Hazardous wastes released by industries are frequently burned in open dumpsites. Extensive deforestation has occurred from illegal logging, and gem strip mining along the Thai border has created vast wastelands. The loss of large areas of mangrove swamps and overfishing are threatening the fisheries that are essential to Cambodian survival.

Widespread soil erosion is a by-product of natural disasters and human mismanagement. River and coastal sedimentation from logging has degraded coastal, marine, and freshwater resources. Water samples reveal residue from toxic pesticides. In 2006, a study by Yale University ranked Cambodia 110 of 132 countries in environmental performance, well below the relevant income and geographic groups. The lowest ranking was in the field of environmental health. Although estimates vary, it is generally believed that a little over half of Cambodia has some forest cover remaining. The government has protected 18.5 percent of the land. Of 123 endemic mammal species, 24 are threatened with extinction, and 19 of 183 endemic bird species are similarly endangered.

After peace was restored in 1991, the Cambodian government launched a recovery effort by passing a body of environmental legislation. The Ministry of Environment was charged with environmental protection and conservation of natural resources and instructed to work with the Ministry of Agriculture, Forestry, and Fisheries to promote sustainable development. This task is made more difficult by overlapping responsibilities, the shortage of skilled staff, and chronic funding shortages. Cambodia has signed the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Tropical Timber 94, and Wetlands. The Law of the Sea agreement has been signed but not ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome; Deforestation; Drinking Water; Hydropower; Malnutrition; Poverty; Waste, Solid.

BIBLIOGRAPHY. CIA, "Cambodia," *The World Factbook*, www.cia.gov(cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993);

UNDP, "Cambodia," www.hdr.undp.org (cited April 2006); World Bank, "Cambodia," *Little Green Data Book*, www.worldbank.org (cited April 2006); World Bank, "Cambodia: Environment," www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Cameroon

THE PRESENT-DAY REPUBLIC of Cameroon was formed in 1961 when the former French Cameroon joined part of British Cameroon to create a new government. In response to continued political stability, Cameroon has created a strong infrastructure while developing the agricultural, petroleum, and transportation sectors. The Chad–Cameroon Pipeline has caused much controversy and concern among environmentalists but has been lauded as an important economic project for both countries. Funding from the World Bank and the International Monetary Fund have fueled development and structural reform in Cameroon; however, the high level of national debt has been an anchor on local prosperity and equitable growth. Democratic reform has also continued at a slower pace than development, in part because of widespread government corruption. The prospect of debt relief from multi-lateral funding agencies represents a promising development.

With a per capita income of $1,900, Cameroon is ranked 183rd of 232 countries in world incomes. Approximately 70 percent of the labor force is engaged in agriculture, chiefly at the subsistence level. Nearly half of Cameroonians live below the national poverty line, and one-fourth of the people are undernourished. Some 30 percent are unemployed. Just over half the population lives in urban areas. Income is unevenly distributed, with the richest 10 percent possessing 36.6 percent of income as compared to 1.9 percent for the poorest 10 percent. The United Nations Development Program (UNDP) Human Development Reports rank Cameroon 158th of 232 countries on overall quality-of-life issues.

Bordering the Bight of Biafra, Cameroon has a coastline of 402 kilometers and shares land borders with the Central African Republic, Chad, the Republic of the Congo, Equatorial Guinea, Gabon, and Nigeria. Cameroon also has 6,000 square kilometers of inland water resources. The terrain of Cameroon varies from the coastal plains of the southwest and north to mountains in the west and a dissected plateau in the central region of the country. Elevations range from sea level to 4,095 meters at Fako on Mount Cameroon. This mountain, the highest in sub-saharan West Africa, is an active volcano. The climate of Cameroon is also varied, with the coast enjoying a tropical climate while the north is semiarid and hot. Cameroon experiences a good deal of volcanic activity, and volcanoes on Lake Nyos and Lake Monoun periodically release poisonous gases into the atmosphere. Cameroon's natural resources include petroleum, bauxite, iron ore, timber, and hydropower. Nearly 13 percent of the land area is arable.

The population of 17,340,702 Cameroonians experiences an HIV/AIDS rate of 6.9 percent. Some 49,000 people have died from this disease since 2003, and it is estimated that 560,000 others are living with it. Some 37 percent of Cameroonians lack sustained access to safe drinking water, and 52 percent do not have access to improved sanitation. As a result, the population has a very high risk of contracting food and waterborne diseases that include bacterial diarrhea, hepatitis A, and typhoid fever and the water contact disease schistosomiasis. In some areas, chances for contracting vectorborne diseases such as malaria and yellow fever are also high. High incidences of disease in Cameroon result in low population growth (2.04 percent) and life expectancy (51.16 years) and high infant mortality (63.52 deaths per 1,000 live births) and death (13.47/1,000) rates. Cameroonian women bear an average of 4.39 children, and 26.6 percent of the adult female population is illiterate as compared to 15.3 percent of adult males.

Most environmental problems in Cameroon are a result of uncontrolled economic activities. Part of the Congo Basin Forest, the second-largest rain forest in the world, lies within Cameroon. However, only 4.5 percent of land area is under national protection. Deforestation is occurring at a rate of nine percent as ecologically valuable tropical forests are cut down for export. The rate of desertification in the Congo Basin Forest has accelerated in response to agricultural mismanagement, overgrazing, and deforestation. The countries that host the rain forest have joined together with international groups to form the Congo Basin Forest Partnership designed to prevent further damage. With a $35 million grant from the United Nations Conference on Environment and Development, Cameroon introduced the Forest and Environmental Policy Development Program in 2006 under the leadership of the Ministry of Environment and Forests. The program targets enhancement of sustainable development and the promotion of biodiversity. Local and international environmental groups also play a major role in protecting the environment of the rain forest.

Overfishing has threatened marine ecosystems and placed the Cameroonian food supply in danger. Poaching as well as destruction of habitats has also placed wildlife at risk. Of 409 mammal species that have been identified in Cameroon, 40 are endangered, as are 15 of 165 known bird species. In a 2006 study conducted by scientists at Yale University, Cameroon was ranked 100th of 132 countries on environmental performance, in line with the comparable income group and slightly above the comparable geographic group. The overall score was reduced because of the low ranking in environmental health. The Cameroonian government participates in the following international agreements on the environment: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Tropical Timber 83, and Tropical Timber 94.

SEE ALSO: Acquired Immune Deficiency Syndrome; Deforestation; Drinking Water; Infant Mortality; Life Expectancy; Overfishing; Overgrazing; Poaching; Poverty; Rain Forests; Subsistence.

BIBLIOGRAPHY. CIA, "Cameroon," *The World Factbook* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); UNDP, "Human Development Report: Cameroon" www.hdr.undp.org (cited May 2006); World Bank, "Cameroon," *Little Green Data Book*, www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Canada

CANADA IS THE world's second-largest country with a population of 33 million (July 2006 estimate). On July 1, 1867, the Constitution Act created the Canadian federation, which originally consisted of four provinces: Ontario, Quebec, New Brunswick, and Nova Scotia. Canada today is a parliamentary democracy with elected legislatures at the federal, provincial, and territorial level. The federal government is made up of an executive branch, consisting of the governor general, prime minister and cabinet.

Canada is divided into 10 provinces and three territories, each with its own legislature and administration. The central government maintains jurisdiction over such areas as national defense, banking, navigation, fisheries, commerce, indigenous peoples' affairs, and international relations. The provinces have jurisdiction over social services such as education and health, land and natural resources, and the regulation of economic activity. Both levels of government have extensive taxation powers. Each territory has legislative powers similar to those of the provinces, although the federal government retains controls over most of the territories' land and natural resources.

Canada's economy is dominated by the services sector (68.7 percent of Gross Domestic Product, or GDP), followed by industry (29.1 percent) and agriculture (2.2 percent). Its key industries reflect the country's rich natural resource base and include transportation equipment, chemicals, processed and unprocessed minerals, food products, wood and paper products, fish products, and petroleum and natural gas. Canada's GDP reached U.S. $934 billion in 2002, positioning it as the world's 12th largest economy. Canada's GDP per capita of $29,300 is the 9th highest in the world, and its GDP growth rate of 3.3 percent compares well to other Organization for Economic Co-operation and Development (OECD) countries. Canada's labor force comprises 16.3 million people (49 percent of the total population) and is distributed among occupations in the services (75 percent), manufacturing (14 percent), construction (5 percent), agriculture (2 percent), and other sectors (3 percent). Canada is highly integrated into the global economy through trade, with 33.6 percent of its GDP dedicated to exports. Despite Canada's strong ties to both Britain and France, Canadian culture and its economy are heavily influenced by the United States, the destination for over 85 percent of Canada's exports and with trade arrangements that include the 1989 United States–Canada Free Trade Agreement (FTA) and the 1994 North American Free Trade Agreement (NAFTA).

Female Bighorn sheep in the Canadian Rockies. Expanding industrial areas are encroaching on wildlands.

Canada's human development index (HDI), which is a comparative, worldwide measure of poverty, literacy, education, life expectancy, childbirth, and other factors, is 0.949. While this gives Canada the 5th highest HDI in the world, its world ranking has slipped relative to other countries over the past decade. High cultural diversity is evidenced by the 71.1 percent of its population in 2001with ethnic origins other than English, French, or Canadian. Although its rural population is declining, Canada's total rural population was 20.6 percent in 2001. Those residing in rural and small town regions are greatest in the Atlantic provinces, Manitoba, Saskatchewan, the Northwest Territories, and Nunavut. Canada compares favorably to other countries with respect to violent crime, as evidenced by its relatively low homicide rate of 1.6 per 100,000 (vs. 9.9 in the United States and 17.2 in Mexico).

With a geographical space of over 2.1 million square kilometers, Canada accounts for a relatively large share of the planet's natural resources, including about 10 percent of the world's forests and renewable fresh water supply. Most of the forestland is owned and managed by the provincial and federal governments (about 71 percent and 23 percent, respectively). While the limits to resource availability have generally not been reached (key exceptions include the Atlantic cod fisheries which collapsed in the early 1990s), resource sustainability remains a serious concern in the long run. Its proximity to the United States also means that both countries must work collaboratively in addressing cross-border environmental issues, such as air and water pollution, and the management of shared wildlife species.

Canada has made significant progress toward achieving its environmental domestic objectives and international commitments since 1995. For example, Canada is a signatory to the Kyoto Protocol. As an Annex I country, Canada has pledged to reduce its carbon dioxide emissions to six percent below

1990 levels by 2012. The Canadian government plans to spend over CA $6 billion to meet the Kyoto requirements, chiefly by purchasing over CA $1 billion worth of emissions credits, greater investment in green technologies, and tax credits for industrial reductions in carbon dioxide emissions.

On the other side, Canada faces some significant environmental challenges. Industrial emissions to air, water, and land represent significant sources of pollution in spite of pollution control advances. Canada is the worst among OECD countries for scaling back on emissions of carbon dioxide, a contributor to global climate change. Over the period from 1990 to 2000, Canada's carbon emissions for each citizen rose by 10.1 percent, more than double the OECD average of 4.8 percent. Expanding urban environments and industrial development are encroaching on wildlands and contributing to increases in energy use and air and water pollution. Urban and agricultural runoff also threatens water quality in several areas. Three provincial capitals—Victoria, Halifax, and St. John's—continue to pump raw sewage directly into the ocean. Currently 487 plant and animal species are classified as being at risk in Canada.

Canada also has the third-largest ecological footprint per person in the world after the United Arab Emirates and the United States. If everyone in the world consumed at Canada's rate, it would take four more earths to support humanity. It takes 7.25 hectares of land and sea to support each Canadian. Municipal footprints range from as low as 6.87 hectares/person in Greater Sudbury to a high of 9.86 for Calgary. In addition, Canada has the second-highest rate of energy consumption per person in the world, behind only the United States.

While many of its environment challenges need to be seriously addressed, Canada is still considered a world leader in many ways—for example, in global security, social service programs, and human rights.

SEE ALSO: Carbon Dioxide; Ecological Footprint Analysis; Kyoto Protocol; Pollution, Air; Pollution, Water; Runoff.

BIBLIOGRAPHY. CIA, *The World Factbook*, "Canada," www.cia.gov (cited April 2006); Energy Information Administration, "Country Analysis Briefs: Canada," www.eia.doe.gov (cited February 2005); Thomas I. Gunton, *The Maple Leaf in the OECD: Comparing Progress toward Sustainability* (David Suzuki Foundation, 2005); Dianne Kinnon, *Improving Population Health, Health Promotion, Disease Prevention, and Health Protection Services for Aboriginal People*, National Aboriginal Health Organization, (National Aboriginal Health Organization, 2002); Marianne Sorensen and Jennifer de Peuter, *Rural Alberta Profile: A Ten-Year Census Analysis (1991–2001)* (Her Majesty the Queen in Right of Canada, 2005); Statistics Canada, "The Daily: Demographic Statistics," September 28, 2005, www.statcan.ca (cited April 2006); Stratos Inc., *Canada Case Study: Analysis of National Strategies for Sustainable Development* (June 2004); UNDP, *Human Development Report 2005*, "Country Fact Sheet: Canada," www.hdr.undp.org (cited April 2006); Ann Vourc'h, OECD, *Encouraging Environmentally Sustainable Growth in Canada: Economics Department Working Papers No. 290*, ECO/WKP (v. 16, 2001); Jeffrey Wilson and Mark Anielski, *Ecological Footprints of Canadian Municipalities and Regions* (Canadian Federation of Canadian Municipalities, 2005).

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Cancer Alley

THE LAND KNOWN to the Louisiana environmental justice movement as Cancer Alley follows the Mississippi River from Baton Rouge to New Orleans. Otherwise known as the chemical corridor, this area is home to facilities producing gasoline, fertilizers, plastics, and numerous other petrochemical products.

This high ground along the river was settled by Europeans who, with slave labor, created sugar cane plantations. After emancipation, many freed men remained in the region but sought to establish independent African-American towns in the interstices between plantation properties. These "freetowns" dotted the landscape of parishes along the river.

The discovery of petroleum in Louisiana in 1901 led eight years later to the building of the massive Standard Oil refinery in Baton Rouge. New oil fields were opened up in and around the Gulf of Mexico from the 1930s and on. Combined with convenient access to the ocean, abundant fresh water from the Mississippi and nearby deposits of other feedstock materials like sulfur and salt, Louisiana was well-suited for the emerging chemical industry. A compliant state government that imposed little in the way of taxes or regulations and the availability of large tracts of undivided land on the river—the plantations—made for an even better location for rapid industrialization.

The chemical plant boom started in the early 1960s, as plantation owners sold out to industries and towns and villages found themselves the neighbors of, and sometimes almost surrounded by, the new facilities. Local residents received few jobs from the new industries, which were highly capital-intensive and have only become more automated over time. Since locals owned homes and land—even though most saw few benefits from industrialization—they stayed where they were. This brought about an increasingly strained relationship between people living on the fencelines of those industries.

The modern industrial corridor has grown to 156 facilities and generates one-sixteenth of the entire toxic emissions of the United States. In 1988, one-third of the nation's underground injections of hazardous waste were in Louisiana. In 1991, Louisiana generated 16,280 pounds of toxic pollution per chemical industry job, compared with Texas at 8,997 and New Jersey at 1,084. Because of Louisiana's industrial tax exemption, the most expansive of any in the country, local school boards lost an estimated $129 million statewide in 1995.

The environmental justice movement in Louisiana cannot be separated from the Civil Rights movement. African Americans, who organized in the 1960s to get access to education, voting rights, employment in industry, became the backbone of environmental justice in the 1980s. Driven by personal experiences of strange smells and gas clouds drifting through their neighborhoods, explosions and chemical leaks that left people to close their doors and windows and hope for the best, and illnesses and deaths of family and friends, a number of local environmental justice fights began at this time.

These local campaigns came out of places like the community of Alsen, just north of Baton Rouge. Surrounded by industrial zoned property, Alsen's neighbors include a disposal facility and injection wells for hazardous waste and several chemical plants. Residents of Alsen and other communities have been able to stop expansions of some facilities and link up to statewide and national organizations to conduct actions like the Great Louisiana Toxics March in 1988. In the mid-1990s, the Shintech Corporation attempted to build a polyvinyl chloride plant in St. James parish. The accumulated experience and infrastructure of the Louisiana environmental justice movement helped these campaigns to win victories such as Shintech's decision not to locate in St. James, and the relocation of the community of Diamond—sandwiched between a chemical plant, an oil refinery, train tracks full of carloads of chemicals, and the Mississippi River.

Disposing of the debris left by Hurricane Katrina poses difficult questions for Louisiana. The Agriculture Street landfill in New Orleans was used to dump debris from Hurricane Betsy in 1965; the mostly African-American neighborhood that was built on top of it subsequently became a Superfund site, and a still-unresolved cleanup or relocation. Progress toward environmental justice in Cancer Alley has come slowly and at great cost to those who have suffered for industrial development.

SEE ALSO: Carcinogens; Disease; Environmental Justice.

BIBLIOGRAPHY: Barbara Allen, *Uneasy Allies: Citizens and Experts in Louisiana's Chemical Corridor Disputes* (The MIT Press, 2003); S. Lerner, *Diamond: A Struggle for Environmental Justice in Louisiana's Chemical Corridor* (The MIT Press, 2005); J. Roberts and M. Toffolon-Weiss, *Dispatches from the Environmental Justice Frontline* (Cambridge University Press, 2001).

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Cane Toad

NATIVE TO THE broader Caribbean region between southern Florida and northern South America, but purposely introduced into Australia and other regions, cane toads have provided a pointed

The cane toad has pronounced parotoid glands on its shoulder, from which it releases a very toxic poison.

illustration of the dangers of introducing species to a new environment, even for very well-intentioned reasons. Large toads with almost omnivorous appetites, cane toads breed prolifically and have proven adaptable to a fairly broad range of environments from coastal mangrove swamps to rainforests, from grasslands to marginal woodlands, and from agricultural areas to urban lots. On its shoulders, the cane toad has pronounced parotoid glands, from which it releases a very toxic poison. Although some predators such as keelback snakes, wolf spiders, freshwater crayfish, saltwater crocodiles, crows, several other types of birds, and several types of rats can tolerate the toad's poison, it is fatal to most mammals, lizards, and snakes that try to kill and eat the toad. Thus, under most conditions, the population of cane toads is almost impossible to control.

The cane toad has become a pest of monstrous proportions in Australia, where, ironically, scientists introduced it to control other pests. In the mid-1930s, the larva of two types of beetles, the French's Cane Beetle and the Greyback Cane Beetle, were devastating Queensland's main cash crop, sugar cane, by attacking the plant's roots. The Australian Bureau of Sugar Experimental Stations introduced various predators to control the beetle larvae, and in 1935, 100 cane toads were imported from Hawaii to the Meringa Experimental Station located near Cairns. The toads proved extraordinarily effective against the beetle larvae, and the operators of the station received permission to release about 3,000 toads into the fields of several local sugar cane plantations. Protests by some leading entomologists caused a moratorium on further releases of the toads, but the commercial pressure to protect the sugar cane crop ultimately outweighed opponents' evidence that the cane toad might very well become a worse pest than the beetle larvae. By the late 1930s, the toads were being released across Queensland.

There are now millions of cane toads in Australia, and their range has extended beyond Queensland and into the Northern Territory. In addition to the beetle larvae, cane toads will eat almost any insect, other amphibians, most small reptiles, some small mammals, and even cat and dog food. In their native range, the toad population is controlled by several snakes, for which they have become the primary food source. But Australians, from specialists to the general public, are naturally skeptical about the introduction of any more non-native species. They have proven a bane to domestic pets with which they have increasingly come into contact and to native species with whom they compete voraciously for food sources. More broadly, the cane toads have become a sort of grim national joke, with canny entrepreneurs creating all sorts of souvenir items featuring the toads for sale to tourists, both from other Australian states and from overseas.

Despite its almost universal vilification, the cane toad has some potential benefits. It is widely used in schools and universities for dissection lessons because of its size and the ease with its tissues can be incised. Its hide has proven to be commercially viable material for making attractive "leather" items such as purses, belts, and shoes. And, lastly, its venom is being studied because it contains many chemical compounds with a broad range of possible pharmacological applications.

SEE ALSO: Amphibians; Australia; Species Invasion.

BIBLIOGRAPHY. Ian Anderson, "No Stopping Them," *New Scientist* (Aug. 1998); John L. Eliot,"Revenge of the Cane Toads," *National Geographic* (March 2005); Constance Holden, "Plague of Toads Down Under," *Science* (Aug. 2005); Christopher Lever, *The Cane Toad: The History and Ecology of a Successful Colonist* (Westbury Academic and Scientific Publishing, 2001); Tim Low, *Feral Future: The Untold Story of Australia's Exotic Invad-*

ers (University of Chicago Press, 2002); Peter Monaghan, "Cane Toads: Faster, Bigger, Scarier," *Chronicle of Higher Education* (Feb. 2006); E. Park, "Way Down Under, It's Revenge of the (Yech!) Cane Toads," *Smithsonian* (Oct. 1990).

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Cape Verde

IN THE 15TH century, the Portuguese discovered the uninhabited Cape Verde archipelago in the North Atlantic and developed in into a major trading center for African slaves and a resupply station for whaling and transatlantic shipping. Today, two major island groups make up the Republic of Cape Verde. The Barlavento (Windward) Islands are composed of Santo Antão, Boa Vista, São Nicolau, São Vicente, Sal, and Santa Luzia. The Sotavento (Leeward) island group includes São Tiago, Fogo, Maio, and Brava. Ever since achieving independence in 1975, Cape Verde has flourished as a stable democracy, but its economic progress has been negatively affected by a number of factors, especially environmental conditions, like drought and seismic activity.

Natural resources on the islands include salt, basalt rock, limestone, kaolin, fish, clay, and gypsum, but none of these resources provides substantial revenue. Less than 10 percent of the land area of Cape Verde is arable, and agriculture provides just over 10 percent of the Gross Domestic Product. Approximately 82 percent of Cape Verde's food supply is imported. Close to 70 percent of the population lives in rural areas. Because of prolonged droughts, the island experiences a chronic shortage of fresh water. Some 20 percent of the population lack sustained access to safe drinking water, and 42 percent lack access to improved sanitation. With a per capita income of $6,200, Cape Verde is ranked 119th in world incomes. A third of the 418,224 people lives in poverty, and over a fifth of Cape Verdeans are unemployed. The United Nations Development Program (UNDP) Human Development Reports rank Cape Verde 105 of 232 countries in overall quality-of-life issues.

Surrounded entirely by the Atlantic Ocean, Cape Verde has a coastline of 965 kilometers. These volcanic islands are steep, rugged, and rocky. Elevations range from sea level to 2,829 meters at Mount Fogo, a volcano located on Fogo Island. The temperate climate generally produces warm, dry summers. Little precipitation falls on the islands, and there is no predictable pattern to its occurrence. Seismic activity is a constant threat on Cape Verde, and droughts became so common in the latter half of the 20th century that most of the population suffered hardship, and large groups of people fled the islands. The harmattan, a hot, dry, and dusty seasonal wind, releases large amounts of dust into the atmosphere and accelerates soil degradation. Cyclones and insect infestations also contribute to environmental degradation on Cape Verde.

In addition to soil erosion and desertification that are consequences of both human and climatic activity, deforestation is expanding as forests are cut down for use in cooking and heating. As habitats are damaged, survival rates of wildlife become problematic. Endangered mammals include the Mediterranean monk seal, the northern bald ibis, the green sea turtle, and the hawksbill turtle. Three of 103 bird species are also threatened with extinction, as are 14 of 659 plant species. Overfishing has damaged marine ecosystems and further reduced available food supplies. The practice of removing large amounts of sand from the beaches to use in construction projects has resulted in coastal erosion.

The Minister of Agriculture, Food, and Environment is responsible for implementing environmental laws in Cape Verde and for monitoring compliance with existing laws. The Minister works with regional and international groups to promote sustainable development of the islands. In 2003, the Cape Verde government joined with three United Nations organizations to involve unemployed youth in reconstructing damaged environmental resources.

The Cape Verde government participates in the following international agreements: Biodiversity, Climate Change, Desertification, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, and Ozone Layer Protection.

SEE ALSO: Beaches; Deforestation; Drought; Earthquakes; Endangered Species; Overfishing; Soil Erosion.

BIBLIOGRAPHY. CIA, "Cape Verde," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); UNDP, "Human Development Report: Cape Verde," www.undp.org (cited May 2006); World Bank, "Cape Verde," *Little Green Data Book,* www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Capitalism

CAPITALISM IS DESCRIBED in *Webster's College Dictionary* as "an economic system in which investment in and ownership of the means of production, distribution, and exchange of wealth is made and maintained chiefly by private individuals or corporations." This is in contrast to the main alternative to capitalism—socialism—that is defined as "a theory or system of social organization in which the means of production and distribution of goods are owned and controlled collectively or by the government." There are many variations or types of capitalism and socialism both in theory and practice, and most countries in the world have mixed economies that have some elements of both production systems. These systems produce both public and private goods and services.

Capitalism can be described as a system: generally as a private sector, market economy regulated by a public sector government. Capitalism can exist as a global system, where exchange transactions that travel over national boundaries are defined as international trade and international finance. Nations can be classified and rank-ordered according to the types of capitalism practiced. One type of ranking would compare levels of taxation and regulation, while another might look at the most dominant formats of business organization.

Capitalism can also be couched as a philosophy. Major philosophical tenets include: emphasis of individual rights over social rights; the right to purchase, own, and sell private property, including real estate; the use of price as a mechanism that guides the demand and supply of goods and services; the reward to entrepreneurs by the earning of profits derived from business operations; and the retention of capital gains resulting from the selling of privately owned assets.

Capitalism also can be experienced as a lifestyle. A capitalist is a person who practices capitalism in a number of roles. These include the entrepreneur, a person who works alone or in partnership to convert an invented idea, product or process to a marketable good or service. A capitalist can also be an investor who provides monetary resources to entrepreneurs, in exchange for a percentage ownership of their organization. A capitalist might be a manager, who seeks higher income and profit sharing associated with a growing business.

A capitalist is also a significant consumer. Income derived from capital gains, business profits, interest earned from renting capital, and salaries is used to acquire assets such as houses, automobiles, and computers, or more general retail consumption of a myriad of goods and services.

Corporate employees can also play the role of capitalist, to the extent they can save a portion of earned wages and invest them to start small-scale businesses; in many cases, home-based and requiring part-time work. In some societies, the majority of residents might be active in business formation of various sizes and scopes. In other societies, the capitalist might be a rare individual, possibly viewed as an opportunistic nonconformist.

In general, a capitalist economy can be described as having a private sector, with the power to produce and distribute goods and services; and a smaller, public sector, which partially taxes and regulates the private sector. The private sector is made up of a myriad set of activities by individuals, partnerships, and corporations, involving investors, entrepreneurs, employers and employees, vendors, and customers. A large volume of transactions occur in thousands of spatially diverse markets.

Capitalism is correlated with science and technology, and is a process where discoveries lead to innovations in how people organize space. These innovations are then packaged and marketed. If successful, new goods or services will diffuse across space as they are utilized by related producers and end consumers. For example, cellular communications towers allow for the use of small and portable communications devices. The diffusion of this technology has been rapid, and many countries now count more cell phones than fixed-line phones.

LEGAL STRUCTURES AND PROCESS

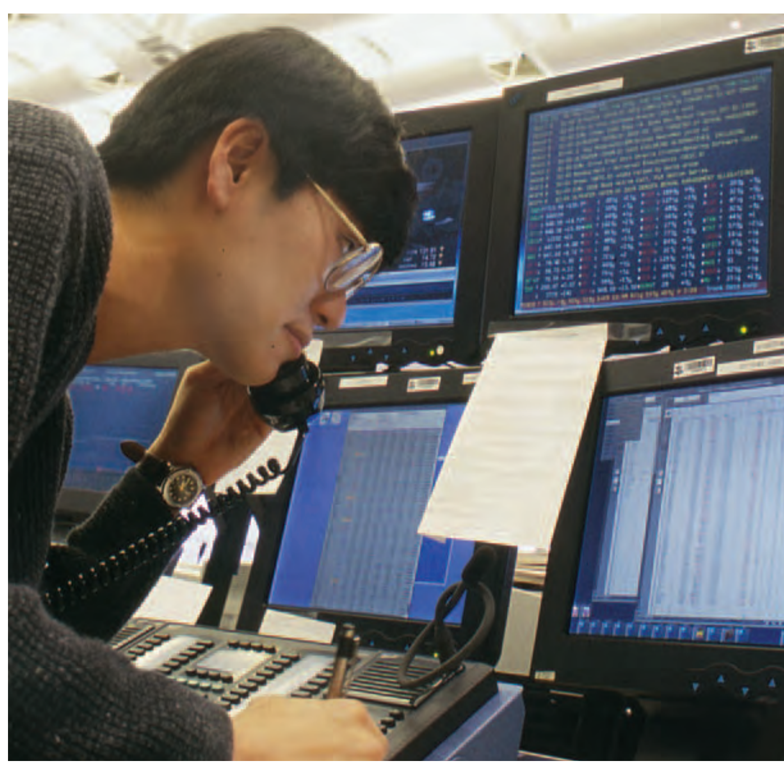
Capitalism will generate a legal structure that constructs a legal process. It is dependent on a public legal system to enforce noncompliance with written contracts, which is a legally binding agreement between two businesses (which themselves are legal entities). Three major legal forms are the sole proprietorship, which is a business is owned by a single individual; the partnership, which is is a contract that defines ownership percentage for two or more individuals; and the corporation, which has a more formal structure, where ownership can be traded between two unaffiliated parties, generally via stock markets. The corporation has the advantage of allowing ownership to shift over time, which means there is no inherent life expectancy or temporal limitation. In addition, corporations tend to have limited liability, related to the potential loss of direct investment, and not personal loss of property or liberty except in cases of gross or criminal negligence. A corporation's life is limited by the decreasing demand from its consumers. This flexible structure has allowed for corporations to become relatively large, in some cases employing upwards of one million employees, having thousands of owners, and supplying goods and services to millions of customers. Corporations that take full advantage of the span of transportation and communications system networks can operate in many locations and thus become global or multi-national.

A corporation is formed by a multi-step process of idea generation, acquisition of investors and capital, the entrepreneur's stock ownership of the newly formed corporation, hiring of organizational and technical managers to develop the good or service, identification of vendors, hiring of employees, marketing to identify and secure customers, and securing a customer service and accounting process.

If unsuccessful, the investment is lost, and the entrepreneur's reputation is damaged. If successful, however, a return on investment is made and a profit is earned, and a business enterprise is able to scale up in size, earning higher revenue and employing more workers. This expansion will be limited by competing firms. Generally, a portion of the profits will be taxed; and to varying extent, government will regulate the firm, especially if there are identified byproducts of the production process, such as air, water and land pollution, and/or safety issues for consumers.

With millions of corporations and thousands of governments in existence, there are numerous interactions between the two entities. Many of these interactions are complementary, and assist in relatively efficient economic activity that has resulted in economic growth. Some of the interactions are contentious, resulting from a disagreement about the level of taxation or the volume of regulations. This can result in firms relocating their business activities to places with lower taxes and regulations.

Corporate ownership can be traded between two unaffiliated parties, generally via stock markets.



There are many environmental impacts resulting from capitalist economic activity. First, there are the land use and land cover changes associated with the raw materials needed for the production, such as the water supply, food, fiber, metals, construction and building materials, and energy. This can involve large areas of land used for cropland, pastureland, plantation timber or selective forest harvesting, and energy and mineral extraction. Second, there are pollution byproducts, which can take gaseous, liquid or solid forms. Pollution impact can be on-site and affect production workers, or migrate across space and affect larger areas. Third, goods and services are consumed in buildings and houses, which in turn are the result of extensive construction. Over time, the area used in clusters of housing and buildings form a set of urban places that convert land from natural or primary production into urban related development.

The mitigation of negative environmental changes takes a number of forms. In many cases, new technologies and markets evolve, including pollution control devices and more efficient production methods. In other cases, the public sector regulates or taxes the private sector to reduce the volume of pollution. An incentive is created to minimize pollution outputs, and thus the burden of pollution-related tax and regulation. Technological changes take place over time, resulting in reduced pollution levels, which may be offset with increased pollution associated with greater economic activity. Spatial changes may occur where pollution is avoided by moving from degraded landscapes to healthier landscapes.

From 2001–2006, the global economy has expanded at an average rate of about four percent per year. Most of this economic expansion has been the result of successful investment in capitalistic activities. In contrast to the period 1800–2000—where some places became economically successful relative to their neighbors, resulting in divergence in per capita incomes—the 21st century begins with strong evidence of convergence, with a set of emerging economies growing at twice the economic growth rates as developed economies. These emerging economies include China and India, and as a group of about 30 nations, contain the majority of the world's population.

The Rise of Capitalism

Capitalism is a process closely related to the industrial revolution, starting in a limited geography in the early part of the 19th century, including the northern United States and Great Britain, and initially expanding and networking slowly outward. At the start of the 20th century, the global economy encompassed approximately $3 trillion in annual economic activity. Most of this monetary value resulted from urban- or city-based capitalistic processes, while most of the world's population was engaged in rural-based subsistence agriculture. The result of the 20th-century set of economic processes is a global scale economic activity estimated at about $60 trillion in 2006, comprised of trillions of individual transactions where goods and services are exchanged.

The system has a base infrastructure that is largely public provision; a network of millions of kilometers of paved roads, railroads, airports and water ports. An interconnected network allows for the completion of a spatial transaction: an order is placed for a good or service using a communications network, which is then delivered using the transportation network. The public infrastructure connects a private infrastructure, consisting of billions of housing units and millions of commercial buildings. Capitalism operates on a public infrastructure, and uses this network to obtain primary produced resources of timber, crops and ranged domesticated animals, ore and energy.

The future implication of continued economic growth at these rates is a mid-century global economy growing from $60 trillion to about $300 trillion. Combined with a demographic transition, which may result in a stabilized global population of about 8 billion persons, there is a potential for the global economy to have a per capita income of about $40,000 per person. This is a level currently enjoyed by countries including the United States, United Arab Emirates, and Norway. Capitalism is characterized by competition and varied outcomes, so there is a range of observed incomes. The potential exists, however, for the large reduction in poverty and even elimination of extreme poverty, and a human condition that, overall, is better than in prior history.

The environmental challenges are how an economic system of this size will obtain sufficient energy that is efficient and sustainable in the long-term, with less environmental problems than the current energy mix that is dominated by oil, coal, and natural gas. Also, there is the future relationship of primary production of food, in an efficient process that provides bountiful per capita caloric needs, while also expanding and maintaining a global network of wild lands, wild vegetation, and animal life.

A capitalist might view the environmentalist as faced with two important challenges. First, to use comprehensive scientific monitoring of the earth to identify new problems to which a wider audience will need to be alerted, and refine the relative relationships of the current set of problems, whose parameters may be shifting. Second, to play a complementary role—as both outside observers and participants of both the public and private sectors of the global capitalist economy—so that the trillions of economic transactions occurring in a global trading system incorporate environmental attributes.

SEE ALSO: Agriculture (including Agricultural Revolution); Economics; Socialism.

BIBLIOGRAPHY. Peter Berger, *The Capitalist Revolution, Fifty Propositions about Prosperity, Equality, and Liberty* (Basic Books, 1986); "Surprise! The Power of the Emerging World," *Economist* (September 16-22, 2006); Milton Friedman, *Capitalism and Freedom* (University of Chicago Press, 2002); Jane Jacobs, *The Economy of Cities* (Random House, 1969); Charles Jones, *Introduction to Economic Growth* (W. W. Norton & Company, 2002); John Maynard Keynes, *The General Theory of Employment, Interest, and Money* (Harcourt Brace & Company, 1964); Mankiw, *Principles of Microeconomics* (South-Western College Pub, 2003); *Random House Webster's College Dictionary*; Jeffrey D. Sachs, *The End of Poverty: Economic Possibilities For Our Time* (Penguin Press, 2005); Xavier Sala-i-Martin, "The World Distribution of Income: Falling Poverty and … Convergence, Period," *The Quarterly Journal of Economics* (v.121/2, 2006); Martin Wolf, *Why Globalization Works*, (Yale University Press, 2005).

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Car Corporate Average Fuel Economy (CAFE) Standards

CORPORATE AVERAGE FUEL Economy (CAFE) Standards are gas mileage standards applied to automobile manufacturers. The standards were developed as part of the Energy Policy and Conservation Act passed by Congress in 1975. The act was designed to conserve energy following the 1973–74 Arab oil embargo, when restricted oil imports led to long lines at gas stations and contributed to economic recession. The measure is calculated by averaging the miles per gallon (mpg) of each vehicle manufactured by a given firm for sale in the United States in a given model year. Since the standard is based on the average of a firm's entire fleet of vehicles, some models may exceed the standard if others fall below it. There are separate standards for passenger cars and light-duty trucks, a category that includes most pickup trucks, vans, and sport utility vehicles (SUVs).

The original goal of the legislation was to double new passenger car fuel economy within 10 years to a corporate average of 27.5 mpg in 1985. The standards, which gradually increased fuel economy requirements, were designed to push technological innovation toward greater fuel efficiency. That goal was met, but the standard was then briefly lowered between 1986 and 1989. The 27.5 mpg standard was then reinstated in 1990, where it remained. Light trucks, originally defined as trucks weighing 6,000 pounds or less, and later redefined as trucks weighing up to 8,500 pounds, have a different CAFE standard.

There are no standards for vehicles that exceed 8,500 pounds. Standards for light trucks were originally set in 1979 at 15.8 mpg for two-wheel-drive vehicles and 17.2 for four-wheel-drive vehicles (the two-wheel/four wheel drive distinction was later eliminated). The National Highway Traffic Safety Administration (NHTSA), the federal government agency that has been empowered by Congress to set the CAFE standards when specific goals were not included in legislation, has raised the light truck standard in several years since its implementation.

The NHTSA has set a light truck standard of 22.2 mpg for model year 2007. The U.S. Environmental Protection Agency (EPA) monitors firms and enforces the standards for both classes of vehicles. Firms that do not meet the CAFE standard are required to pay a fine based on the amount by which their fleet fails to meet the requirements. Due to the low mileage vehicles they tend to manufacture, many European firms have been required to pay these fines, while no Asian or American firms have had to pay this civil penalty.

CONFLICTS AND CONTROVERSY

CAFE standards have been the subject of much political debate. Most economists agree that the standards have served their purpose of increasing fuel efficiency, although some argue that alternative measures, such as increased gas taxes, would be more effective for achieving these goals. Environmental organizations support the use of CAFE standards as a means to reduce air pollution, greenhouse gas emissions, and natural resource extraction.

Yet many environmental groups, such as the Sierra Club, believe that the standards need to be increased. Environmentalists also see the existing standard as flawed given the dramatic rise in the use of pickup trucks and SUVs for traditional passenger car purposes. When the policy was enacted, the separate light truck standard was justified given the need for hauling construction and farm materials. These vehicles made up roughly 20 percent of the market at that time. Today, almost half of all new vehicles sold fall in the light truck category, most of which are used for the same purpose as conventional passenger cars. The result has been that overall vehicle fuel efficiency has actually decreased in recent years.

Automobile manufacturers oppose the legislation of higher fuel economy standards. They believe that such mandates increase production costs, raise the price that consumers will have to pay, and lower sales. Makers of SUVs are especially concerned, given that these less-fuel-efficient vehicles are more profitable than most passenger cars. The Alliance of Automobile Manufacturers, a trade organization that includes manufacturers such as Ford and General Motors, lobbies against legislated standards and advocates instead for tax incentives for consumers who purchase fuel-efficient vehicles. Some auto manufacturers have also suggested higher gas taxes as a means to encourage greater fuel conservation.

In 2002, legislation was introduced in the U.S. Senate to raise CAFE standards in order to improve fuel efficiency by almost 30 percent over a 10-year period. Environmentalists supported the bill for the effect it would have on reducing greenhouse gas emissions. The auto industry opposed it and enlisted organized labor to generate popular opposition. They argued that higher vehicle prices resulting from the new standards would dampen auto sales and result in significant job loss. A number of Democrats joined the majority of Republican senators opposing the bill and it was defeated.

SEE ALSO: Automobiles; Energy Crisis (1973); Fossil Fuels; Greenhouse Gases; Petroleum; Pollution, Air; Sport Utility Vehicles (SUVs).

BIBLIOGRAPHY. Alliance of Automobile Manufacturers, "Our Position on CAFE," www.autoalliance.org (cited March 2006); David Austin and Terry Dinan, "Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increased Gasoline Taxes," *Journal of Environmental Economics and Management* (v.50/3, 2005); Roger H. Bezdek and Robert M Wendling, "Fuel Efficiency and the Economy," *American Scientist* (v.93/2, 2005); James A. Dunn Jr., "The Politics of Automobility," *Brookings Review* (v.17/1, 1999); David Greene, "Why CAFE Worked," *Energy Policy* (v.26/8, 1998); National Highway Traffic Safety Administration, "CAFE Overview," www.nhtsa.dot.gov (cited March 2006); Sierra Club, "Global Warming and Energy: CAFE (Corporate Average Fuel Economy)," www.sierraclub.org (cited April 2006).

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Carbon Cycle

THE CARBON CYCLE describes the movement and storage of carbon on earth. Knowledge of the carbon cycle helps us to understand the impacts of anthropogenic additions of carbon to the atmosphere on the storage and movement of carbon.

Places where carbon is stored are called pools or reservoirs. The five pools of carbon are sedimentary rock, terrestrial soils, the atmosphere, land vegetation, and oceans.

By far, the largest amount of carbon is buried in sedimentary rock, and this quantity is considered inactive in the carbon cycle. The active (or surface) pools constitute less than 1 percent of the carbon on earth, and they contain 40 x 10^{18} g C. Within this active carbon, the oceans constitute the largest pool (38,000 x 10^{15} g C, or 38,000 gigatons of carbon [GtC]). Movement (or fluxes) of carbon to and from the ocean happen primarily with the atmosphere, and the input and output of carbon to the ocean are almost balanced. Oceans take up carbon dioxide through diffusion, which is then used by photosynthetic plankton to produce sugars, or is taken up by organisms to produce shells. Some of the carbon, particularly from shell-producing organisms, sinks to the ocean floor and is buried in the sediments, which can eventually become part of the inactive carbon pool. The largest flux of carbon out of the ocean is back into the atmosphere, and this occurs via respiration of ocean organisms.

Terrestrial soils make up the second-largest pool of active carbon (1,500 GtC). Inputs of carbon (made up mostly of sugars) to soils occur when terrestrial vegetation sheds litter or dies. This organic matter is decomposed by organisms within the soil and becomes part of the soil carbon pool. Output of carbon from soils happens through the respiration of carbon dioxide from soil organisms, which, together with the respiration of land plants, generally equals the amount of carbon taken up by land plants, thus balancing the carbon budget for terrestrial systems. Land plants constitute the smallest pool of carbon (560 GtC). Vegetation takes up carbon dioxide from the atmosphere to make sugars and other carbon-based compounds. Such carbon compounds are either used within the plant for storage, reproduction, or respiration or they are transferred to the soil through litterfall or when plants die. This process, like any other that removes carbon from the atmosphere is an example of carbon sequestration.

The atmosphere is the third-largest pool of carbon (750 GtC), and the only two forms of carbon found here are methane and carbon dioxide. As we have seen, the atmosphere exchanges carbon with the ocean and land plants and receives carbon from soils. In addition, the atmosphere is the only pool known to be increasing with anthropogenic additions to the carbon cycle. Fossil fuel emissions and land clearing constitute an additional flux to the atmosphere of about 7 GtC/year. The combustion of fossil fuels and the burning of forests emit carbon dioxide, while the draining and clearing of wetlands release methane. It is known that half of this additional flux (about 3.2 GtC/year) remains in the atmosphere, slowly increasing the concentrations of carbon dioxide and methane. The fate of the other half of this additional flux (or carbon "sink"), however, is not fully known. It is possible that the oceans are absorbing some of the extra carbon.

UNDERSTANDING THE CARBON CYCLE

General knowledge of how the carbon cycle works improved as scientists developed an understanding of anthropogenic forces on the cycle. The idea that addition of carbon to the atmosphere could affect the climate was first described by a Swedish chemist, Svante Arrhenius, in 1896. He understood that carbon dioxide could trap heat reradiating from the earth's surface and predicted that an increase in atmospheric carbon dioxide would result in a warmer climate. Actual atmospheric concentrations of carbon dioxide were measured by Charles Keeling on Mauna Loa in Hawaii beginning in the 1950s. At that time, the carbon dioxide concentration was about 315 ppm (parts per million), up from 280 ppm in preindustrial times. This recording of carbon dioxide concentration continues on Mauna Loa, and today it records 381 ppm. In the summer, there is a slight decrease in atmospheric carbon dioxide concentration as land plants become active and perform photosynthesis (the majority of photosynthesis takes place in the northern hemisphere). In the winter, carbon dioxide concentration rises slightly as plants respire carbon during their nonphotosynthetic period. Such measurements of atmospheric carbon dioxide concentration will be essential as humans continue to burn fossil fuels and emit greenhouse gases to the atmosphere.

SEE ALSO: Carbon Dioxide; Carbon Sequestration; Fossil Fuels; Greenhouse Gases; Methane.

BIBLIOGRAPHY. Daniel B. Botkin and Edward A. Keller, *Environmental Science: Earth as a Living Planet* (John Wiley & Sons, 2003); Tim Flannery, *The Weather Makers: The History and Future Impact of Climate Change* (Atlantic Monthly Press, 2006); William H. Schlesinger, *Biogeochemistry: An Analysis of Global Change* (Academic Press, 1997).

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Carbon Dioxide (CO_2)

CARBON DIOXIDE (CO_2) is a chemical compound made up of one carbon atom and two oxygen atoms. While it is a trace gas in the atmosphere in terms of volume, it is of central interest to atmospheric chemistry due to its capacity to trap incoming solar radiation in the atmosphere. For this reason, it has become known as a greenhouse gas, where increases of carbon dioxide into the atmosphere cause climate changes, which include global warming. Other greenhouse gases include methane (CH_4), nitrous oxide (N_2O), tropospheric ozone (O_3), halocarbons (CFCs, HFCs, HCFCs), and water vapor (H_2O_v). Carbon dioxide is the principle greenhouse gas that contributes to climate change and global warming, as increases in carbon dioxide have contributed most to climate change compared to other greenhouse gases over time.

Carbon dioxide is part of larger carbon cycles on Earth. All living things are composed primarily of carbon, so the cycling of carbon through the various spheres can provide indications of the health of the planet. Unlike other greenhouse gases, carbon dioxide is not broken down or destroyed through chemical reactions. Aside from time spent in the atmosphere mainly as carbon dioxide, carbon also moves through the biosphere, hydrosphere and lithosphere. For example, atmospheric carbon dioxide is taken out of the atmosphere and up into the biosphere through photosynthesis. The carbon can then stay in this "reservoir" until the forest dies and decomposes, is cut down, or is burned. At this time, carbon is then released again to the atmosphere mainly as carbon dioxide.

There are many reasons why carbon dioxide is so influential in climate change. Among them, carbon dioxide has a long "residence time:" emissions can stay in the atmosphere for up to 200 years. For instance, emissions from a 1911 Model T Ford are potentially in the atmosphere today. This also means that even if all carbon dioxide emissions were halted today, declines in atmospheric carbon dioxide would only begin after the carbon dioxide cycled out of the atmosphere into another reservoir. Furthermore, carbon dioxide is the greenhouse gas most directly responsible for climate change by way of human activities (called *anthropogenic* climate change). This is also called the *enhanced greenhouse effect*. In the climate science community, there is overwhelming consensus that human activity has significantly driven climate changes in the past two centuries.

It is important to understand that there are also natural sources of carbon dioxide emissions. These include plant decomposition and volcanic activity, which contribute to a baseline *natural greenhouse effect* that makes the world habitable. Without them, the earth would on average be about 60 degrees F cooler and the planet would be covered with ice. With this natural greenhouse effect, humans have been able to live and enjoy benefits such as forest and food growth.

Looking more carefully at this distinction in sources of carbon dioxide emissions, climate research has shown that three quarters of atmospheric warming since 1850—the beginning of the Industrial Revolution—has been attributed to anthropogenic sources. These anthropogenic sources include fossil fuel burning (primarily coal, gas, and oil) and land use change. In the United States, roughly a quarter of anthropogenic climate changes can be attributed each to transportation, industry, household use/infrastructure, and land use and land-cover changes.

Current heavy reliance on carbon-based sources for energy has led to significant human contributions of carbon dioxide.

Thus, increases in concentrations of atmospheric carbon dioxide and associated climate changes critically permeate economic, environmental, political, cultural, and societal aspects of life on the planet.

Current heavy reliance on carbon-based sources for energy in industry and society has led to significant human contributions of carbon dioxide, and thus further changes in the climate, such as sea level rise. This particular period of time has been referred to as the Anthropocene Era, or the Age of the Hydrocarbon Human. Measurements over time show that atmospheric carbon dioxide concentrations have now risen to approximately 381 parts per million (ppm), a 36 percent increase from preindustrial levels (around 280 ppm). These data have been aggregated with other climate proxy data—such as ice cores, tree rings, and archaeological information—that help to understand past atmospheric concentrations of carbon dioxide. Together, these have shown that the recent increase in atmospheric carbon dioxide exceeds the bounds of natural variability experienced during the preceding 650,000 years.

Within carbon-based industry and society there are uneven patterns of consumption and consequent carbon dioxide emissions. One way to consider anthropogenic carbon dioxide emissions is on the country level. At this scale, the United States is the world leader, accounting for approximately 25 percent of global carbon dioxide emissions. Related to this, the United States is also the world leader in oil consumption, where 20 million barrels are consumed every day. China follows second, as a large consumer of coal, accounting for about 14 percent of global carbon dioxide emissions. Russia (7 percent), Japan (5 percent), and India (5 percent) are the third-, fourth-, and fifth-largest carbon dioxide emitters, respectively. These five countries are then followed in order by Germany, the UK, Canada, Italy, and South Korea. Emissions are increasing at a faster rate in the global south; left unchecked, many predict that Chinese emissions will surpass those of the United States by 2030. Another way this is considered is through per capita—or individual—carbon dioxide emissions. The United States leads the planet in per capita emissions, with 19.1 metric tons per year.

While China ranks as the second-largest emitter of carbon dioxide emissions, the individual emissions of a typical citizen in China are less than 1/8th that of the United States. The individual emissions of a citizen of Russia or Japan are both about one-half that of a U.S. citizen, while a citizen of India emits less than 1/20th that of a U.S. citizen. This per capita approach provides a much different picture of carbon dioxide emissions. Different perspectives like these can serve to reshape and broaden views on current and future plans for carbon dioxide emissions reductions policies and programs.

SEE ALSO: Atmosphere; Carbon Cycle; Chlorofluorocarbons; Global Warming; Greenhouse Gases; Methane; Nitrogen Oxides; Ozone and Ozone Depletion.

BIBLIOGRAPHY. John T. Houghton, *Global Warming: The Complete Briefing* (Cambridge University Press, 2004); Fred T. MacKenzie, *Our Changing Planet* (Prentice Hall, 2002); Stephen H. Schneider, Armin Rosencranz, and John O. Niles, eds., *Climate Change Policy: A Survey* (Island Press, 2002); William H. Schlesinger, *Biogeochemistry: An Analysis of Global Change* (Academic

Press, 1997); Spencer R. Weart, *The Discovery of Global Warming* (Harvard University Press, 2003).

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Carbon Sequestration

CARBON SEQUESTRATION OCCURS when carbon is removed from the atmosphere, or captured directly from industrial emission sources, and then stored (sequestered) where it cannot readily reenter the atmosphere. Most atmospheric carbon is present in the form of carbon dioxide (CO_2) and methane. Although these gases constitute a minor component of the total atmosphere (less than 0.1 percent of all atmospheric gases), they are among the primary greenhouse gases and contribute directly to global warming.

Burning fossil fuels and converting forest lands to agriculture release large amounts of carbon to the atmosphere and are leading to a rise in atmospheric CO_2 and methane levels. Stabilizing atmospheric greenhouse gas concentrations will require either a reduction in the amount of carbon being released or an increase in the rate of carbon sequestration. Many countries are pursuing both strategies.

There are two different approaches to carbon sequestration: Biological and technological. Both focus on CO_2, which is removed either directly from the atmosphere or at the point of emission and sequestered in a form or location where it is not radiatively active (that is, where it will not contribute to global warming). In some cases, sequestered carbon remains out of the atmosphere for hundreds or thousands of years, while in others the period of sequestration may be relatively short (years to decades).

Biological carbon sequestration takes advantage of the natural carbon cycle, and is primarily concerned with the uptake of atmospheric CO_2 and its storage as organic matter. Whenever photosynthesis (CO_2 uptake) is greater than respiration (CO_2 release), the result is carbon storage.

On land, green plants take up CO_2 through photosynthesis and store that carbon in leaves, stems, and roots. When leaves are shed or a plant dies, that stored carbon is either released back into the atmosphere relatively quickly through the process of decomposition, or it may be sequestered for much longer periods; for example, undecomposed tree trunks, wood products such as lumber, or soil organic matter. The longer the sequestration time, the more valuable the process is for climate change mitigation.

In the ocean, most photosynthesis is done by single-celled algae called phytoplankton, floating near the surface. Phytoplankton grows and dies quickly and much of the stored carbon is released back into the atmosphere when the algal cells decompose. If dead algae sink below the depth where decomposition occurs, however, their stored carbon can be sequestered for long periods as organic matter in marine sediments.

MEASUREMENTS AND PREDICTION

To predict changes in atmospheric greenhouse gas concentrations as a result of fossil fuel burning and deforestation, we need accurate measurements of global biological carbon sequestration. The greater the rate of carbon sequestration, the less rapid the expected rise in atmospheric CO_2. For individual countries and municipalities, quantifying biological carbon sequestration may be important for negotiating carbon emission standards or for validating carbon trading schemes. A variety of methods are used to calculate rates of biological carbon sequestration; these include measurements of carbon in wood, soil, and ocean sediments, measurements of CO_2 concentrations in the air and water, and computer simulations of the carbon cycle.

Strategies to increase biological carbon sequestration by land plants usually focus on increasing the amount of carbon in organic matter that decays slowly. Allowing forests to regrow or planting new forests results in carbon sequestration in wood and in soil. In agricultural lands, conservation tillage (or no-till soil) management practices result in higher amounts of soil carbon. The amounts of carbon that might be sequestered through improved forestry and agricultural practices are potentially quite large, with estimates for the United States of up to 50 percent of its annual fossil fuel emissions. Biotechnology also may play a role in efforts to enhance biological carbon sequestration. For example, the chemical structure of wood can be bioengineered to slow the natural process of decomposition, thereby lengthening the time carbon may remain sequestered in this form.

Technological carbon sequestration involves capture of CO_2 at the point of emission (its conversion to a form that can be transported in pipelines) and its long-term storage underground or under water. Much of the CO_2 emitted through fossil fuel burning comes from stationary sources such as power plants, oil refineries, and other energy intensive industries. Existing technology can be used to remove CO_2 from industrial flue gases and prevent it from entering the atmosphere. Chemical or physical solvents are used to trap CO_2, and CO_2 can also be separated from other gases cryogenically by cooling and condensation. Most CO_2 capture technologies now in place work best with high CO_2 concentration flue gases, however, and may need to be modified to work with the more dilute flue gases from many CO_2 emission sources.

Long-term sequestration of CO_2 captured in this way can be achieved via injection into underground geological formations or into the ocean. Candidate sites for geological sequestration are deep saline aquifers, old oil and gas fields, and coal beds. The potential CO_2 storage capacity of these geological formations worldwide is very large. Due to the costs involved in transporting captured CO_2, however, it is important that potential geological sequestration sites be relatively close to emission sources. Studies suggest that these conditions are common enough that carbon sequestration through capture and storage underground can be an important CO_2 emissions mitigation strategy. Carbon sequestration in ocean waters is theoretically possible, either by piping highly concentrated CO_2 below 1,000 meters where it would remain trapped by the overlying salt water, or by piping it into shallower waters where it would dissolve and disperse. In either case, possible impacts on marine life would be an important concern. For both biological and technological carbon sequestration, the feasibility of any particular approach rests on a complete accounting of the costs (monetary, energetic, and environmental) and benefits (amount of carbon stored and its sequestration time).

SEE ALSO: Carbon Dioxide; Carbon Cycle; Greenhouse Gases.

BIBLIOGRAPHY. David Gerard, *Carbon Capture and Sequestration Integrating Technology, Monitoring, Regulation* (Blackwell Publishers, 2007); W.M. Post, R.C. Izaurralde, J.D. Jastrow, B.A. McCarl, J.E. Amonette, V.L. Bailey, P.M. Jardine, T.O. West, and J. Zhou, “Carbon Sequestration Enhancement in U.S. Soils,” *BioScience* (v.54, 2004); W.H. Schlesinger, *Biogeochemistry: An Analysis of Global Change* (Academic Press, 1997).

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Carbon Tax

A CARBON TAX is a market-based instrument (MBI) designed to reduce the severity of climate change. It does so by discouraging the use of energy sources that emit carbon dioxide (CO_2) by making their use more expensive, through economic rather than government regulation. A carbon tax increases the price of CO_2–emitting energy sources, making investments in cleaner, alternative energy generation a more competitive and financially attractive way of generating power.

Many countries around the world have introduced a carbon tax, including Denmark, Switzerland, Sweden, Norway, Holland, Finland, Austria, Italy, and Germany. The German government introduced a carbon tax in 1999 as part of a wider ecological policy initiative that aimed to reduce CO_2 emissions, encourage investment in energy-efficient technology, and provide an economic boost to the German green-goods market. The revenue collected from the carbon tax in Germany has been used to reduce the pressure on other parts of the German economy by lowering the burden of income-related costs such as pension contributions. Socially, this has been particularly important for Germany. Since reunification in 1990, the German economy has endured long periods of recession and high levels of unemployment.

The European Union (EU) plans to introduce an industry-specific carbon tax on airlines in 2008 as part of a strategy to meet targets set by the Kyoto Protocol. Carbon dioxide pollution from aircraft presently accounts for 3 percent of the EU total, and in Britain (where there has been a rapid increase in the availability of cheap air fares), air travel is predicted to account for 25 percent of emissions by 2030.

The Tyndall Centre for Climate Change Research suggests that, unless the United Kingdom drastically reduces the amount of emissions caused by air travel, all householders, motorists, and businesses will have to reduce their CO_2 pollution levels to zero. Otherwise, it is argued that the British government climate change targets will not be met. The EU hopes a carbon tax on airlines will increase the price of air travel sufficiently to discourage its use and encourage people to use alternative forms of transportation.

FAIRNESS OF USE

A carbon tax is a regressive tax, however, which means people on low incomes pay more than those on high incomes because a greater percentage of their wage is consumed by energy and travel costs. The United Nations argues that a carbon tax is an inefficient way of reducing CO_2 emissions in poorer countries because they do not have the capacity to set, monitor, or enforce such schemes.

New Zealand was to implement a carbon tax in 2007, but after the 2005 general election the government abandoned the plan because it was determined to be too costly to implement, and greater cuts in CO_2 emissions could be gained through other schemes, such as carbon sinks.

SEE ALSO: Economics; Global Warming; Markets.

BIBLIOGRAPHY. K. Baumert, *Carbon Taxes vs. Emissions Trading: What's the Difference, and Which Is Better*? Global Policy Forum, www.globalpolicy.org (cited 1998); BBC News, *EU Plans Airlines CO_2 Reductions*, www.bbc.co.uk (BBC, 2005); Hardy and Markandya, *Study on the Relationship Between Environmental Energy Taxation and Employment Creation* (University of Bath, 2000); Northern Territory University, *The Economics of Carbon Taxes*, www.cs.ntu.edu.au (cited April 2006); NZ Climate Change Office, www.climatechange.govt.nz (cited April 2006); Tyndall Centre for Climate Change Research, *Decarbonising the UK: Energy for a Climate Conscious Future* (Food and Agriculture Organization, 2005); *Fostering Environment in Decentralised Decision-Making*, www.fao.org (cited April 2006).

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Carbon Trading

CARBON TRADING DESCRIBES an economic market trading scheme that will encourage a reduction in emissions of the climate-changing gases caused by anthropogenic activities such as the burning of fossil fuels for energy generation. Unlike a carbon tax, which is a rigid market-based instrument that simply increases the cost of emitting carbon dioxide (CO_2), carbon trading allows a more flexible approach.

The most common form of carbon trading occurs within a cap-and-trade environment. A government sets an overall cap on the level of emissions and issues emitters with allowances that can be bought and sold amongst members of the scheme. The scheme works by allowing a company that produces too many emissions to purchase allowances from an emitter that has produced less than their entitlement, thus ensuring the overall emission targets set by a government are met.

Trading in gases that pollute the atmosphere was first trialed in the United States under provisions in the Clean Air Act in 1990 (United States). Known as the Acid Rain Program, the U.S. government imposed a cap on sulphur dioxide (SO_2) emissions from power plants, distributed allowances and the permission of the owners to meet targets by installing new technologies, burning fuels with a lower sulphur dioxide content, engaging in projects that reduced SO_2 emissions from other parts of the economy, or through the trading of allowances between other participants in the scheme. Between the late 1980s and 2000, sulphur dioxide emissions from U.S. industry had been reduced by 5 million tons per year.

The success of the Acid Rain Program provided the United States with a strong argument that trading schemes could successfully reduce carbon emissions and should therefore be employed as a mechanism to reduce CO_2 emissions under the terms of the Kyoto Protocol. Although the United States pulled out of the Kyoto Protocol in 2001, Articles 6 and 17 provide mechanisms that enable member nations to trade greenhouse gases. The Kyoto Protocol allows all greenhouse gases to be traded either directly through the transfer of allowances or through the Clean Development Mechanism. This mechanism primarily allows polluters in the developed world to earn credits for investing either in technologies that lower emissions in developing nations, or through investment in carbon sinks.

BIG PLAYERS IN CARBON TRADING

The United Kingdom (UK) launched the world's first economy-wide carbon trading scheme in March 2002 to help it meet emission targets set by the Kyoto Protocol. Over the first three years of the scheme, CO_2 emissions were reduced by 5.9 million tons. The UK is now part of the European Union Emissions Trading Scheme, which was launched in January 2005. This is by far the world's most ambitious trading scheme, and when fully operational, 12,700 industrial organizations will be able to trade carbon allowances.

Carbon trading also operates at a voluntary level, either directly through company endeavors or through programs such as the Chicago Climate Exchange. In 2000, Canada's second-largest greenhouse gas emitter, TransAlta, released voluntary plans to reduce their emissions of CO_2 to zero by 2024, primarily through carbon trading. The Chicago Climate Exchange is a pilot project that trades CO_2 in a stock market-like environment. Companies trading on the exchange include Rolls-Royce, Ford, New Belgian Brewing Company, Dupont, Motorola, and IBM. Each company trading on the Chicago Climate Exchange has set voluntary targets to reduce emissions by 4 percent of their 1998 to 2000 average by 2006.

Critics argue that carbon trading will not significantly reduce climate gas emissions and will further reinforce social inequalities between the developed and developing world. Carbon trading does not encourage a significant change in polluting behavior by developed nations and excludes most poor countries because they produce very few emissions and thus have little to trade.

The European trading scheme, moreover, does not include emissions from transport or the aviation industry, which together account for 50 percent of their emissions. Russia has also been singled out as a potential problem. Kyoto Protocol targets were set to 1990 levels, and at that time Russia was still part of the Soviet Union and producing massive amounts of climate-changing emissions through energy production in decrepit, coal-fired power stations. Since the collapse of the Soviet Union, Russia now possesses significant carbon credits. Because many of the old coal-fired power stations have been decommissioned, there are fears that if Russia was to trade all of its credits, there could be a significant increase in CO_2 emissions.

Trading via carbon sinks is also seen as problematic. Establishing a carbon sink—such as replanting areas of cleared tropical rainforest—would provide significant biodiversity benefits. There is no sound scientific method of determining precisely how much carbon is sequestered during the growing phase, however, or any political guarantee that the sink will remain in place for the life of the project it was designed to offset.

SEE ALSO: Economics; Global Warming; Markets.

BIBLIOGRAPHY. Department for Environment Food and Rural Affairs (DEFRA), *United Kingdom Emissions Trading Scheme,* www.defra.gov.uk (cited April 2006); J. Edmonds, et al., *International Emissions Trading and Global Climate Change, Impacts on the Cost of Greenhouse Gas Mitigation* (Pew Centre on Global Climate Change, 1999); M. Hopkins, "Emissions Trading: The Carbon Game," Nature Online, www.nature.com. (cited 2004); M. Hopkins, "Carbon Trading Grows in New Year," Nature Online, www.nature.com. (cited 2005); F. Lecocq, *State and Trends of the Carbon Market 2004* (Carbon Finance, World Bank, 2004); N. McDowell, "Developing Countries to Gain from Carbon-Trading Fund," *Nature* (v.4, 2002); A. Petsonk, D. Dudek, and J. Goffman, *Market Mechanisms and Global Climate Change* (The Trans-Atlantic Dialogues on Market Mechanisms, 1998); P. Propham, Independent Newspaper, *Rainforest*

Brought Back to Life as Carbon Trading Takes Off, www.news.independent.co.uk (cited April 2006); R. Rosenzweig, M. Varilek, and J. Janssen, *The Emerging International Greenhouse Gas Market* (Pew Centre on Global Climate Change, 2002).

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Carcinogens

CARCINOGENS CAN BE defined as potential cancer-causing agents that are found within our natural (air, water, soil), social (lifestyle and dietary choices, voluntary vs. involuntary exposures), and built (synthetic chemicals, pharmaceuticals, radioactive substances) environments. Carcinogens can induce cancer in an organism and as such, the biological environment (genetics, aging, sex) plays a role in the degree of vulnerability to the carcinogen(s) in question. Bacteria, parasites, and viruses have also been implicated for their role in cancer causation; their impact varies depending on the biological environment.

The most direct method to evaluate the effect(s) of a carcinogen is through the use of animal models.

According to the International Agency for Research on Cancer (IARC), the most recent description of the *categories of agents* includes “both ‘specific’ as well as ‘groups’ of related chemicals, complex mixtures, occupational or environmental exposures, cultural or behavioural practices, biological organisms, and physical agents.” The IARC Monographs provide a complete listing of all of the carcinogens assessed to date.

In an attempt to better understand, potentially lessen, and possibly eliminate human exposure to carcinogens, testing and evaluation of carcinogenic agents are frequently conducted within the field of science. Numerous carcinogens have been assessed by organizations such as the IARC and the U.S. Environmental Protection Agency (EPA). According to J.B. King, there are three main methods for directly testing an agent’s carcinogenic potential in an ethical manner (i.e., not knowingly putting humans at risk of being exposed to carcinogenic agents for experimental purposes). As with any method, each of these tests has its own advantages and disadvantages.

METHODS OF TESTING

The first method of testing is conducted with cultured cells. In order to minimize species variation, human cells can be used. However, when an agent is evaluated in the absence of the complex nature of an entire biological system—as in the case with cultured cells—the metabolic activation of the test agent may not occur, which can result in false negatives. The main objective for using cultured cells is to test compounds by monitoring their effects on the cell functions that are involved in the process of transforming normal cells into cancer cells (i.e., DNA damage).

The second method includes testing on microorganisms. Using this method, scientists can examine the carcinogen’s ability to generate mutations. The Ames test—developed by Bruce Ames in 1975—was the first method to use the bacterium *Salmonella typhimurium*. This bacterium was genetically altered so that it could detect chemically induced mutations. The Ames test is relatively simple to administer and can quickly examine a large number of agents. A limitation with this method is the frequent occurrence of false positive and false negative results. Such inaccuracies can occur because the premise behind this test is that carcinogens are also mutagens. However, this is not always the case. Therefore, the Ames test has been used by many researchers as a screening test for carcinogens prior to testing on animals.

The third and most direct method to evaluate the effect(s) of a carcinogen is through the use of animal models. These tests are conducted primarily to examine the ability of the carcinogenic agent(s) to induce cancer(s) and/or to damage the DNA of animals. However, because humans have different genetic predispositions and are not confined to various controlled environments, they often experience multiple and varied exposures to carcinogens at different doses for various durations and at different points in time throughout their lifetimes. As Curtis D. Klaassen notes, the route of exposure (ingestion, inhalation, absorption, or parenteral), as well as the carcinogen's ability to metabolize in the body, plays a role in the effect the agent has on the body. These factors make it difficult to draw parallel comparisons among humans, let alone between animals and humans.

Nevertheless, animal experiments are the best available method for testing carcinogens to date. Because different strains of the same species vary in their reaction(s) to carcinogens, it has been suggested by King that different species should be used in animal tests in order to fully understand and more accurately classify carcinogens.

To date, the best available approach for understanding human carcinogenic exposure are those methods used in the field of epidemiology. The association between human exposures to occupational carcinogens and cancer can be traced back to the late 1700s, when Sir Percivall Pott recognized the association between exposure to soot among chimney sweepers (which was later identified as benzo[a]pyrene) and the occurrence of scrotum cancer. Since then, numerous occupational epidemiological studies have been conducted in an attempt to better understand human exposure to specific carcinogens. Research has been undertaken using occupational and health records in conjunction with the testing of blood, serum, and other biological samples.

HURDLES TO INVESTIGATION

Nevertheless, there are limitations with these types of studies, because the examination of several exposures (such as those found in the natural, social, and built environments) over one's lifetime are difficult to isolate, despite their critical role in cancer causation. There is also the possibility of delayed effects—or a latency period—between carcinogenic exposure and the manifestation of cancer. This creates further difficulties in the identification of causative agents. Additionally, as Jack Siemiatycki and his associates note, several earmarked "occupational carcinogens" (i.e., asbestos, radon gas, and benzene) are not strictly monitored or measured in the general environment; therefore, one cannot be certain that these presumed occupational carcinogens are in fact solely the result of workplace exposures. This gives rise to concerns on a micro level, such as deciphering the totality of study findings. It also raises concerns on a macro level such as the implementation of stringent policies and regulatory measures as well as social responsibility.

Other epidemiological studies have been conducted in contaminated sites, such as the Hiroshima and Nagasaki atomic World War II bomb sites and the nuclear fallout accident at Chernobyl in 1986. These sites gave rise to an increase of certain cancers, and these populations became of interest to epidemiologists around the world. Numerous human observational studies have been conducted with the populations of these regions in order to better understand deleterious health outcomes as a result of carcinogenic exposures.

Epidemiological studies have been successful at implicating some cultural practices for their role in cancer causation. For instance, Parviz Ghadirian and associates found that in certain regions of Iran, the custom of eating opium dross, as well as the consumption of contaminated bread containing large quantities of silica fibers originating from extraneous seeds used in the bread, have been suspected as the "initiating" carcinogenic factors for esophageal cancer. Additionally, some cooking practices (including inhalation-exposure to cooking fumes, the consumption of charred meat, the consumption of pickled or moldy foods) have been associated with certain cancers.

The use of epidemiological studies to understand carcinogenic agents is not limited to occupational and/or environmental agents. Several viruses and bacteria have also been implicated in cancer causation. For instance, the bacteria helicobacter pylori (h-pylori) has been found to be associated with stomach cancer. Likewise, some studies have linked the human papillomavirus (hpv) to cervical cancer.

Based on a number of different types of studies that examine carcinogenicity, in addition to other relevant data presented, the IARC assesses carcinogenic agents on an ongoing basis. These carcinogens fall into one of four groups, and can move up and down the ranks as new information becomes available. Carcinogens are categorized as "Group 1 when the agent is *carcinogenic to humans*; Group 2A when the agent is *probably carcinogenic to humans*; Group 2B when the agent is *possibly carcinogenic to humans*; Group 3 when the agent *is not classifiable as to its carcinogenicity to humans*; and Group 4 when the agent is *probably not carcinogenic to humans*." The IARC has reviewed almost 900 agents since 1972. In 2002–03, there was some controversy in the literature among several scholars and researchers regarding possible industry influence in the decision-making process concerning some of the carcinogens reviewed. Notwithstanding, there are numerous carcinogens that are yet to be reviewed that we are voluntarily and involuntary exposed to in our environments every day.

SEE ALSO: Animal Rights; Asbestos; Cancer; Chernobyl Accident; Disease; Health; Hiroshima: Radioactivity; Smoking.

BIBLIOGRAPHY. Kristen E. Anderson et al., "Dietary Intake of Heterocyclic Amines and Benzo(a)Pyrene: Associations with Pancreatic Cancer," *Cancer Epidemiology Biomarkers and Prevention* (v.14, 2005); Dan Ferber, "Carcinogens: Lashed by Critics, WHO's Cancer Agency Begins a New Regime," *Science,* (v.301, 2003); Matthew Firth, James Brophy, and Margaret Keith, *Workplace Roulette: Gambling with Cancer* (Between the Lines, 1997); "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans," various links, http://monographs.iarc.fr/ (cited April 2006); H.J. Kim et al., "Dietary Factors and Gastric Cancer in Korea: A Case-Control Study" *International Journal of Cancer* (v.97/4, 2002); Paul Kleihues and Jerry Rice, "Letters: Integrity of the Conduct of the IARC Monographs Program; IARC Monographs Program; Reply to Dr. Sass," *International Journal of Occupational and Environmental Health* (v.9/1, 2003); P. Nicolopoulou-Stamati, L. Hens, C.V. Howard, and N. Van Larebeke, *Cancer as an Environmental Disease* (Kluwer Academic Publishers, 2004); Lorenzo Tomatis, "The IARC Monographs Program: Changing Attitudes towards Public Health," *International Journal of Occupational and Environmental Health* (v.8/2, 2002); WHO and International Agency for Research on Cancer (IARC), "IARC Monographs on the Evaluation of Carcinogenic Risks to Humans: Preamble," January 2006, http://monographs.iarc.fr/ (cited April 2006).

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Caribbean Sea

LOCATED ADJACENT TO the Atlantic Ocean, the Caribbean Sea covers the majority of the Caribbean Plate. With an area of approximately 1,710,000 square kilometers (1,063,000 square miles), the Caribbean Sea surrounds dozens of islands of different sizes, with Cuba being the largest. Cuba is part of a group of islands known as the Greater Antilles, along with the Dominican Republic, Haiti, Jamaica, and Puerto Rico. The Lesser Antilles includes two arcs of small islands known as the Windward and Leeward Islands. The Caribbean is a mix of independent states, such as Barbados and Trinidad and Tobago, as well as various dependent territories, such as Aruba, Martinique, and the Virgin Islands.

The Caribbean Sea borders a total of approximately 40 nations, depending on how its limits are defined. Mexico's Yucatan Peninsula and the eastern coasts of Belize, Costa Rica, Guatemala, Honduras, Nicaragua, and Panama border the sea on its western edge. South American coasts are found in Colombia, the Guianas (French Guiana, Guyana, and Suriname), and Venezuela. English, Spanish, French, and Dutch are spoken in the Greater Caribbean, as well as Amerindian languages.

The origin of the name *Caribbean* (pronounced kar-*uh*-**bee**-*uh*n) can be traced to the Carib Indians, skilled boat builders and sailors who navigated the sea. The Caribs once lived throughout the Lesser Antilles, but their numbers were greatly reduced in the colonial period. Starting in the late 1400s, the Caribbean islands served as ports for colonial expeditions from various European nations. With the arrival of Europeans, the indigenous populations, such as the Arawak and Caribs, were decimated by introduced diseases such as smallpox. Colonial empires then turned to African slaves to work in plantation agriculture for crops such as sugarcane and bananas until the end of slavery in the 1800s. In modern times, the Caribbean region makes up an important African diaspora.

Since the mid-1950s, there has been a transition from a primary focus on agricultural production to economies oriented around tourism, services, and manufacturing. There is currently an emphasis on the development of ecotourism and improvements to community involvement in existing tourism programs. Tourism in the Caribbean has historically been based from isolated resorts, beaches, or cruise ships, which limits benefit to local people.

Economic assistance from the United States to the Caribbean region was reduced after the Cold War, and European preferential purchases of bananas and sugar are being phased out. These products are central to the economies of several islands. Bilateral and multilateral trade pacts involving the Caribbean are increasingly common as leaders look to improve economic cooperation among the islands and strengthen ties with Latin American countries considered part of the Greater Caribbean. Although the creation of the Caribbean Community (Caricom) began over 30 years ago, with the aim to integrate states of the region, progress toward a Caribbean Single Market and Economy (CSME) has been slow. CSME finally entered into force on January 3, 2006. The Association of Caribbean States, created in 1994, covers a larger area than Caricom. Its goals are to strengthen economic cooperation, preserve the environmental integrity of the Caribbean Sea, and promote sustainable development throughout the region.

The Caribbean faces many challenges. A central problem is an increase in crime, often linked to drug and gun trafficking. The Caribbean Sea lies in a trafficking corridor between South America and the United States. A significant portion of cocaine passing though various ports is distributed and used

Martinique 1902

At 7.50 a.m., on the morning of May 8, 1902, the volcano of Mt. Pelée on the Caribbean island of Martinique erupted. A deadly cloud of poisonous gas descended on the town of St. Pierre. A wealthy planter who was watching the scene, Fernand Clerc, managed to get his wife and children into a carriage and escape into the hills as the final eruption took place and hot ash showered the whole of St. Pierre. This totally devastated the entire town, burning the largely wooden buildings, and killing about 30,000 people who lived there.

Off the coast of Martinique, the *Roraima* from the Quebec Line was moored in the bay, about half a mile from the town. The vessel was showered with volcanic debris and started to burn. Scalding hot ash covered the passengers and crew. Of the 68 passengers and crew, only about 20 survived.

By contrast, most of the people in the town died immediately. When the air cleared, Clerc returned and found only two survivors. One of them was a young shoemaker, Léon Comprer-Léandre, who had, miraculously, managed to find shelter. The other was Auguste Ciparis (of Ludger Sylbaris), a prisoner held on a charge of murder whose lonely cell had only a narrow vent, away from the volcano. He was badly burned, but was released and became “the man who lived through Doomsday” at Barnum’s Traveling Circus in the United States. He was the first black man ever to star in the segregated performances. Some accounts have a girl, Havivra da Ilfrile, surviving, and there was also a woman who survived the eruption but died soon after giving a description of the event. All around the world, French colonies collected money to pay for the rebuilding of St. Pierre. However, the administrative capital of Martinique was moved to Fort-de-France.

domestically. Another problem is extreme poverty in both rural and urban areas. There are wide gaps between rich and poor within and among Caribbean states and territories.

VULNERABLE COASTS AND ISLANDS

A large portion of the Caribbean population lives in the coastal zone, which is prone to damage from hurricanes and tropical storms. Vulnerability in low-lying areas creates concern over climate change, with the potential for rising sea levels. Caribbean islands share several additional environmental problems, such as increased sedimentation in rivers due to deforestation, dredging, and mining. Fluvial sediments often deposit in coastal waters. Water pollution originates from industrial waste, untreated sewage, landfills, and pesticide use. Solid waste in the form of plastic, glass, and metal also harms marine life, such as sea turtles. Caribbean biodiversity loss has led to the creation of new marine and terrestrial protected areas in recent years, but many precious natural resources remain at risk. An unprecedented loss of coral colonies has been attributed to sea temperature increase in combination with disease. Overextraction of fish is another widespread problem.

SEE ALSO: Bananas; Coastal Zone; Cocaine; Drugs; Overfishing; Poverty; Sea Turtles; Sugar.

BIBLIOGRAPHY. Germán Arciniegas, *Caribbean: Sea of the New World* (Marcus Wiener, 2003); David T. Duval, *Tourism in the Caribbean: Trends, Development, Prospects* (Taylor and Francis, 2004); Gary S. Elbow and Guntram H. Herb and David H. Kaplan, eds.,"Scale and Regional Identity in the Caribbean," *Nested Identities*, (Rowman and Littlefield Publishers, 1999); Robert B. Potter, David Barker, Dennis Conway, and Thomas Klak, *The Contemporary Caribbean* (Prentice Hall, 2004); UNEP, *Caribbean Environment Outlook* (2005).

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Carpooling

CARPOOLING OCCURS WHEN a group of people, who live and work near each other and share the same approximate work hours, share a ride to their place of employment. There are a number of environmental, health, economic, and social advantages to carpooling.

Carpooling is an overall effective means of reducing the amount of automobile emissions into the atmosphere, which is a major source of air pollution, particularly in wealthier nations. Automobiles emit five gases linked to global warming (carbon monoxide, carbon dioxide, nitrous oxide, chlorofluorocarbons, and ozone smog). Carpooling can help alleviate air pollution, which in turn contributes to the overall health of individuals. Air pollution can lead to various respiratory ailments, cancer, impaired central nervous functioning and cirrhosis of the liver. In addition, if individuals carpooled on a regular basis, there will be less of a need for individuals with respiratory ailments to avoid time out of doors.

Carpooling also helps the environment by reducing the total number of commuter trips. Each passenger, in addition to the driver, represent one less vehicle trip. If four people drive to work separately, those four cars, making a total of eight trips to and from work, would emit three times the amount of gas emissions into the air. The same four workers, if they carpooled, would make one trip each way, thus cutting down on the total emissions into the air. The long-term environmental benefits are significant. It is estimated that the emissions in the atmosphere today will possibly linger there for more than one hundred years. Limiting the number of emissions in the atmosphere will lessen humans' impact on global warming.

There are economic and social advantages to carpooling as well. Carpooling reduces the amount of money spent by drivers on automobile-related expenditures such as maintenance, parking, and fuel. Thus, carpooling saves consumers' money while it simultaneously creates more space in parking garages and lots. Carpooling also increases the amount of free time that riders can spend on leisure, family, and intellectual pursuits.

Free time is further enhanced by High Occupancy Vehicle (HOV) lanes, which makes time management more efficient along municipal interstates and larger highways. In addition, carpooling allows for commuters to get to know one another, encouraging social interaction. This, in turn, may lead to lowering stress when commuting to and from work.

If carpooling becomes a norm, it will help to reduce society's dependence on fossil fuels. For example, the population in the United States currently consumes over 19 million barrels of oil per day, some of which is used to power automobiles. Ten million barrels of this oil is imported. If fewer automobiles are being driven, oil consumption will decrease, resulting in a reduction in dependence on imported oil. Nevertheless, current levels of carpooling readership are relatively low. It is likely that incentives (like increased numbers of HOV lanes) and increases in gas prices will drive more commuters toward carpooling.

A major source of air pollution is the emissions from automobiles, particularly in wealthier nations.

SEE ALSO: Automobiles; Fossil Fuels; Global Warming; Greenhouse Gases; Pollution, Air.

BIBLIOGRAPHY. EPA, "Transportation Benefits: Carpooling," www.epa.gov (cited May 2006); D. Stanley Eitzen and Maxine Baca-Zinn, *Social Problems,* 10th ed. (Allyn and Bacon, 2006); Erin Kelly, "Earth Day Has Seen Great Gains, but Earth Can Do Better," *USA Today* (April 20, 2004); Loudon County, Virginia, "Carpooling," www.loudoun.gov (cited May 2006).

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Carrying Capacity

THE CONCEPT OF carrying capacity has a complex history; the only definition that would capture all of its meanings would be "conveyed or supported by some encompassing context, site, or resource." However, one can distinguish four major types of carrying capacity concepts since the term was coined circa 1845, and it is the variety of more specific meanings—the different Xs and Ys—and their mutual influences over time that has given the concept both its power and its flaws.

MECHANICAL CAPACITY

At its origins, carrying capacity referred to mechanical or engineered attributes of manufactured objects or systems. It arose first in the context of shipping. In 1845, a "tonnage duty" imposed by the Republic of Texas was described as applying to steamboats "according to their carrying capacity only," as distinct from the overall volume of the boats. In the late 19th century, the term was used in this sense in discussions of steam ships, Native American canoes, the British merchant fleet, and as a way of expressing the volume of the world's glaciers. Parallel applications included the carrying capacity of the electric commuter rail system in Paris, measured in people transported per hour; the capacity of lightning rods and transmission lines to carry electricity; and the capacity of irrigation ditches and pipelines to carry water.

Beginning in the 1870s, carrying capacity was applied to living organisms and natural systems, while retaining its literal sense of conveying or transporting something. In an 1873 monograph, The Topography and Geology of Santo Domingo, carrying capacity referred to how much weight the inhabitants' pack animals could haul. In the Botanical Gazette of 1887, the legs of certain bees were said to have a carrying capacity for the pollen of specific flowers. An 1888 article in *Science* referred to the carrying capacity for floodwaters of the main branch of the Atchafalaya bayou in Louisiana. The American Naturalist of 1896 used carrying capacity in relation to the cells through which water moved in cucumber plants.

LIVESTOCK AND WILDLIFE

The second type of carrying capacity concept emerged in the context of livestock in the late 1880s, when the implied subject—the animals that carried freight—became instead the things being "carried" by the land where they lived. Two articles in 1886 referred to "the stock carrying capacity" of New Zealand; in 1889, in *Science*, carrying capacity was explicitly (and without the qualifier "stock") used as a measure of rangeland productivity, in units of sheep per square mile. In essence, the meaning of "carrying" had changed from a literal to a much more figurative sense. This new concept gained momentum due to widespread and severe overgrazing in the American West at the time, and by the turn of the century it was sufficiently well established.

During the 1920s and 1930s, early wildlife managers applied this concept of carrying capacity to game animals and their habitats. Aldo Leopold encountered the term and the concept in 1914–15, when he briefly worked in the Forest Service's Office of Grazing. According to C. Meine, "the discovery would reverberate through his work for the rest of his life," beginning with the infamous collapse of the deer population on the Kaibab plateau in the mid-1920s. The episode, which recurred later in Wisconsin and elsewhere, introduced an additional variable not considered in the livestock context: predators. Leopold's pioneering 1933 textbook, *Game Management,* defined carrying capacity as "a property of a unit of range" that varied in space and time and that could be exceeded during cyclic or irruptive increases in a species's population, resulting in high mortality: "In hoofed animals there is so far no visible evidence of any density limit except the carrying capacity of the food."

NEW POSTWAR DEFINITIONS

After World War II, two additional types of carrying capacity concepts emerged concurrently, with overlapping points of origin but widely divergent audiences and applications. One retained flora and fauna as its object but transformed the epistemological basis of carrying capacity from inductive and applied to deductive and theoretical. The other shifted the object of the concept to humans and expanded its scale to continents and the entire globe, giving rise to the neo-Malthusian sense of carrying capacity that pervades general use of the term today.

In his 1953 textbook, *Fundamentals of Ecology,* Eugene P. Odum observed that populations "characteristically increase in size in a sigmoid or S-shaped fashion … regardless of whether one is dealing with fruit flies in a milk bottle or with fish in a new pond." He defined carrying capacity as the asymptote to which the sigmoid curve converged, an "upper limit" K, where "a more or less equilibrium level is reached." The apparent universality of the sigmoid curve was derived not from field measurements—which Odum conceded were "few, incomplete, and hard to come by"—but from laboratory experiments (with "fruit flies, flour beetles, or other convenient organisms") in artificially optimized environmental conditions of temperature, food, space, and so on. Such conditions were said to reveal the "intrinsic rate of natural increase" of different organisms; differential equations could then be used to infer "the environmental resistance created by the growing population itself, which brings about an increasing reduction in the potential reproduction rate as population size approaches the carrying capacity." Paradoxically, "ideal" environmental conditions allowed carrying capacity to appear as a property of organisms abstracted from any environment. Models could then be developed and tested for single or multiple species.

Odum recognized that his concept of carrying capacity could be applied to humans as well; indeed,

Conceptual Flaws of Carrying Capacity

Except in its earliest, literal sense, carrying capacity has been plagued with serious conceptual flaws due to the contrasting but frequently conflated characteristics of its various uses. Should carrying capacity be understood as a fixed quality (the tonnage of a ship) or as a dynamic one (grass in a pasture)? Is it a function of human technology and adaptation, or of natural processes? Finally, can something discerned at very small, bounded scales—in a Petri dish or a ship, a pasture or a pipeline—be accurately applied at much larger scales?

In both range and wildlife management, carrying capacity begged the question it was intended to address—that is, how many animals a given habitat could actually support. Simply using the term implied that such a number could be determined; but, as R.Y. Edwards and C.D. Fowle aksed, what if the number varied over time? Range scientists have found that many grasslands fail to exhibit relatively stable carrying capacities for livestock, especially in drier and more variable climates. In 1961, H.A. Paulsen Jr. and F.N. Ares, two prominent range scientists, concluded that "Sustained grazing capacity does not exist" on U.S. semidesert ranges in the southwest. Similar conclusions have been reached for large areas of Africa, where efforts to impose stable stocking rates have frequently backfired, both socially and ecologically.

The problem recurs in ecology more generally. Odum's generalized carrying capacity assumed an idealized growth curve and spatial homogeneity, but neither assumption stands up to empirical scrutiny. As K.S. Zimmerer noted, "the assumption of a 'continuing steady-state basis' embedded in the definition of carrying capacity is simply unwarranted." If a Petri dish can be viewed as an environment, then by analogy, so the world's ecosystems as capable of supporting a certain number of organisms—but only by assuming linearity across time and space.

Postwar carrying capacity concepts seem to have blurred into each other, the ecological providing scientific credibility and the neo-Malthusian providing political traction and hyperbole. Many prominent ecologists, such as Paul Ehrlich (1968) and Garrett Hardin (1968), have encouraged crossing back and forth between the two. It is noteworthy that when carrying capacity in its fourth sense first appeared in *Science,* in A.M. Woodbury's 1955 article, "Ecology and the Population Problem," it was placed in scare-quotes, as if the author recognized he was using the term in an unusual, perhaps inappropriate way.

the logistic equation at the basis of his model had its origins in the work of Belgian mathematician Pierre-François Verhulst (1804–49) to model human population growth. Yet the final type of carrying capacity concept differs fundamentally in scale, audience, and application. Ecologist-ornithologist William Vogt published Road to Survival in 1948, in the shadow of the horrors of World War II. Defining carrying capacity as the ratio of biotic potential to environmental resistance ("C = B: E"), Vogt conceded that "the equation finds complicated expression in terms of civilized existence." But he insisted on applying it to continental and global scales:

> The equation is, perhaps, oversimplified, but it expresses certain relationships—almost universally ignored—that every minute of every day touch the life of every man, woman and child on the face of the globe. Until an understanding of these relationships on a world scale enters into the thinking of free men everywhere, and into the thinking of rulers of men who are not free, there is no possibility of any considerable improvement of the lot of the human race. Indeed, if we continue to ignore these relationships, there is little probability that mankind can long escape the searing downpour of war's death from the skies.

It is important to recognize this as a new concept of carrying capacity, even though the idea it expressed was older than the term itself. As early as 1820, William Godwin had attempted to calculate the number of humans the world could support. In his polemical response to Malthus, *Of Population,* Godwin took China as demonstrating the maxima of possible cultivation and population density, which he then applied to the earth's habitable area, arriving at a figure of 9 billion people. Although his estimate may now appear prescient, Godwin was in fact mocking the idea of a determinate number, and neither he nor Malthus ever used the term carrying capacity.

SEE ALSO: Malthus, Thomas Robert; Population; Tragedy of the Commons.

BIBLIOGRAPHY. R.H.J. Behnke, I. Scoones, et al., eds. *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas* (Overseas Development Institute, 1993); R.Y. Edwards and C.D. Fowle, The Concept of Carrying Capacity, Twentieth North American Wildlife Conference, 1955; Paul R. Ehrlich, *The Population Bomb* (Ballantine Books, 1968); Garrett Hardin, "The Tragedy of the Commons," *Science* (v.162/3859, 1968); Aldo Leopold, *Game Management* (Charles Scribner's Sons, 1933); C. Meine, *Aldo Leopold: His Life and Work* (University of Wisconsin Press, 1988); Eugene P. Odum, *Fundamentals of Ecology* (W.B. Saunders, 1953); H.A. Paulsen Jr. and F.N. Ares, "Trends in Carrying Capacity and Vegetation on an Arid Southwestern Range," *Journal of Range Management* (v.14/2, 1961); William Vogt, *Road to Survival* (William Sloane Associates, 1948); A.M. Woodbury, A. M. "Ecology and the Population Problem," *Science* (v.122, 1955); K.S. Zimmerer, "Human Geography and the 'New Ecology': The Prospect and Promise of Integration," *Annals of the Association of American Geographers* (v.84/1, 1994).

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Carson, Rachel (1907–61)

IN 1962, HOUGHTON Mifflin published Rachel Carson's *Silent Spring*. Although the book had received considerable attention prior to its publication, its actual appearance still created a sensation. The book provides a thorough, systematic, and yet passionate expose of the careless uses of chemicals by agricultural and industrial concerns, often in collusion with governmental agencies that were shortsighted in their attempts to promote increased productivity. In particular, Carson highlighted the enormous environmental hazards created by the widespread use of the pesticide DDT. Because of the book's unprecedented impact, the publication of *Silent Spring* has often been identified as the genesis of the environmental movement in the United States.

Silent Spring represented the culmination of Carson's career as a scientist and as a writer. On the basis of three previous books, Carson had earned considerable respect as a scientist and something of a literary reputation as a prose stylist. In *Silent Spring*, she supported her own observations and conclusions with references to the work of a broad spectrum of other scientists. Following its publication, many other prominent scientists came forcefully to her defense when her positions were challenged.

Nonetheless, the chemical industry marshaled its considerable resources to impugn not only Carson's thesis and supporting evidence, but also her character and motives. Carson had taken on the chemical industry at a time when it had achieved an unprecedented importance within the American economy, and the criticism was not unexpected, even though its ferocity struck her and many others as excessive. The attacks on Carson were ultimately counterproductive because they created widespread curiosity about *Silent Spring*, in which Carson's sincerity, clarity, and rationality were persuasively displayed.

Carson was born in 1907 in Springdale, Pennsylvania. Growing up among the Allegheny Mountains, she spent many solitary hours observing the natural world up close and then making precocious efforts to put her observations into words. When she enrolled in the Pennsylvania College for Women, located in Pittsburgh, she initially declared English as her major, but eventually switched to biology, graduating magna cum laude in 1929. She then completed a Master's degree in zoology at Johns Hopkins University and began completing coursework toward a doctoral degree. However, following her father's death, she assumed the responsibility for supporting her mother; about a decade later, following her sister's death, she raised her two nieces. Thus, it became financially unfeasible for her to complete a doctoral degree.

After teaching zoology for five years at the University of Maryland, Carson worked for the U.S. Bureau of Fisheries as an aquatic biologist. One of her major responsibilities involved writing feature articles on the Bureau's activities that could be disseminated to general periodicals and newspapers. Eventually, she began to supplement her income by writing, on her own time, on nature-related topics for major periodicals such as the *Atlantic Monthly* and for newspapers such as the *Baltimore Sun*. One article for the *Atlantic Monthly* prompted Simon and Schuster to offer her a contract to expand it into a book. That first book, *Under the Sea-Wind* (1941), was released shortly before the Japanese attack of Pearl Harbor and was more critically than commercially successful. In contrast, the second volume of what would become a trilogy about the sea, *The Sea Around Us* (1952), achieved great commercial and critical success, spending 86 weeks on the *New York Times* best-seller list and winning a National Book Award for nonfiction. The income from this book permitted Carson to resign from her position with the Bureau of Fisheries in order to concentrate on her writing. She completed the trilogy with *The Edge of the Sea* (1955).

In contrast to the fortuitous circumstances surrounding her contract to write *Under the Sea-Wind*, Carson had considerable difficulty in finding a publisher for *The Sea Around Us*. Therefore, when she initially conceived of the idea for *Silent Spring*, she was hardly surprised when she had difficulty finding a publisher who was interested in the project. Although Carson spent four years writing the book, its publishing gestation stretched over almost a decade. The serialization of parts of the book in the *New Yorker* did much to bring notice to the book in advance of its publication. Ironically, despite the great notoriety that the book brought her, Carson died less than two years after its publication, from breast cancer.

SEE ALSO: DDT; Pesticides; Policy, Environmental.

BIBLIOGRAPHY. Paul Brooks, *The House of Life: Rachel Carson at Work* (Houghton Mifflin, 1972), republished as *Rachel Carson: The Writer at Work* (Sierra Club, 1998); Martha Freeman, *Always, Rachel: The Letters of Rachel Carson and Dorothy Freeman, 1952–1964* (Beacon, 1995); Carol B. Gartner, *Rachel Carson* (Ungar, 1983); Frank Graham, *Since Silent Spring* (Fawcett, 1970); Linda Lear, *Rachel Carson: Witness for Nature* (Holt, 1997); Alrene Rodda Quaratiello, *Rachel Carson: A Biography* (Greenwood, 2004); Philip Sterling, *Sea and Earth: The Life of Rachel Carson* (Crowell, 1970); Craig Waddell, *And No Birds Sing: Rhetorical Analyses of Rachel Carson's Silent Spring* (Southern Illinois University Press, 2000).

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Carter, Jimmy Administration

JAMES EARL ("JIMMY") Carter Jr. (1924–) was the 39th president of the United States and served from 1977–81 as the leader of the Democratic Party. Walter Mondale, former U.S. Senator from Minnesota, served as his vice president. Citizens scarred by the Watergate scandal, which led to President Richard Nixon's downfall and eventual resignation, perceived Carter as exemplifying simple principles of faith and honesty. Carter claimed a desire to restore integrity and morals to the American presidency and politics in general.

In terms of environmental challenges, the Carter administration is notable in its efforts to manage the oil shortages of the early 1970s, which had contributed to persistent levels of high unemployment and inflation in the country. The oil crisis further revealed America's gross reliance on foreign oil. To address this dependence, the Carter administration planned to invest in alternative energies, together with conservation measures and an oil tax. However, this plan was stopped by the U.S. Senate. Public and political will for investment in alternative energy sources were simultaneously dampened by the core meltdown at the Three Mile Island nuclear energy plant in Pennsylvania. Nevertheless, Carter was more successful in his role in protecting 100 million acres in Alaska from land development, and establishing the Superfund to deal with environmental disasters. He also ordered the Tennessee Valley Authority to implement the 1974 Ford Foundation report to become a research-oriented society and initiate conservation techniques. An engineer himself, Carter also boldly challenged the Army Corps of Engineers, pursuing a "hit list" of high impact and expensive dam projects that he intended to derail. This last fight proved too difficult to win, but demonstrated Carter's willingness to go after even the most "sacred cows" in pursuit of environmental protection.

The later part of the Carter administration was marred by international events that overtook the domestic agenda, including the revolution in Iran that led to the captivity of American hostages in the Iranian capital of Tehran and the Soviet invasion of Afghanistan. Though he successfully negotiated arms deals with the Soviet Union, championed human rights internationally, and promoted peace in the Middle East, he lost the 1980 presidential race to Ronald Reagan, former Republican governor of California. Carter's strong record on the environment remains notable however, especially as contemporary American presidents begin to wrestle with the problem of nonrenewable energy dependence, a high-priority problem highlighted by Carter decades ago. Despite the failures of his presidency, Americans have come to admire Carter's post-presidency involvement in various public works through Habitat for Humanity and his role as a peacemaker on the international front. Carter's leadership efforts to secure peace during and after his presidency led to him receiving the Nobel Peace Prize in 2002.

SEE ALSO: Iran; Nixon, Richard Administration; Reagan, Ronald Administration; Tennessee Valley Authority; Three Mile Island Accident.

BIBLIOGRAPHY. David S. Freeman, "Lessons Not Learned," Energy Systems and Policy, (v.13/1, 1989); Erwin C. Hargrove, *Jimmy Carter as President: Leadership and the Politics of the Public Good* (Louisiana State University Press, 1988); Burton I. Kaufman, *The Presidency of James Earl Carter, Jr.* (University Press of Kansas, 1993); President Jimmy Carter's biography, www.whitehouse.gov (cited November 2006).

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Cash Crop

CASH CROPS TYPICALLY refer to food and nonfood plants whose yields are sold. Also called *export* or *commercial crops*, cash crops are intended to produce income, whereas *subsistence* crops are grown to feed one's family and/or livestock, as well as to use in barter. Cash crops are usually sold as primary commodities. Value-added processing may occur within the country of production, and/or the crops may be transported elsewhere for further processing and packaging.

Examples of cash crops include, but are by no means limited to: Bananas, cocoa, coffee, cotton, cut flowers, grains, sugarcane, tea, tobacco, and tomatoes. Cash crops can be grown in tandem with subsistence foods and one another, but more frequently they are produced in monocultures dependent on capital-intensive inputs of chemical or synthetic fertilizers, herbicides, and/or pesticides. Also, cash crop production requires water supplies (irrigation systems and/or wells), transportation, human labor, harvesting equipment, and land. Some or all of these resources might be diverted from (and thus preclude or limit) other uses. Cash crop production, therefore, has significant environmental impacts.

Cash crops now dominate the agricultural sectors of so-called underdeveloped or third world countries, and with notable social and economic effect. By the latter half of the 19th century, household- and village-level production in those regions became restructured within larger regional systems, colonial states, and world commodity markets. This forced integration of peasants and farm laborers into commodity and financial circuits controlled from overseas undermined traditional food security. In *Late Victorian Holocausts*, Mike Davis invokes a political ecology perspective to argue that it was "subsistence adversity (high taxes, chronic indebtedness, inadequate acreage, loss of subsidiary employment opportunities, enclosure of common resources, dissolution of patrimonial obligations), not entrepreneurial opportunity, that typically promoted the turn to cash crop cultivation."

Money earned from cash crop production during good export years allowed wealthier landowners to pursue crop brokerage, lending at high rates, and investing in rental properties—some of which were acquired from their less successful neighbors. Marginal subsistence producers suffered, and many were forced into circumstances that led to marked declines in their conditions of production and terms of trade. By the late 19th century, millions of agriculturists had been integrated into the world markets, where prices for their commodities were prone to fluctuations based on global supplies and imperial politicking. Further, these agriculturists were made highly vulnerable during natural disasters, such as droughts or floods. As Esther Boserup argues, the emphasis on cash crop production during the colonial era reconfigured divisions of labor among smallholders. Regardless of a society's patterns of labor in subsistence activities, cash crops and their attendant technologies tended to be introduced to men by men, restricting women's roles in this new and increasingly important agricultural activity.

The post-WWII birth and expansion of the United Nations International Monetary Fund (IMF) and World Bank provided additional channels for Western development efforts. Guided by *modernization theory*, IMF and World Bank assistance has promoted large-scale agriculture (cash crop production), industrial development, and further integration of poorer countries into global markets. Cash crop production reorients subsistence-based economies to export for foreign markets, allowing the state and its elites to acquire foreign revenue. When cash crop prices fall due to overproduction, local producers lose money—and possibly their land—while wealthier consumers get a bargain.

If producers follow the logic of economies of scale, cash crop production may then be increased to make up for the decrease in price. This may require better lands being devoted to cash crops, while staple foods are grown on lower quality lands and/or are imported. Environmental impacts of agribusinesses—and thus economies of scale related to cash crop production—include heavier demands on land that lead to deforestation to clear lands for cash crops, loss of biodiversity, decreased soil quality, erosion, increased chemical inputs, and/or pollution, among other problems.

SEE ALSO: Bananas; Cocoa; Coffee; Cotton; Fertilizers; Herbicides; IMF; Irrigation; Modernization Theory; Monocultures; Pesticides; Political Ecology; Subsistence; Sugar; Tobacco; Tomatoes; World Bank; Underdeveloped World.

BIBLIOGRAPHY. Esther Boserup, *Women's Role in Economic Development* (Aldine, 1970); Deborah Barndt, *Tangled Routes: Women, Work, and Globalization on the Tomato Trail* (Rowman & Littlefield, 2002); Mike Davis, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (Verso, 2000).

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Caspian Sea

THE CASPIAN SEA covers a vast strategic area in central Asia. It is the world's largest inland sea at around 386,400 square kilometers. An immense body of water—with many of the same properties of an ocean—it varies in salinity, climate and temperature from northern to southern latitudes. Before the breakup of the Soviet Union, the Caspian was effectively a Soviet lake, with only the southern strip of coastline controlled by Iran. After 1989 the newly formed, independent countries of Turkmenistan, Azerbaijan, and Kazakhstan all shared the Caspian, vastly complicating the indeterminate legal status of the sea. This legal problem is one of the main reasons for the increasingly alarming environmental crisis affecting the sea and the surrounding coastline. However, a long history of shortsighted exploitation of oil resources remains the main reason for a worsening ecological crisis.

Baku, the capital of Azerbaijan on the Caspian coast, began experiencing serious environmental consequences from oil development as early as 1870. More than a century of urbanization and industrialization in the Caspian zone has made the sea a dumping ground for waste. Even feeding rivers like the Volga bring in thousands of tons of petroleum and nitrate wastes from the sprawling agricultural lands of central Russia every month. Although the fall of the Soviet economy led to some decrease in pollution, new, ambitious schemes for oil production agreed between the various bordering countries threaten to severely worsen the current ecological crisis. The most famous, immediate and pressing consequence of the Caspian's developing ecological and economic calamity is the possible eradication

Caspian Sea Caviar

The sturgeons fished from the Caspian Sea have long been prized for their eggs (or "roe"), which are known as caviar from the Persian word *Khagavar* ("roe generator"). This was prized in antiquity and has long been a term synonymous in Western culture with luxurious living and opulence. Most of the fishermen were Russians or Persians—with both countries having access to the Caspian Sea.

The most popular types of sturgeon are the Beluga, the Ossetra, and the Sevruga, with the rare golden Sterlet caviar being the favorite dish of the Tsars of Russia, as well as popular with the Shahs of Persia, European royalty, and some Soviet Communist leaders. The number of sturgeon in the Caspian Sea has fallen considerably because of over-fishing, and in September 2005, the U.S. Fish and Wildlife Service banned the U.S. import of Beluga caviar from the Caspian Sea in order to try to protect the numbers of sturgeon there.

As the population of sturgeon in the Caspian Sea has fallen, sturgeon from the Black Sea are now caught in larger numbers, although the connoisseurs prefer the fish from the Caspian. In addition, fish farms have been established in France, Uruguay, and off the coast of California. The roe of the whitefish and also the North Atlantic salmon are occasionally used as substitutes when Russian or Iranian sturgeon supplies dwindle.

of the sturgeon catch, which provides almost all of the world's caviar. Pollution, pesticides, and unregulated fishing after the Soviet collapse led to an eightfold decline in the sturgeon catch from 1991–94. The Convention on International Trade in Endangered Species recommended that signatory countries refuse the import of Caspian Sturgeon. The World Wildlife Federation has suggested that the Caspian sturgeon may risk extinction if illegal poaching and consumption of caviar is not reduced.

It is not only sturgeon that may pay the price of uncontrolled petroleum development in the Caspian. Unlike the neighboring Aral—were sea levels have decreased—sea levels in the Caspian have risen dramatically, possibly as a consequence of the unbalanced climatic conditions caused by the drying of the Aral. Farms, industrial plants, and even nuclear power stations built on once-dry ground are being threatened by higher and more vigorous Caspian waves. Other biological products and resources are being sapped as land becomes saturated by oil products and the Caspian becomes more and more of a petrochemical dumping ground. Environmental groups have estimated the natural resources of the Caspian waters to be worth far more than $500 million. Oil production may reap short-term economic benefits for new and struggling post-Soviet nations; but the long-term political, social, environmental, and ultimately economic consequences of unbridled oil development will be severe.

SEE ALSO: Aral Sea; Azerbaijan; Convention on International Trade in Endangered Species; Iran; Kazakhstan; Turkmenistan.

BIBLIOGRAPHY. R.H. Dekmejian and H.H. Simonian, *Troubled Waters: The Geopolitics of the Caspian Region* (IB Tauris, 2003); R. Ebel and R. Menon, ed., *Energy and Conflict in Central Asia and the Caucuses* (Oxford, 2000); Lutz Kleveman, *The New Great Game: Blood and Oil in Central Asia* (Atlantic, 2003).

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Catalytic Converters

A CATALYTIC CONVERTER is a device that is designed to reduce dangerous emissions from combustion engines such as those used in automobiles. It works by enhancing the combustion of unburned hydrocarbons that would otherwise enter the atmosphere through the exhaust. The closed chamber of a catalytic converter is lined with a substrate of porous material through which the gas is forced to pass. This results in the chemical conversion of carbon monoxide to carbon dioxide, the reduction of nitrogen oxide to its component nitrogen and oxygen, and the conversion of the unburned hydrocarbons to water and carbon dioxide. Releasing carbon dioxide into the air is not beneficial to the environment, but is preferable to the alternative. For example, catalytic converters are credited with having reduced the numbers of accidental deaths and suicides from inhaling carbon monoxide in cars by many thousands.

Catalytic converters are customarily made of steel, but recent research has focused on the use of ceramics and alternative materials that may provide better emission control. This has had some unanticipated consequences; for example, when it was discovered that catalytic converters were found not to work in the presence of lead, which resulted in the abolition of leaded gasoline and concomitant reductions in the negative health impacts caused by the lead. Catalytic converters have been used in North America since the 1970s, and are being adopted in many countries around the world.

The Environmental Protection Agency introduced more strict emissions controls after the 1960s, and by 1975 all new vehicles were fitted with the devices. Catalytic converters may be retrofitted to older vehicles, but this kind of measure can only really be effective as part of an integrated transport and emissions strategy. Many countries have extensive public transport systems with aged or secondhand vehicles such as buses that are significant contributors to emissions.

Research concerning the genuine efficiency of catalytic converters suggests that laboratory conditions testing that approach 99 percent efficiency may dip to around 70 percent in traffic conditions. Consequently, plans to reduce emissions internationally have been undermined by the failure of technology and by the unwillingness of many governments to implement and enforce stringent, but manageable emissions controls. Catalytic converters should also be maintained and serviced properly to ensure optimum performance. This adds a cost to the policing of vehicles, especially since the testing equipment is expensive and many countries have inefficiently policed transportation systems. Nevertheless, the introduction of catalytic converters has made a significant contribution in the fight to reduce air pollution, and most new vehicles are produced with a catalytic converter. Comparatively low-cost versions have been adopted for use with two- and three-wheeled vehicles in countries such as India and China.

SEE ALSO: Automobiles; Carbon Dioxide; Gasoline; Lead.

BIBLIOGRAPHY. W. Amatayakul and O. Ramnas, "Life Cycle Assessment of a Catalytic Converter for Passenger Cars," *Journal of Cleaner Production* (v.9/5, 2001); Asian Development Bank, "Reducing Vehicle Emissions in Asia: Policy Guidelines for Reducing Vehicle Emissions in Asia," www.adb.org (cited July 2006); S. Samuel, et al., "Real-World Performance of Catalytic Converters, Proceedings of the Institution of Mechanical Engineering," *Journal of Automobile Engineering* (v.219/D, 2005).

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Cattle

CATTLE ARE DOMESTICATED bovine ruminants raised primarily for milk, meat, hides/leather, and/or labor. Cattle in many communities around the world symbolize status, as well as serve significant social and ritual functions through exchange as dowries, inheritance, and/or gifts.

The etymology of the term *cattle* underscores the claim that cattle are "wealth on the hoof" to pastoralists, agro-pastoralists, ranchers, and other enthusiasts. The Oxford English Dictionary traces "cattle" to an ancestral word, *catel*, which referred to property, wealth, and capital. Over time, the word became synonymous with moveable property or wealth. By the 16th century, English usage of *catel* privileged livestock, and the 17th century marked the beginning of the usage of *cattle* for livestock, while the Anglo-French *chattel* retained the broader meaning of property or article of property.

Applications of the term *cattle* have varied over time and place. The term *cattle* now typically refers to calves, heifers, cows, bulls, steer, and oxen, thus restricting the term to the bovine genus. But in some localities, the designation of cattle has also included sheep, goats, horses, mules, camels, swine, and other animals.

There are approximately 1.4 billion head of cattle (bovine) in the world today, all of which probably descended from the now extinct aurochs (*Bos primigenius)*. Once widespread in Europe, southern Asia and North Africa, aurochs were domesticated at least 8,500 years ago, during the Neolithic Era. They became of great economic importance to farmers, as the animals provided food for humans, directly through their milk and meat, and indirectly through their labor and fertilizing manure. Because cattle are ruminants, they can digest plant foods that humans cannot. Cattle thus transform areas that are not suitable for farming into productive lands by eating grasses and other high cellulose plants, which they then convert into protein, fat, and other nutrients. Small-scale livestock herding, as practiced by pastoralist populations, has proved well-suited to marginal lands. But, as human populations continue to escalate and the rural poor are pushed from viable resource bases, pastoralists struggle to maintain adequate herds.

Through selective breeding, humans have assisted in modifying the genetic makeup of aurochs's offspring. Today, the resultant cattle have been classified into over 270 breeds, which are typically divided into two major species: *Bos taurus* (European breeds) or *Bos indicus* (zebu breeds). These divisions are oft-contested, but breeders and the livestock industry oversee decisions about when animals constitute a distinguishable breed. Cattle do remain closely enough related to some other Bovids, such as bison and yak, that they can be interbred and produce viable offspring (e.g., Beefalo as offspring of American Bison and domestic cattle).

Despite the seemingly wide variety, certain cattle breeds dominate commercial beef and dairy production, which are in turn dominated by large corporations. As Eric Schlosser describes, the growth of fast food restaurants and franchise grocery stores has encouraged the meatpacking industry in the United States to consolidate to the point that the top four meatpacking firms account for over 80 percent of the cattle slaughtered in the United States. This has deflated prices that ranchers get for cattle and

Certain cattle breeds, including crossbreeds like these calves, dominate commercial beef and dairy production.

forced many ranchers out of the business altogether. For both beef and dairy production, many family ranches and farms have been replaced by Concentrated Animal Feeding Operations, or feedlots. Cattle are bred and fed so that their rates of maturation have increased. The spread of Bovine Spongiform Encephalopathy (mad cow disease) and the overproduction of methane have been attributed to this trend. Such trends are also occurring in many parts of the world, as demands for cattle products increase while per capita holdings decrease.

Following the logic of economies of scale, the desire to increase productivity and profitability in the beef and dairy industries has fueled certain types of biotechnology. For example, in 1993 Monsanto Corporation's bovine somatotropin (rBST), a genetically engineered bovine growth hormone, was approved by the Federal Food and Drug Administration for use in the United States to increase the production of milk in commercial dairy cows. The context for the approval of rBST and the consequences of its uses have remained highly controversial. Still, research focusing on genetic modification (GM) continues, with attempts to produce GM cash crops for cattle feed, GM cows that may present resistance to mastitis or tick-borne diseases, and more.

SEE ALSO: Agriculture; Bovine Growth Hormone; Bovine Spongiform Encephalopathy; Cash Crop; Domestication; Genetics and Genetic Engineering; Livestock; Mad Cow Disease; Methane; Pastoralism; Ranchers.

BIBLIOGRAPHY. Cattle Today, www.cattle-today.com (cited January 2007); International Livestock Research Institute, www.ilri.org (cited January 2007); Oklahoma State University's Department of Animal Science, "Breeds of Livestock," www.ansi.okstate.edu/breeds (January 2007); Valerie Porter ed., *Mason's World Dictionary of Livestock Breeds, Types, and Varieties*, 5th ed. (CABI Publishing, 2002); Eric Schlosser, *Fast Food Nation: The Dark Side of the All-American Meal* (Perennial, 2002).

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Center for Disease Control (CDC)

THE U.S. CENTERS for Disease Control and Prevention (CDC), located in Atlanta, Georgia, is one of the 13 major operating components of the Department of Health and Human Services (HHS), the primary U.S. government agency for protecting the health and safety of all Americans. The CDC strives to objectively measure and inform the U.S. public, Congress, partners, and stakeholders about the state of the public's health. Since it was founded in 1946 to help control malaria, the CDC has remained at the forefront of public health efforts to prevent and control infectious and chronic diseases, injuries, workplace hazards, disabilities, and environmental health threats. According to the CDC, it is globally recognized for conducting research and investigations to improve people's daily lives and respond to 21st century health emergencies such as emerging infectious diseases (such as SARS, monkeypox, and pandemic influenza); terrorism; environmental threats (such as hurricanes, wildfires, and toxic chemical spills); and lifestyle choices (such as tobacco use, poor nutrition, and lack of physical fitness).

The component of the CDC that works to prevent illness, disability, and death from interactions between people and the environment is the National Center for Environmental Health (NCEH). The NCEH is especially committed to safeguarding the health of populations that are particularly vulnerable to certain environmental hazards, such as children, the elderly, and people with disabilities. According to the NCEH, its main activities include public health surveillance, applied research, epidemiologic studies, laboratory and statistical analyses, behavioral interventions, operations and systems research, communication and education, standards, and training and technical assistance for officials of state and local health agencies in preventing and responding to public health challenges.

For the past three decades, the NCEH has provided an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring. NCEH scientists have been determining which environmental chemicals enter people's bodies, how much of these chemicals are present, and how the amounts of these chemicals may be related to health. Chemicals or their metabolites were measured in the blood and urine of a random sample of National Health and Nutrition Examination Survey (NHANES) participants, aged 6–59 years.

A metabolite is a chemically altered form, as produced in the body, which reflects the level of the original chemical of concern. Participants were selected within the specified age ranges to be a representative sample of the U.S. population with respect to gender and race/ethnicity. The environmental chemicals currently being measured by NCEH reflect people's exposures to metals, tobacco smoke, polycyclic aromatic hydrocarbons (PAHs), polychlorinated dibenzo-p-dioxins and dibenzofurans, polychlorinated biphenyls (PCBs), phthalates, phytoestrogens, pesticides, herbicides, and insecticides.

One example of how NCEH's biomonitoring surveillance data serves as a powerful public health tool involves the levels of lead measured in blood before and after the United States began its phase-out of lead in gasoline in 1975. Although the human exposure data collected during the 1976–91 time-frame demonstrated a substantial decline in blood lead levels of the entire U.S. population, certain socio-demographic factors continued to be associated with higher blood lead levels, including younger age, male gender, non-Hispanic black race/ethnicity, and low income level. These data were especially critical due to the neurodevelopmental effects associated with low-level environmental exposure to lead and spurred scientists to scrutinize the environment for other sources of lead exposure.

SEE ALSO: Disease; Health; Policy, Environmental.

BIBLIOGRAPHY. *Center for Disease Control*, www.cdc.gov (cited July 2006); Environmental Protection Agency, www.epa.gov (cited July 2006); R. Jackson, "Will Biomonitoring Change How We Regulate Toxic Chemicals?" *J. Law Med. Ethics* (v.30/3, 2002); J.L. Pirkle, et al., "The Decline in Blood Lead Levels in the United States: The National Health and Nutrition Examination Surveys (NHANES)," *JAMA* (v.272/4, 1994).

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Central African Republic

FORMERLY KNOWN AS Ubangi-Shari, the Central African Republic (CAR) won its independence from France in 1960, setting off three decades of tumult and military rule. A period of unstable civil government between 1993 and 2003 ended with a military coup and the installation of a transitional government. Barely three percent of the land area is arable, but the economy of the CAR is chiefly dependent on subsistence agriculture and forestry. The agricultural sector accounts for some 55 percent of the Gross Domestic Product (GDP), and the timber industry provides 16 percent of export earnings. Other natural resources include diamonds, uranium, timber, gold, oil, and hydropower, with diamonds furnishing 40 percent of export earnings.

Less than a third of the population lives in urban areas, and industry accounts for only one-fifth of the GDP. Unemployment rate stands at eight percent. The poor infrastructure and transportation systems make it difficult to fully exploit resources. With a per capita income of only $1,100, CAR is the 26th poorest country in the world. Vast inequality exists with the most affluent 10 percent controlling almost half of the country's resources. Despite regular grants from France and the international community, the CAR is unable to adequately meet the needs of the population. The United Nations Development Program (UNDP) Human Development Reports rank CAR 171 of 232 countries on overall quality of life issues.

LANDLOCKED AND FACING AN EPIDEMIC

True to its name, the CAR is located near the geographic center of the vast continent. Landlocked, CAR shares borders with Cameroon, Chad, the Democratic Republic of the Congo, the Republic of the Congo, and the Sudan. The flat to rolling mountainous plateau of CAR gives way to scattered hills in the northeast and southwest. Elevations range from 335 meters at the Oubangui River in the south to 1,420 meters at Mont Ngaoui in the northwest. The tropical climate produces hot, dry winters followed by mild to hot, wet summers. Floods are common throughout the country, and the north is subject to the harmattan, a seasonal hot, dry, and dusty wind that accelerates the pace of soil erosion and desertification.

The CAR population of 4,300,000 people suffers from an HIV/AIDS rate of 13.5 percent. By 2003, an estimated 23,000 deaths had occurred, and another 260,000 were living with HIV/AIDS. The people of CAR are susceptible to certain diseases due to the lack of potable water and proper sanitation. While three-fourths of urban residents have sustained access to safe drinking water, only 61 percent of rural residents do so. No more than 27 percent of urban and 12 percent of rural residents have access to improved sanitation. As a result, residents have a very high risk of contracting food and waterborne diseases, including bacterial diarrhea, hepatitis A, and typhoid fever as well as malaria, a vectorborne disease, and meningococcal meningitis, a respiratory disease. Consequently, residents experience low life expectancy (43.54 years) and growth rates (1.53 percent) and high infant mortality (85.63 deaths per 1,000 live births) and death rates (18.65 deaths per 1,000). On the average, women produce 4.41 children. The low literacy rate (51 percent), particularly for females (39.9 percent), makes it extremely difficult to disseminate information on heath and environmental issues that might bring a halt to the cycle of disease and poverty.

THREATS TO HABITAT AND ECOSYTEMS

In 2006, scientists at Yale University ranked the CAR 86 of 132 countries on environmental performance, above the comparable income and geographic groups. The poor showing was a result of the low score for the category of environmental health. Long celebrated as a major wildlife refuge, CAR is now experiencing major threats to habitats and destruction of ecosystems as a result of deforestation and poaching. Of 209 mammal species, 14 are endangered, as are three of 168 bird species.

As part of the Congo Basin, CAR is home to four floristic domains that include the Sudanopsahellan steppes, the Sudan wooded savanna, the Sudano-Guinean woodlands, and the equatorial forests. Ecologically valuable tropical timber such as Sapelli, Ayous, and Sipo are stripped from the forests as loggers select only the most valuable trees in order to defray the exorbitant costs of transporting timber. By some estimates, nearly a third of the forests have been destroyed in this fashion.

The Ministry of Environment, Waters, Forests, Hunting, and Fishing oversees the implementation and monitoring of environmental laws and regulations in the Central African Republic. The government has divided the country into two action zones. The first of these is concerned with overseeing hunting and conservation activities, while the second is made up of buffer zones that deal with agricultural and industrial activities. Protected zones within the Central African Republic have three classifications: forbidden access reserves, national parks in which no hunting is allowed, and wildlife reserves. The government has protected nearly 9 percent of CAR forests, including such areas as the Dzanga-Sangha Special Dense Forest Reserve. Working with local Non-Government Organizations, these areas generate approximately $200,000 each year from ecotourism activities.

The government of the Central African Republic participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Ozone Layer Protection, and Tropical Timber 94. The Law of the Sea agreement has been signed but was never ratified.

BIBLIOGRAPHY. CIA, "Central African Republic," *World Factbook* www.cia.gov/cia; Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (New Brunswick: Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (Santa Barbara: ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (Jefferson, North Carolina: McFarland, 1993); Urbain Ngatoua, "Conservation of Biodiversity in the Central African Republic," *Yale F&ES Bulletin* 102: 249-252; UNDP, "Human Development Report: Central African Republic," www.hdr.undp.org; World Bank, "Central African Republic," www.worldbank.org; Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited 2006).

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Central Park (NY)

PERHAPS THE BEST-KNOWN urban park in the United States, Central Park is an 843-acre area located in the center of New York City, offering a sharp contrast to the expansive metropolitan landscape. Central Park's boundaries are marked by on the south by 59th Street (Central Park South), on the north by 110th Street (Central Park North), on the east by Fifth Avenue, and on the west by Eighth Avenue (Central Park West).

The history of Central Park is extensive. Among many lesser-known inhabitants, it was poet and newspaper editor William Cullen Bryant (1794–1878) who in 1844 called for the creation of a public park that would be open to all inhabitants, no matter their social position or ethnic origins. By 1850, most of the city's 500,000 residents lived below 38th Street, several blocks lower than the Park's current 59th street southern border. In 1853, the New York State Legislature approved a bill that designated the future location for a public park. Contrary to popular belief, Central Park was not a genuine forest preserved from urbanization: Before 1850, it combined a treeless, rocky terrain and stagnant swampland that was later to be transformed into a public park with artificial lakes.

In 1857, the commissioners of New York City had organized a public competition for architects to design the project, and received 33 anonymous entries. Finally, architects Frederick Law Olmsted (1822–1903) and Calvert Vaux (1824–95) were chosen to design the Greensward Plan in 1858. Olmsted was inspired by Birkenhead Park, near Liverpool, which had opened in 1847, as the first public park in England. Instead of a square plan as in parks in Paris or Versailles, Central Park was designed with some irregular lines that would seem more natural.

According to scholars Elizabeth Blackmar and Roy Rosenzweig, many people were first opposed to the construction of Central Park, such as the "1,600 poor residents, including Irish pig farmers and German gardeners, who lived in shanties on the site." Some fights even broke out as many farmers resisted. Nevertheless, Blackmar and Rosenzweig acknowledge that "the park first opened for public use in the winter of 1859 when thousands of New Yorkers skated on lakes constructed on the site of former swamps."

However, Central Park did not really emerge from the soil of Manhattan. According to the Central Park Conservancy website, some 500,000 cubic feet of topsoil was carted in from New Jersey, totaling more than 10 million cartloads of material by 1873. Official statistics indicate that there were more than 4 million trees, shrubs, and plants, representing more than 1,400 species, when Central Park was completed in 1878—after about twenty years of work. The Central Park Zoo was created in 1871.

Throughout the years, Central Park has encountered periods of abandon and misuse. From time to time, it was invaded by homeless people who wanted to live on its premises: thousands of victims of the 1930s' Great Depression built shacks in Central Park, which was nicknamed "Hooverville" in reference to President Herbert Hoover (1874–1964). A similar movement arrived in the 1970s, when groups of hippies spent day and night in the park. As the growing occurrence of trash, bugs, and crime became more frequent in the park, other visitors felt uncomfortable with these circumstances, proving that a park cannot be dedicated only to a single group or just for the poorest; but must remain equally accessible to the whole population. This is sharp contrast with 19th century rules, when children needed special written permission to play ball in Central Park.

From the 1960s, Central Park has been a place for demonstrations, philharmonic concerts, rock concerts, and giant gatherings like the visit of Pope John Paul II, who celebrated mass on Central Park's Great Lawn for about 125,000 people in 1995.

New sections appear from time to time in Central Park: A peace park named "Strawberry Fields" opened in 1985 as a memorial for Beatles founder John Lennon (1940–80), who was assassinated just 100 yards away from the park on Central Park West and West 72nd Streets, on December 8, 1980. The memorial's name is a tribute to a Beatles song, "Strawberry Fields Forever," composed by Lennon with Paul McCartney in 1966.

Central Park remains famous because its concept and success have inspired many other cities—like Chicago and Quebec City—to build similar large urban playgrounds since the late 19th century. Some urban parks are larger than Central Park: The Jamaica Bay Park in Queens (also in New York City) and the Fairmount Park in Philadelphia, which is about ten times the size of Central Park.

SEE ALSO: Olmstead, Frederick Law; United States, Urban Parks Movement; Urban Planning.

BIBLIOGRAPHY. Elizabeth Blackmar, Roy Rosenzweig, and Kenneth T. Jackson (ed.), "Central Park," *The Encyclopedia of New York City,* (Yale University Press, 1995), www.centralpark.com (cited November 2006); Elizabeth Blackmar and Roy Rosenzweig, *The Park and the People: A History of Central Park* (Cornell University Press, 1992); Central Park Conservancy, www.centralparknyc.org (cited November 2006); City Mayors: Central Park Anniversary, www.citymayors.com (cited November 2006); M. Gandy, *Concrete and Clay: Reworking Nature in New York City* (Cambridge, MIT Press, 2002.)

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Central Planning

IN CENTRAL-PLAN ECONOMIES, major policy decisions are made in advance by the government. Most of the central plan economies were socialist or Communist countries such as the Soviet Union, China, and most of Eastern Europe. However, central plans or elements of such plans also appeared in the fascists states of Italy and Germany. The time span of central plans may vary, but three- and five-year plans were the most common in Communist economies of eastern Europe. Decisions in central planning are focused on the volume and growth of production, consumption, and construction. In almost all cases, planned economies existed for a longer or shorter period in Communist countries. Such plans are still coordinating the economies of Cuba and North Korea. Central-plan economies are usually regarded as inflexible systems. However, they gained success in the post-World War II reconstruction. Some eastern European countries, such as Hungary and German Democratic Republic, had limited economic success until the 1970s as a result of economic reforms.

Central-plan economies aim to eradicate unemployment and determine capital investment in certain branches of the economy, such as heavy industry and engineering. Consequently, consumer demand and services play a secondary role in such economic systems. In 1991's *What Happened in Eastern Europe in 1989*, Daniel Chirot described the Soviet system as the most advanced 19th-century economy in the world. While the central-plan economy develops rapidly, it can cause supply problems and lead to shortages of certain consumer goods. In extreme cases, people have had to stand in line for hours to get basic commodities such as bread, meat, and dairy products in central-plan economies. Because the black market was strongly supervised, and smuggling and illegal trade were punished, some Communist countries implemented reforms to address shortages. One of the most successful examples was 1968's Hungary. Direct plans were abandoned, and factories became partly individual market actors with the right to export and make contracts.

Economic theorists point out the frequent shortages and supply problems of central-plan economies. According to Hungarian economist János Kornai, such problems were the result of the unilateral targets of investments, heavy and chemical industry, gigantic electric dams, and large-scale mining projects. Critics of such economic systems point out that one firm was responsible for a particular field of production in central-plan economies. Therefore, only a few varieties of tractors, buses, coats, and refrigerators were available on the market. However, commodities were available on subsidized prices set by authorities and not evaluated by market forces.

The environmental aspects of central-plan production are regarded as quite negative, as they are associated with accelerated development of heavy industry, engineering, and mining. Besides numerous new factories, gigantic infrastructural projects were often carried out to improve energy production. The aims of such plans concerning industrial output might be unrealistically high, accounting for over 10 percent of the annual Gross Domestic Product. The result of such aims is the growth of emissions and different ways of environmental pollution. For example, untreated industrial sewage polluted various waterways and lakes in Communist countries. Lake Baikal in Siberia, the largest freshwater resource on the globe, has a long history of pollution and contains a number of endangered species. The Sulphur Triangle of Czechoslovakia, Poland, and the German Democratic Republic used to be one of the most polluted areas globally. There, heavy industries and mining were concentrated, and underdeveloped technology was combined with high emissions. Air, water, and soil pollution harmed the health of millions in the region.

Various infrastructural projects of planned economies were also heavily debated within and out of country borders. Giant dam projects were in favor of China and the Soviet Union, but appeared also in Eastern Europe as well. The Gabikovo-Nagymaros electric dam project has been one of the most debated large-scale projects of the former Communist countries. The project was built on river Danube between Czechoslovakia (now the Slovakia) and Hungary, and generated mass protest of over 140,000 participants in Hungary before the fall of the Communism. The highly politicized dam issue became the tool of arm-twisting of the opposition of the Communist government.

SEE ALSO: Air Pollution; China; Communism; Cuba; Economics; Germany; Hungary; Italy; Korea, North; Political Economy; Russia (and Soviet Union); Socialism; Water Pollution.

BIBLIOGRAPHY. E. Arfon Rees, ed., *Decision-making in the Stalinist Command Economy, 1932–37* (Macmillan Press, 1997); G. Fink, *Socialist Economy and Economic Policy* (Springer-Verlag, 1985); Peter Gey, Jiri Kosta, Wolfgang Quaisser, eds., *Crisis and Reform in Socialist Economies* (Westview Press, 1987); John Bennett, *The Economic Theory of Central Planning* (B. Blackwell, 1989).

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Chad

IN 1960, CHAD won its independence from France and began a 30-year period of intense civil unrest that included invasions by Libya. Even though peace was declared in 1990, periodic outbreaks of violence continued among rebels in the north. In 2005, amidst claims that Chad was sponsoring rebel fighters in Darfur in western Sudan, guerilla fighters from the Sudan joined northern Chadian guerillas in fighting Chadian government troops, attempting to unseat the controversial President Idriss Deby. Tens of thousands of people in Chad and the Sudan have been killed in the prolonged battle that has spread to other countries including Uganda. Around 250,000 black Sudanese refugees have fled to Chad, but in April 2006, the government threatened to expel them.

Less than 3 percent of the land in Chad is arable, but more than 80 percent of the labor force is engaged in subsistence agriculture and livestock production. Some 60,000 Chadian farmers have been forced to leave their homes to escape violence, diminishing the food supply that is essential to survival for poor Chadians. Oil reserves in southern Chad have been estimated at two billion barrels; and since 2000, foreign investment in the oil industry has boosted the struggling economy. Other export products consist of cotton, cattle, and gum Arabic.

Despite increasing oil revenues, Chad is still heavily dependent on foreign aid and investment capital for survival. However, in January 2006, Paul D. Wolfowitz, the president of the World Bank, suspended all loans to Chad when the government backed down on its promise that most of the revenues from the controversial Chad-Cameroon pipeline would be used for poverty reduction. With a per capita income of $1,800, Chad is ranked 185 of 232 countries in world incomes. Eighty percent of the people live on less than $1 a day in abject poverty, and 34 percent are seriously undernourished. The United Nations Development Program (UNDP) Human Development Reports rank Chad 173 of 232 countries on overall quality of life issues.

Landlocked, Chad shares borders with Cameroon, the Central African Republic, Libya, and Nigeria as well as a 1,360 kilometer border with the Sudan. The broad, arid plains of central Chad give way to desert in the north, mountains in the northwest, and lowlands in the south. Elevations range from 160 meters at Djourab Depression to 3,415 meters at Emi Koussi. Southern Chad experiences a tropical climate, but the climate of the north is desert. In addition to petroleum, Chad's natural resources include uranium, natron, kaolin, fish in Lake Chad, gold, limestone, sand and gravel, and salt. Locust plagues and droughts may occur throughout Chad, and the north experiences the harmattan, hot, dry, dusty season winds that serve to speed up the processes of soil erosion and desertification.

The inability of the Chadian government to guarantee adequate supplies of potable water and proper sanitation facilities in rural areas creates an environment in which disease and soil and water pollution flourish among the population of 9,900,000. One-fourth of Chadians lives in urban areas, where 40 percent of the residents have access to safe drinking water. In rural areas, less than a third have such access. While 30 percent of urban residents have access to improved sanitation, rural residents have no access at all. Consequently, Chadians have a very high risk of contracting food and waterborne diseases, including bacterial and protozoal diarrhea, hepatitis A, and typhoid fever, as well as vectorborne diseases such as malaria and respiratory diseases such as meningococcal meningitis. Chad suffers from an HIV/AIDS rate of 4.8 percent that has killed 18,000 people. It is estimated that 200,000 are currently living with the disease. Because Chadians are so vulnerable to disease, the country experiences low life expectancy (47.52 years) and population growth (2.93 percent) and high infant mortality (91.45 deaths per 1,000 live births) and death rates (16.38 deaths per 1,000 population). Chadian women give birth to an average of 6.7 children. The people of Chad speak three of four major African languages, and the population lacks cultural cohesion. Only 56 percent of males and 39.3 percent of females over the age of 15 can read and write either French or Arabic. These factors combine to limit the dissemination of health and environmental information.

A NASA dust storm image over Chad reflects the hot, dry, seasonal winds that speed up desertification in the north.

MISERABLE ENVIRONMENTAL RECORD

In 2006, a study by scientists at Yale University ranked Chad at the bottom of 132 countries on environmental performance with scores drastically below the comparable income and geographic groups. Particularly low scores were received in the areas of air quality and water resources, and Chad received no points at all in the category of environmental health. Just over 10 percent of Chad's land area is forested, but the government has protected only 0.1 percent of total land area. Of 134 mammal species identified in Chad, 17 are endangered, as are five of 141 bird species. About two-thirds of the land area in Chad is covered by desert, and the desert is expanding by three to five kilometers each year.

The international community is assisting the government of Chad in poverty reduction efforts. Under the guidance of the Ministry of Environment and Water and the Ministry of Land Management, Urbanism, and Habitat, environmental initiatives include the Project for Conservation and Management of Natural Resources and the UNDP-financed Integrated Plan for Water Development and Management. Such measures are designed to promote sustainable development and management. The Chadian government has ratified the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Ozone Layer Protection, and Wetlands. Agreements on Law of the Sea and Marine Dumping have been signed but not ratified.

BIBLIOGRAPHY. CIA, "Chad," *World Factbook,* www.cia.gov/cia; Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, Africa *and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); UNDP, "Human Development

Report: Chad" www.hdr.undp.org; World Bank, "Chad" www.worldbank.org; Yale University, "Pilot 2006 Environmental Performance Index" www.yale.edu.

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Chang Jiang (Yangtze) River

AT 3,937 MILESLONG, the Chang Jiang is the third-longest river in the world and the longest river in Asia. It has its source some 16,000 feet high in the Kunlun Mountains, and flows across seven Chinese provinces (Qinghai, Yuanan, Sichuan, Hubei, Auhui, and Juangsui) before it empties into the East China Sea, just north of Shanghai. With more than 700 rivers and streams flowing into the main channel of the Chang Jiang, the river system drains more than 695,000 square miles.

It deposits about 6 billion cubic feet of silt onto its floodplain, where about half of the foodstuffs consumed by China's billion-plus people are grown, including a large percentage of the nation's rice, wheat, barley, corn, and beans. Some 350,000 million Chinese live on lands drained by the Chang Jiang River system, and there are almost 30 major cities along the river. In addition to Shanghai, the most significant of these cities are Nanjing, Hankow, and Chongqing.

The Chang Jiang is the major artery for the transportation of goods between the Chinese interior and the coast. Ocean-going vessels can navigate the Chang Jiang up to 600 miles from its mouth, and it is navigable by river steamers for another 400 miles. In addition, the Chang Jiang system is connected to the Huang He (or Yellow) River system by the Grand Canal. Because of the volume of its flow, especially during the monsoon season, the Chang Jiang has been prone to recurring, disastrous flooding. In 1911, more than 100,000 people died because of the flooding; in 1931, 145,000; in 1935, 142,000; and in 1954, 30,000. Although the loss of life from such floods has been greatly reduced in recent decades, the property loss and economic disruption has remained high. Severe flooding also occurred in 1981 and 1998.

In part to control this flooding and in part to provide hydroelectric power to fuel China's dramatic economic growth, the Chinese government has undertaken one of the greatest construction projects in history on the Chang Jiang. When it is completed in 2009, the Three Gorges Dam will be 600 feet high and 1.5 miles long. When fully operational, the hydroelectric plant at this dam will provide the equivalent of one-ninth of China's total production of electricity in 2000. The dam has had its critics. It lies along a well-known earthquake fault. Moreover, the heavy silt carried by the river may prove a chronic problem for the hydroelectric turbines and may build up behind the dam and actually exacerbate the flooding dangers. The lake that forms behind the dam will cover 80,000 acres of farmland and 140 towns and villages. In all, some 1.5 – 2 million people will be forced to relocate, along with about 1,600 industrial plants. Ecologically, the dam may greatly reduce the number of species in one of China's richest ecosystems. Of particular concern are those species found only in the river basin, most notably river dolphins, alligators, and paddlefish named for the river.

SEE ALSO: China; Dams; Rivers; Three Gorges Dam.

BIBLIOGRAPHY. Rob Bowden, *The Yangtze* (Raintree, 2004); Linda Butler, *Yangtze Remembered: The River Beneath the Lake* (Stanford University Press, 2004); Deirdre Chetham, *Before the Deluge: The Vanishing World of the Yangtze's Three Gorges* (Palgrave Macmillan, 2002); Ben Thomson Cowles, *Through the Dragon's Mouth: Journeys into the Yangtze's Three Gorges* (Fithian Press, 1999); Ying Hong, translation by Mark Smith and Henry Zhao, *Peacock Cries at the Three Gorges*, (Marion Boyars, 2004).

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Chaos Theory

CHAOS THEORY DERIVES from physics and mathematics, and is a form of systems theory that seeks to describe highly complex and disordered systems, such as the atmosphere; although some attempts have been made to apply chaos theory to both the social and ecological sciences. The theory states that complex and seemingly chaotic systems, whose structure cannot be described by linear mathematics, are actually underwritten by orderly processes, an idea that has been termed *deterministic chaos*. The theory utilizes nonlinear mathematics to describe these systems, and attempts to understand change in terms of the values that the variables take on, in contrast to the related complexity theory, which seeks to explain change in terms of variability from outside the system in question. In rejecting linearity, both chaos and complexity theory have replaced the classical notion of linear causation with the idea of *self-organization*, in which the individual components of the system are viewed as independent agents (as opposed to independent and dependent variables) that spontaneously rearrange themselves according to their individual properties and external conditions.

VARIOUS TYPES OF ATTRACTORS

A system, according to chaos theory, can exhibit either some pattern of stability or order according to some range of values that its variables can take, or be driven into chaotic behavior based on another set of values of the variables. That the chaotic behavior arises as a function of the defining equations and the values of its variables illustrates the idea of *deterministic chaos*. The set of values for the equation that produce stable results are termed *attractors*. A perfectly stable system that never varies from its steady state would have its equation graphed out such that it would be a point (the trajectory of values never deviates the initial values); such a set of values is termed a *point attractor*. A homeostatic system, one that deviates from its original state but that is brought back to its original state, has its trajectory of values following a toroidal trajectory, forming what is known as a *toroidal* or *doughnut attractor*. In illustrating the differences in explanatory power that chaos theory offers in explaining systems behavior, what is usually depicted is the *butterfly* or *Lorenz attractor*. With this attractor, a system will follow a toroidal path for a given set of values, but small variations can cause the system to shift into an alternative toroidal trajectory. That is, the equation describes a system with two homeostatic pathways possible, with small changes at a critical moment causing them to switch between stable trajectories. The resulting graphed trajectories appear to be two adjacent and linked *toroidal attractors*, vaguely resembling the wings of a butterfly, hence the name *butterfly attractor*. Higher order attractors, with three or more stable states, are possible as well. The set of values that drive the system into chaotic behavior are termed *strange attractors*. The trajectories followed by the equation under the conditions of strange attractors often exhibit recursive self-similarity (*fractal structure*).

THE BUTTERFLY EFFECT

Both attractors and *strange attractors* illustrate another important concept in chaos theory, this being *sensitivity to initial conditions*. Very minute changes in value for the variables could cause an orderly system to switch between stable states, as in a Lorenz attractor. Alternatively, these minute changes in values could drive the system into chaotic behavior, as in strange attractors. This idea of sensitivity to initial conditions has been popularized as the *butterfly effect*, which basically states that the minute turbulence produced by a butterfly flapping its wings in one location could make the difference between pleasant weather and violent storms elsewhere on the planet. *Sensitivity to initial conditions* is a concept that chaos theory shares with complexity theory; although the two differ, in that chaos theory views this sensitivity to be endogenous to the system, whereas complexity theory tends to stress the sensitivity of its component variables to exogenous noise. Chaos theory is broadly concerned with describing closed systems, whereas complexity theory tends to view systems more openly.

Chaos theory has found only limited application to ecological systems. Robert May is generally credited with first using nonlinear equations in an ecological context in 1974. He applied these nonlinear equations in describing the dynamics of population growth, using the growth rate, carrying capacity and population as the only variables. He discovered that by varying the growth rate, a variety of responses in the population could be attained, with stable populations occurring at low rates of growth,

Damselfish Study

A study of fluctuating damselfish populations—a marine species that spawn on a monthly cycle and whose eggs hatch with the full moon—were found to fluctuate dramatically from month to month, and were not predictable in either linear or nonlinear population growth models according to standard population growth or predator-prey relationship models. Rather, researchers found that variations in exogenous factors such as winds and currents played a crucial role in the survival of damselfish hatchlings, and that when these were factored into the equations, the populations followed nonlinear dynamics. That is, the sensitivity driving chaotic fluctuations did not arise from the population variables themselves, as chaos theory would assert, but rather arose due to sensitivity to environmental noise (exogenous factors). These results are more in line with the predictions of complexity theory.

stable cycles of population levels occurring at moderate levels of growth (with periodicity of the cycles increasing as the growth rate increases), and finally with chaotic fluctuations occurring above a high threshold of the growth rate. That the equation can give various stable conditions or be driven into chaos due to sensitivity to one of its variables is consistent with chaos theory.

DETERMINISTIC CHAOS IN ECOLOGY

Subsequent research looking for deterministic chaos in ecological contexts typically focus on fluctuations in species composition, especially as situated in trophic structures. For instance, classic studies of snowshoe hare populations—which fluctuated in phase with the population of its predators, leading to the formalization of predator and prey relations—were re-examined in light of non-linear dynamics, and were found to vary according to both their food supply as well as to predator populations. Although *deterministic chaos* has been demonstrated in the laboratory setting for fluctuating populations, it has been more difficult to demonstrate in nature. This difficulty arises in no small part to a paucity of appropriate data; since a proper analysis would require monitoring the population of the species in question, its population of food species, population of predator species, and relevant environmental variables over a number of decades—and such extensive datasets are rare. Furthermore, natural systems appear to select for inhibitors; measured population growth rates are rarely high enough to initiate chaotic behavior in their descriptive equations.

The endogenous deterministic chaos predicted by chaos theory is characteristic of closed systems, and has largely only been demonstrated in laboratory settings. The climatic and atmospheric sciences have utilized chaos theory, however, since the atmosphere is largely a closed system when viewed as a whole. Although the social sciences have also begun to utilize both chaos and complexity theories, the area of human-environment interactions has largely been overlooked, but is an area that is drawing increasing attention from researchers.

SEE ALSO: Butterfly Effect; Complexity Theory; Ecosystems.

BIBLIOGRAPHY. James Gleick, *Chaos: Making a New Science* (Penguin Books, 1987); Stuart Kauffman, *At Home in the Universe* (Oxford University Press, 1995); L. Douglas Kiel and Euel Elliott, eds., *Chaos Theory in the Social Sciences* (University of Michigan Press, 1996); Robert M. May, “Biological Populations with Non–Overlapping Generations: Stable Points, Stable Cycles and Chaos,” *Science* (v.186, 1974); Carl Zimmer, “Life After Chaos,” *Science* (v.284, 1999).

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Chavez, Cesar (1927–93)

A MIGRANT FARM worker in his youth, Cesar Chavez (1927–93) went on to become one of America’s most legendary labor leaders and a heroic icon for Latino/Chicano civil rights. Chavez's activism began in 1952 as an organizer for Saul Alinsky's Community Services Organization, when he became its general director in 1958. In 1962, along with Dolores Huerta, Chavez co-founded the National Farm Workers Association, which grew to become the United Farm Workers Organizing Committee, AFL-CIO four years later. In 1972, the organization was chartered as an independent affiliate of the AFL-CIO, and was renamed the United Farm Workers of America (UFW). Until his death, Chavez served as the UFW's president and was its most public representative and spokesperson.

TRANSFORMING MIGRANT LABOR

Through Chavez's work, farm workers and migrant labor were transformed during the 1960s and 70s into a powerful political force for La Causa, or The Cause, a movement for progressive social change that continues to this day. In 1965, the UFW began its successful five-year-long Great Grape Boycott against table grape purchases in order to raise awareness of poor working conditions in the vineyards. During this time, Chavez successfully allied a variety of labor unions, student groups, minority organizations, religious and governmental leaders, as well as consumers nationwide in joint protest; and Chavez undertook the first of a series of long hunger strikes that cemented him in the public's mind as a nonviolent campaigner for justice in the tradition of Dr. Martin Luther King, Jr. and Mahatma Gandhi. Inspired by Gandhi, Chavez maintained a deep spiritual concern for peace and became an ethical vegan when he realized that the principle of nonviolence mandated kindness and compassion toward all beings in a civilized society. In this respect, Chavez's influence on the UFW can still be seen today in the organization's commitment to fighting for farm animal welfare alongside its concerns for social justice and improved farm working conditions.

Under Chavez, the UFW targeted environmental racism against America's migrant farm workers. Beginning in the 1960s, Chavez introduced health and safety provisions into contract negotiations and led activist campaigns against the irresponsible use of toxic pesticides by the agricultural industry, citing the danger to farm workers who were routinely sprayed with large amounts of pesticides while working in the fields. Further, Chavez noted how large pesticide clouds entered into farm workers' communities, thereby exposing workers' families to hazardous pathogens. In his view, this constituted an intolerable systematic poisoning of people in the name of agribusiness profit and efficiency. In response, the UFW filed lawsuits on behalf of workers' right to know information relating to pesticide use, and litigation was also pressed to place bans on certain pesticides, especially DDT. For the DDT lawsuit, Chavez teamed the UFW with California Rural Legal Assistance and the Environmental Defense Fund, a major legal organization within the environmental movement. This legal action formed the basis for an eventual governmental ban on the use of DDT.

Chavez is recognized as a political leader who successfully linked labor, civil rights, and environmental issues, and contributed to the growth of the environmental justice movement, which seeks to eradicate the toxic burden that falls upon people of color in the United States.

SEE ALSO: DDT; Justice; Pesticides; United Farm Workers.

BIBLIOGRAPHY. Susan Ferriss and Ricardo Sandoval, *The Fight in the Fields: Cesar Chavez and the Farmworkers Movement* (Harcourt Brace, 1997); Marion Moses, "Farmworkers and Pesticides," in Robert D. Bullard (ed.), *Confronting Environmental Racism: Voices from the Grassroots* (South End Press, 1993); Laura Pulido, *Latino Environmental Struggles in the Southwest* (Ph.D. dissertation, University of California at Los Angeles, 1991); United Farm Workers, www.ufw.org (cited June 2006).

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Chemical Additives (in Foods)

VARIOUS REASONS EXIST for adding chemicals of different types to food, including the preservation of perishable items, flavor and color enhancement, and the inhibition of growth of undesirable bacteria or mold. The practice of adding chemicals to food has a long and mostly successful history; without such practices as salting and pickling, the inhabitation of many lands such as Britain, where the winter climate prevents food gathering for many months, would have been impossible. The majority of these processes relied upon natural substances and methods that are perfectly harmless and beneficial. However, particularly in the pre-modern age, chemical reactions were largely unpredictable, and harmful effects, poisoning, and illness were possible. As the number of food products have multiplied in the modern world and become subject to intensive agriculture and processing, the possible health implications of additives have also multiplied. It has become a complex and lengthy process to ensure government approval of additives, while also requiring regular monitoring of existing additives.

TESTS, LABELS, AND ADDITIVES

Testing on both laboratory animals and nonliving tissue is routinely required before such approvals are awarded. Scientists must consider not just what is a safe level of intake of the additive in a single helping, but also what may be ingested by heavy consumption over a substantial period of time. An acceptable level of noneffect (NOEL, or no-effect level) can be divided by 100 to determine a suitable daily dose. Some types of food dye have, as a result, been found to cause cancers under some conditions and have subsequently been withdrawn. Similarly, some chemical additives have been linked to conditions such as attention deficit disorder and hyperactivity in children. As standards of health care have improved, many illnesses that previously led to serious, negative health impacts have been eradicated or controlled, so the impact of what would have been considered less-important effects have become evident. At the same time, apparently new forms of allergies are becoming manifest or more obvious and, consequently, food producers are more careful in labeling and packaging their products to ensure that they comply with national and international regulations, and protect themselves from litigation.

In some cases, states have taken the decision to add chemicals to basic foodstuffs in order to promote positive health outcomes. Such cases have included the addition of vitamins, iodine to combat goiter, and fluoride to improve dental health.

However, many food additives often have little to do with health or nutrition, even though they have enabled low-fat or supposedly "healthy" products in many categories. Additional reasons include the use of coloring to disguise the unattractive results of processing. Such processes change people's expectations of food from its natural state, even though there may be perfectly valid and even health-promoting reasons for changing the food. Even when evidence of negative health effects associated with additives is unclear—as is the case with monosodium glutamate, widely used as a flavor enhancer—consumer pressure is increasing to ensure that retailers disclose the use of such additives and provide additive-free alternatives when requested. Many exotic flavorings and colorings are now sourced in tropical lands such as the Philippines, where they have come to represent important export industries and provide another reason to document and maintain the existence of often little-known flora and fauna.

SEE ALSO: Delaney Amendment; Food; Food and Drug Administration (U.S.); Food Irradiation.

BIBLIOGRAPHY. Larry A. Branen, et al., eds., *Food Additives* (CRC, 2001); U.S. Food and Drug Administration, www.fda.gov (cited October 2006); Richard J. Lewis, *Food Additives Handbook* (Kluwer Academic Publishers, 1989); Bill Statham, *What's in Your Food?* (Perseus Publishing, 2007).

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Chernobyl Accident

ON APRIL 26, 1986, the worst accident in history at a nuclear power plant occurred at the Chernobyl power station near the town of Pripyat, about 70 miles north of Kiev in the Ukraine. Reactor 4 of the complex exploded, creating an inferno that spewed massive amounts of radioactive particulate matter into the atmosphere. The Soviet authorities responded by dumping boron and sand onto the inferno by helicopter. After the fire had been contained, the ruins of the reactor were encased in a thick shell of concrete. The destroyed reactor was a Soviet RBMK model, which was notorious for its design flaws. Worst of all, because the power plants with RBMK reactors were designed to permit reprocessing of fuel rods for military applications, it was not possible to provide them with the containment shells that are standard in Western plants. In addition, the staff at the Chernobyl complex was not sufficiently familiar with the intricacies of the RBMK reactors, or even with nuclear power plants. On the night of the accident, the staff attempted to power down Reactor 4 in order to conduct a safety test. However, prior to conducting the test, they disabled many safety features and proceeded despite clear indications of accelerating irregularities within the reactor, precipitating the meltdown in the core that was the source of the explosion.

Official Soviet accounts differ significantly from other sources in calculating the manifold effects of the disaster. Between 31 and 70 people died, either in the explosion or because of their exposure to massive amounts of radiation in the efforts to extinguish the fire. Some 800,000 workers, about half of them military personnel, were involved in the effort to seal the ruined reactor in concrete. Because half of these workers were from the Ukraine and the rest were from all corners of the former Soviet Union, it has been almost impossible to trace the health effects of their exposure to the Chernobyl complex. Investigators have estimated that about 15,000 of these 800,000 workers died in the decade following the disaster.

CANCER DISASTER

The population in the immediate vicinity and downwind of the plant experienced unusually high incidences of cancer. For instance, within a decade of the accident, more than 4,000 children who had lived in the vicinity of the plant were diagnosed with thyroid cancer—though the official government report on the health effects of the disaster have indicated just nine fatal cases from thyroid cancer among the affected children. It is expected that in the future, unusually high rates of other cancers, in particular leukemia, will become evident among adults in the affected region. Soon after the accident, an area 18 miles away from the Chernobyl complex was declared an exclusionary zone, off limits to all but those who continued to work at the complex, where the other three reactors continued to operate for some time after the ruined reactor had been sealed off. Because the Chernobyl complex is located only 10 miles from the border with Belarus, the most severe downwind contamination occurred there, not the Ukraine. In all, about 135,000 people were permanently relocated out of the most badly contaminated areas, while another 270,000 people have continued to live in areas with identified radiation hazards. Despite predictions of nightmarish medical consequences from this widespread exposure to high doses of radiation, the health effects have thus far been more anecdotally frightful than statistically catastrophic.

Radioactive fallout from Chernobyl was tracked across eastern Europe and Scandinavia and eventually to the eastern United States. But the damage caused by the fallout beyond Belarus and parts of western Russia was, for the most part, relatively negligible. Exceptions have included populations such as the Laplanders of northern Scandinavia, whose nutritional reliance on their reindeer herds, in which certain isotopes have become concentrated, has placed them at an increased risk. One of the most contaminated areas near the Chernobyl complex was the so-called Red Forest, where the radiation damage caused pine trees to turn red as they died. This entire forest, covering several squares miles, was buried to reduce the surface radioactivity of this "hot zone" to less dire levels. Ironically, although there has been evidence of damage at the chromosome level in the tissues of sampled wildlife, the enforcement of the exclusionary zone around the plant has amounted to the creation of a wildlife sanctuary in which the numbers of many species have dramatically increased.

SEE ALSO: Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); Nuclear Weapons; Radioactivity; Three Mile Island Accident; Ukraine.

BIBLIOGRAPHY. C.C. Bailey, *The Aftermath of Chernobyl: History's Worst Nuclear Power Reactor Accident* (Kendall/Hunt, 1989); E.B. Burlakova, ed., *Consequences of the Chernobyl Catastrophe on Human*

Health (Nova Science, 1999); R.P. Gale and Thomas Hauser, *Final Warning: The Legacy of Chernobyl* (Warner, 1988); J.H. Gittus, et al., *The Chernobyl Accident and Its Consequences* (United Kingdom Atomic Energy Authority, 1987); Viktor Haynes and Marko Bojcun, *The Chernobyl Disaster* (Hogarth, 1988); Louis Mackay and Mark Thompson, eds., *Something in the Wind: Politics after Chernobyl* (Pluto, 1988); Grigorii Medvedev, *The Truth about Chernobyl*, translated by Evelyn Rossiter (Basic, 1991); R.F. Mould, *Chernobyl—The Real Story* (Pergamon, 1988); C.C. Park, *Chernobyl: The Long Shadow* (Routledge, 1989); P.P. Read, *Ablaze: The Story of the Heroes and Victims of Chernobyl* (Random House, 1993); Boris Segerstahl, ed., *Chernobyl: A Policy Response Study* (Springer-Verlag, 1991); Iurii Shcherbak, *Chernobyl: A Documentary Story*, trans. by Ian Press (Macmillan, with Canadian Institute of Ukrainian Studies, 1989); L.R. Silver, *Fallout from Chernobyl* (Deneau, 1987).

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Chiapas

THE STATE OF Chiapas is located in the southern part of Mexico, where it has a long coastline on the Pacific Ocean. It borders Guatemala on the east, and the Mexican states of Tabasco to the north, Veracruz to the northwest, and Oaxaca to the west. It has a land area of 28,528 square miles (73,887 square kilometers), which is smaller than South Carolina but resembles in shape. Its population in 2005 was 4,200,000, making it the seventh most populous state in Mexico. Chiapas is located in a tropical area with periods of high rainfall. In the northern area, near Teapa on the border with Tabasco, rainfall has averaged 118 inches (3,000 millimeters) per year. The area was previously dominated by rainforests; however, wide areas have been cut to make way for farming and ranching. The geography of Chiapas in the southwestern area on the Pacific Coast is a lowland area with very fertile soil. The southeastern coastal region of Soconusco is tropical and extensively farmed, with plantation crops of bananas and coffee.

With a population in 2005 of 4,200,000, Chiapas is the seventh most populous state in Mexico.

The Altos de Chiapas (Chiapas Highlands) is a high plateau in the central part of Chiapas. It contains seven parallel mountain ranges where the elevations provide a temperate climate, with frequent fogs watering cloud forests. The cloud forest Reserva de la Biosfera el Teiunfo has many horned ugans and quetzals. The rainfall decreases in Chiapas from east to west and south. However, even on the shore of the Pacific Ocean, the rainfall is abundant.

The highlands have steep mountainsides, with a rocky soil that is too thin and poor to support agriculture. The Lacandon rainforest is a jungle area with a soil that, even with modern fertilizers, would be unproductive. The several Mayan tribes have long practiced farming using slash and burn agriculture (swidden). They rotate the areas that are cleared from pristine forests or from older fields, creating a sustainable agriculture. Illegal logging, hunting, and oil exploration are threatening the area's rich biodiversity.

Notable ecological landmarks in Chiapas include the Lagunas de Montebello, located near Comitan. The Blue Waterfalls (Cascadas de Aqua Azul) are near Palenque, which is one of the most important ruins of the Mayan Indians of pre-Columbian times. Another important site in the Lacondon rain forest is Bonampak, which has the best-known Mayan murals. In 1994 an insurgency began between the Mexican government and the Zapatistas (Zapatista Army of National Liberation). The Zapatistas (EZLN) took their name from Emiliano Zapata

(1879–1919), a populous partisan who led a violent land reform movement until he was killed. The Zapatistas have established some autonomous "Zapatista municipalities" in several areas, and claim that the Mexican government neglects its people, especially Mayan Indians. The Zapatistas also point to a history of environmental exploitation and neglect in the region and include a series of sustainable agricultural and conservation issues to the planks of their governance structure in the region.

SEE ALSO: Climate, Tropical; Cloud Forests; Mexico.

BIBLIOGRAPHY. George Collier, *Fields of the Tzotzil: The Ecological Bases of Tradition in Highland Chiapas* (University of Texas Press, 1975); Nicholas P. Higgins, *Understanding the Chiapas Rebellion: Modernist Visions and the Invisible Indian* (University of Texas Press, 2004); Karen L. O'Brien, *Sacrificing the Forest: Environmental and Social Struggles in Chiapas* (Westview Press, 1998).

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Chile

THE REPUBLIC OF Chile is a developing country in South America that has undergone many political, social, and economic transitions since becoming a democratic state in 1989. Known for its spectacular natural beauty, Chile has a varied landscape that is dotted with the Andes mountain range, the Atacama Desert, diverse forests, rich agricultural land, glaciers, and coastal environments. With a population of over 16 million inhabitants, this country has taken great strides to alleviate poverty and incorporate itself into an increasingly globalized world. A country desperate to achieve rapid economic growth and development, it initially paid little regard to the environmental consequences that would arise with such progress. This resource-rich country adopted aggressive neoliberal policies in its post-dictatorial phase, which led to impressive growth rates, macroeconomic stability, and reductions in poverty. Due to these key advancements, Chile is often praised as a model for other Latin American countries. Nevertheless, there have been troubling environmental and social repercussions as increasing pressures have been exerted on natural resources in pursuit of economic gains.

The country's forests, agricultural lands, fisheries, and minerals have been exploited to such an extent that massive degradation and ecological destruction

Valparaiso

The port of Valparaiso in Chile is located on the Pacific coast, some 71 miles northwest of Santiago, Chile's capital. Valparaiso is now an important cultural center—in 2003 it became Chile's "Cultural Capital"—and it is also a U.N.E.S.C.O. World Heritage site.

Valparaiso was a small port during the Spanish colonial period, and became the main port for the Chilean Navy after independence in 1818. It attracted many foreign ships, especially English, French, German and Italian. Soccer was first introduced to Chile by English migrants in Valparaiso. Many important political figures were born in the city, including Chilean presidents Salvador Allende and Augusto Pinochet, and Australian prime minister Chris Watson. Chilean poet and diplomat Pablo Neruda, and Nicaraguan poet Rubén Dario, both lived in Valparaiso.

Of particular interest, in terms of its layout, is that the city covers a very small flat piece of coastline, with much of the city on steep hills and cliffs. As a result, roads have sharp inclines, and advertisements for S.U.V.s in Chile frequently show them negotiating the streets of Valparaiso. Although there is a small tram service covering the immediate port area, funicular railways provide transportation, and there are countless pathways and alleyways between houses for taking shortcuts. This means that tourists, who often cannot easily negotiate the labyrinthine streets, find themselves exhausted as they make their way from cruise-ships to important tourist sites such as the house of Thomas Cochrane, founder of the Chilean Navy; the Chilean Naval Museum; and the Protestant Cemetery.

have compromised these ecosystems and biodiversity. High rates of air pollution attributed to copper mining and vehicle emissions have posed serious health threats to a large percentage of the Chilean population. Pesticide use and other waste products have put water quality at risk, and overharvesting of fish species has led to stock depletions. Native forests face heavy deforestation as well as loss of plant and animal species diversity. With these resources at risk, the poor are especially vulnerable because they largely rely on these resources to support their livelihoods. Also, most of the accumulated wealth has remained concentrated in the hands of the elite, further widening disparities and tensions between rich, poor, marginalized, and indigenous groups. The indigenous Mapuche Indians have suffered tremendous injustices, experiencing discrimination and loss of land to forestry and energy companies. They are well known for their aggressive struggle to reclaim land rights in order to preserve their culture and heritage. International attention has put these social and environmental issues in perspective.

INTERVENTION FOR THE ENVIRONMENT

After years of neglect and abuse, international pressure forced the Chilean government to acknowledge the need to mitigate detrimental practices by establishing proper environmental legislation and institutions. It was understood that the economy could not grow, let alone be sustained, if resources were in jeopardy and unsustainable practices were continued. In 1994, the General Environmental Framework Law came into place with its three sustainable development tenets revolving around environmental sustainability, poverty alleviation, and equitable growth. At the same time, the decentralized National Environmental Commission (CONAMA) was formed to take on the responsibility of coordinating government environmental policies and regulations. These efforts were crucial in creating a forum for environmental dialogue and democratic participation. The 2005 environmental performance review undertaken by the Organization for Economic Co-operation and Development (OECD) made numerous recommendations for a greener future. The more notable recommendations included strengthening international environmental cooperation and the efficient implementation of environmental policies. As Chile continues to grow in the 21st century, it must consolidate environmental policies with larger social, economic, and sectoral decisions if sustainability is to be achieved for current and future generations.

SEE ALSO: Andes Mountains; Cloud Forests; Mining.

BIBLIOGRAPHY. David Caruthers, "Environmental Politics in Chile: Legacies of Dictatorship and Democracy," *Third World Quarterly* (v.22/3, 2001); Jane Newbold, "Balancing Economic Considerations and the Rights of Indigenous People Mapuche People of Chile," *Sustainable Development* (v.12, 2004); OECD, *Environmental Performance Review: Chile* (U.N. Economic Commission for Latin America and the Caribbean, 2005).

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Independent Scholars

Chimpanzees

CHIMPANZEES ARE PRIMATES that belong to the anthropoid great ape family *Pongidae*, which includes gibbons, gorillas, and orangutans. Chimpanzees are in the suborder *Anthropoidea*, the order of *Primates*, and one of only two members of the genus *Pan*. As *Pan* troglodytes, Chimpanzees were until recently considered to be the sole members of the genus *Pan*. However, Bonobos, which have been variously called pygmy, dwarf, or Gracile chimpanzees, are now classified as the second species in the genus, *Pan paniscus*. Bonobos (pygmy chimpanzees) are found only on the south side of the Congo River in the Democratic Republic of the Congo. Chimpanzees are not known to swim, so rivers have acted as major barriers to their movements. Chimpanzees are found in equatorial central Africa, from Senegal to western Tanzania in tropical rain forests and savannas. There are three subspecies of the common chimpanzee (or simply chimpanzee).

The subspecies *Pan troglodytes verus* can be found from Gambia to the Niger River. The *Pan troglodytes troglodytes* subspecies live in the forest regions in central Africa. The subspecies *Pan troglodytes schweinfurthi* is found mainly in western Uganda and Tanzania. Like the other great apes, chimpanzees do not have a tail. They are strong animals with powerful arms and legs, and an arm span twice their height. They can easily grasp objects with their hands or with their feet. They range between 3.25 feet (one meter) to 5.5 feet (1.7 meters) in height. Males usually weigh 110 pounds (50 kilograms) on average, while females weigh 90 pounds (41 kilograms) on average. However, in captivity some males have attained weights of 200 pounds and females weights of 175 pounds. Chimpanzees have large ears, and arms that are longer than their legs. They can walk upright on their feet for short distances, but they usually walk on all fours. With their arms extended, their front limbs rest on the knuckles of their hands. While some chimpanzees are covered with long black hair, they are usually bald from the forehead to their crown. Some have dark faces and some have tan faces.

DIET AND COMMUNITY GROUPS

Chimpanzees eat insects, leaves, fruit, nuts, bird's eggs, fish, and occasionally small animals such as red-tailed monkeys, small bush pigs, or small antelopes. They may engage at times in organized hunts. During the day, chimpanzees move about while foraging in small bands or parties of six to a dozen members. The bands, part of a community of 25–100 members, may be all male, all mothers with infants, or mixed bands of males and females. Individuals come and go from the community. An alpha male usually rules the community, although groups of all females have been seen. Females tend to move about as individuals and eventually migrate to a separate chimpanzee community, while males usually stay in their birth community. Sexual maturity occurs around 10 or 11 years of age, with physical maturation by age 14. Mating takes place throughout the year, with a gestation period of about eight months. However, females bear only once every three or four years. The newborn chimpanzee is helpless like human babies; their mothers care for them until about five years of age.

Chimpanzees can live to be 50 years old in the wilds. However, only a few live that long. Their natural enemies are leopards, cheetahs, lions, and other chimpanzee communities. Encounters with another community may incite a deadly conflict. The greatest enemy of chimpanzees is man.

CONNECTION TO HUMANS

Using tools has been among the behaviors of chimpanzees observed in recent studies. West African chimpanzees have been reported using rocks as tools in order to crack open tough nuts. In East Africa, they have been observed using twigs as tools for feeding on termites and ants. Trees provide places of rest and sleep during afternoon naps. At night, they build nests from leaves; however, they are diurnal, and often forage at night. Chimpanzees have been known for centuries, but were only closely studied beginning in the 20th century. Researchers have found that chimpanzees and humans share a number of physical and social traits. Physically, chimpanzees and humans share almost completely (99 percent) identical polypeptides, which are proteins. The similarities between humans and chimpanzees have made them inviting subjects for medical and psychological research.

Chimpanzees are genetically the closest to humans. They have been used extensively in laboratories for medical research because they are subject to diseases similar to those of humans. These include the common cold, pneumonia, poliomyelitis, tuberculosis, influenza, and chicken pox. A disease outbreak can threaten a whole community with destruction. Ebola and other zoonotic diseases are of growing concern to researches, as increased contact with humans may endanger chimpanzees by contracting deadly diseases.

Chimpanzees are among the most intelligent of all animals. Animal psychologists have sought to use chimpanzees to study learning, communication behaviors, and intelligence. Researchers have found that chimpanzees can be taught to communicate with humans using sign language, and have had significant success in teaching chimpanzees and Bonobos sign language. Human speech is not within their natural capacities. However, both have been taught to use hundreds of symbols and hand signals.

Recent studies have revealed that chimpanzees learn from each other. Experiments that challenge them in problem solving have been used to study their intelligence. Their behaviors are mimicked and passed on to the next generation, creating a "chimp culture" in each community. These behaviors are passed down from chimpanzee to chimpanzee without any human interference or intervention. Jane van Lawick-Goodall, a famous English naturalist, conservationist, and author began patiently observing a band of chimpanzees in the Gombe Stream Game Reserve in Tanganyika (now Tanzania) in 1960. She was able to move with a band of chimpanzees, studying them ever closer as they grew more familiar with her. For months, she recorded many behaviors that other naturalists had not previously observed. When her observations and finds were published, scientific understanding of chimpanzees underwent an enormous transformation.

Among the many revolutionary discoveries Goodall made was that chimpanzees sometime eat meat and that they are not strict vegetarians as previously believed. Moreover, she noticed that they eat meat for periods, then return to a vegetarian diet for other periods. Also, they will sometimes engage in chimpanzee cannibalism, or they will eat meat when chance opportunities arise. Goodall also described the complex social order that exists within chimpanzee bands. She also described "wars" between different groups of chimpanzees. Other researchers have observed in recent years that chimpanzees engage in acts of violence against their own. Some researchers believe that these observations may offer clues to the development of warfare among humans. Goodall's findings have enabled conservationists to better protect chimpanzees, which are threatened by poachers seeking "bush meat" or babies for sale to zoos or to pet collectors. After returning to England, she championed efforts to protect chimpanzees in the wild through movies, television, books, and with political advocacy.

Chimpanzees are considered an endangered species by conservation organizations like the World Conservation Union. They were originally found in 25 countries, but are extinct in four of those and close to extinction in others. They are threatened by poaching for the bush meat trade, deforestation, and traffickers for display and medical laboratories. All three subspecies and the Bonobos are listed on the Red List of Threatened Species issued by the International Union for the Conservation of Nature and Natural Resource (IUCN) as endangered. The western chimpanzee and the Nigerian chimpanzee are the most threatened.

SEE ALSO: Goodall, Jane; Interspecies Communication; Lab Animals; Primates.

BIBLIOGRAPHY. Christophe Boesch and Hedwige Boesch-Achermann, *Chimpanzees of the TAI Forest* (Oxford University Press, 2000); Jane Goodall, *The Chimpanzees of Gombe: Patterns of Behavior* (Harvard University Press, 1986); Jane Goodall, *My Life with the Chimpanzees* (Aladdin Paperbacks, 1996); Vernon Reynolds, *Chimpanzees of the Budongo Forest: Ecology, Behaviour, and Conservation* (Oxford University Press, 2005); Claire Robinson, *Chimpanzees* (Reed Educational and Professional Publishing, 1998); E.S. Savage-Rumbaugh, *Ape Language: From Conditioned Response to Symbols* (Columbia University Press, 1986); M.K. Termerlin, *Lucy: Growing Up Human, a Chimpanzee Daughter in a Psychotherapist's Family* (Science & Behavior, 1975); F.D. Waal, *Chimpanzee Politics: Power and Sex Among Apes* (Harper, 2000); R.W. Wrangham, et al., eds., *Chimpanzee Cultures* (Harvard University Press, 1996); R.M. Yerkes, *Chimpanzees: A Laboratory Colony* (Yale University Press, 1943).

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China

THE PEOPLE'S REPUBLIC of China has the highest population of any country in the world, with an estimated 1.311 billion people in 2006. The population of India, the second country in the world to exceed a billion people, is not far behind at 1.122 billion. The rates of natural increase for each of these Asian giants, 0.6 percent for China and 1.7 percent for India, indicates that India will surpass China in total population some time around 2040, when both countries will have over 1.45 billion inhabitants. As India continues to gain significantly in population through mid-century, China is predicted to actually decline in population between 2025 and 2050 for several reasons: 1. the continuance of its low rate of natural increase (RNI), 2. the the government's view that the birthrate is satisfactory (12 births per 1,000 people as opposed to India's 24 births per 1,000) by married women in their child-bearing years (15–49), and 3. China's continuance of its one-child-per-family policy through the next five-year plan, 2006–10.

China's experience with its one-child policy has led to some serious problems. Cultural preference is for a male child. In many instances, first-born girls have become victims of female infanticide. Despite this severe outcome, China intends to limit its population to 1.37 billion by 2010 in large part through the continuance of the one-child policy. The one-child policy has produced another inequity within China's population: By 2020 there will be approximately 40 million more men than women in the population. This imbalance has already caused many men to question whether they will have the opportunity to marry and have a family of their own.

China is the fourth-largest country, with a total area of 9.6 million square kilometers, which is slightly smaller than the United States. The country has a mid-latitude location in eastern Eurasia and an extremely diverse climatic system. The land surface is varied, with extensive mountain regimes and desert areas in the west, loess plateaus in the north, and alluvial plains in the east. Despite the size of the country, only 15 percent of the land area is suitable for agriculture. Within this sector a great variety of agricultural products are produced. Double-cropping of rice is practiced extensively in the warm and humid southeastern China. Rice gives way to wheat and other more drought-tolerant crops in the north. The arid west is dotted with oasis-type agricultural systems.

Industrial growth in China has been very rapid in the past two decades. Spectacular strides have been made in metal production, machine manufacture, energy production and use, transportation equipment, telecommunication systems, and a wide variety of consumer goods. In addition, the service sector of the Chinese economy continues to expand with employment in the industrial sector. With a total labor force nearing 800 million, China is an economic force to consider in the global arena. The agricultural sector comprises half the labor force and contributes only 13 percent of the Gross Domestic Product (GDP). The combined industry and service sectors comprise the other half of the labor force, with a collective contribution to GDP at 87 percent. The labor force in agriculture has dropped from over 70 percent in the late 1970s to its present level, and is predicted to continue this decline as more farm workers exit the rural areas and move to industrial and service sector jobs in the cities. By the year 2015, it is estimated that the percentage of the Chinese population will be evenly divided between urban and rural habitats. The significance of this shift is striking: As recently as 1975, rural residents represented approximately 84 percent of the population, while urban residents represented a mere 16 percent.

China's one-child policy has led to serious problems. Cultural preference is for a male child, spurring female infanticide.

The rural areas of the country are suffering from rapid depopulation, the abandonment or downgrading of small farms to part-time activities, and low productivity. Nonetheless, the Chinese government has provided significant financial support to the enhancement of rural education. China's nine-year compulsory education system is well established within the rural areas and literacy rates among young students have greatly improved. In addition, programs to modernize agricultural activities in rural China are expanding and thrusts are being made to improve adult education as well. The Chinese government spent nearly $12 billion on rural education in 2002, up from $5 billion in 1997. Despite these dramatic changes, the rural areas are far behind urban places in terms of economic development and social equity. The rural shortfall is related to the broader set of inconsistencies between China's phenomenal economic growth and the less than desirable increases of inequality in the social sector. The next five-year plan is taking this inequity into account. Education differences between the urban and rural areas are one of the major targets for change. China's 2000 national census showed that the countrywide illiteracy rate for those aged 15 and above was slightly over five percent. The rural areas, by contrast, registered nearly 12 percent in this category.

Imbalances between urban and rural areas exist, as well in the availability of medical and hygiene facilities. Urban places have 80 percent of these facilities available to them, while the rural areas, representing 70 percent of the population, have only 20 percent. Another area of concern to planners is China's surprisingly low per-capita income, which was reported to be $6,600 in 2005, compared to the world average of $9,190. These figures represent gross national income in purchasing price parity (GNI PPP), which refers to gross national income converted to international dollars using a purchasing price parity conversion factor. The resulting dollars indicate the amount of goods and services that cold be purchased in the U.S. market. Not only is China well below the world average in this category, it is far below Hong Kong ($34,670), Japan ($31,410), and the United States ($41,950).

Nuclear Shelters in Beijing

With the threat of nuclear war in the 1950s and 1960s, the municipal authorities in Beijing constructed nuclear shelters, otherwise known as the "underground city." The original plans were for the shelters and tunnels to protect as much as half of the population, and was initially secret, but their existence became known to outside commentators during the mid-1970s, with some foreign visitors allowed to view them from 1979–1980. Most of the tunnels are now open to the public, and tourists can buy a ticket to enter the tunnels, many of which have been refurbished. There still remain restrictions on photography in the tunnel systems.

The tunnels, which often come from corner shops, railway stations and the like, are relatively narrow but are designed for three men to walk side-by-side. It was said that the tunnels would allow most of the population of the city, walking steadily, to leave the contaminated area and get into the countryside. There are padded steel doors at intervals, and there are even ventilation shafts. Some of these still connect with hutongs (narrow alleys) and it is not uncommon for tourists visiting the shafts to hear noises and even conversations taking place in hutongs.

The larger tunnels connect with the Beijing underground and there are underground light industrial workshops, shrines, medical care facilities and sanitation. Many of the tunnels also had Communist slogans asking people to work harder and strive for a better country. The material excavated in Beijing was turned into bricks for use around the capital.

The "underground city" is believed to cover an area of 33 square miles (85 square kilometers), going out to the Western Hills, the Summer Palace and also to the International Airport. There are also another series of tunnels, which remain secret, for Communist Party officials and government bureaucrats to escape through in times of war. It has been claimed that soldiers used the tunnel during the ending of the Tiananmen Square protests in 1989.

China's rapidly expanding economic sector changed from a centrally planned system to one that is more market oriented. In the late 1970s, the country abandoned collectivized agriculture, a practice introduced early in the Maoist era and a copy of the system pioneered under the now defunct Soviet Union. In 2005, China achieved the enviable status as the second-largest economy in the world behind the United States. However, the impact of its large population growth resulted in very low per capita income. In 2005, over 150 million Chinese were subsisting below the international poverty line, which is two dollars per day. China is one of the world's leaders in energy consumption as its economy rapidly expands. Its impact on the global trade in oil is considerable. China produces over three million barrels of oil per day, but its consumption is twice that amount. The deficit is made up with imports from a variety of oil-producing regions worldwide. Natural gas and coal are extensively used in China, and the country has extensive reserves of both of these energy sources.

The completion of the Three Gorges Project along the Yangtze River stands as a symbol of the scale of Chinese development efforts. The idea of damming the Yangtze to produce hydroelectric power was first proposed during the time of Sun Yat-sen early in the 20th century. In the 1950s, following a series of floods, Mao Tse-tung ordered the country's engineers to produce feasibility studies on damming the river. The project was officially started in 1993 and is expected to be fully completed and to include a ship elevator system by 2009. The dam, which is 1.5 miles wide and 600 feet high, is by far the largest in the world and is heralded as the most gigantic engineering effort in China since the building of the Great Wall. The reservoir behind this massive structure stretches for 400 miles into the interior of China. This river system will allow ocean-going vessels access to regions rich in manufacturing activities and agriculture, and will reach the major city of Chongqing with its more than 30 million people. Hydroelectric power generation at the dam will produce over 18,000 megawatts of power, an amount sufficient to satisfy 10 percent of China's energy needs.

The dam will also be beneficial in its containment of flooding on the unpredictable and sometimes violent Yangtze River. Devastating floods along the river have claimed over one million lives in the last 100 years, and caused untold damage to communities in its path. The Three Gorges Project is economically important; however, construction of the dam was severely criticized from the beginning. Construction and the subsequent filling of the vast reservoir displaced over 700,000 people from their homes in the river valley. In addition, hundreds of small villages and towns ended up at the bottom of the reservoir, along with countless archaeological items and thousands of acres of farmland. The agricultural land lost to the project is some of the most fertile in all of China.

China's growth in energy production has led to another serious environmental issue: coal-fired plants providing desperately needed energy for urban areas and industry are spewing tons of carbon matter into the atmosphere on a daily basis. Two-thirds of the energy produced in China comes from the estimated 800 million tons of coal consumed annually. Add to this the fast-growing consumption of oil and natural gas, and it is clear that China will soon become the leading emitter of carbon into the atmosphere. Ironically, China is a member of the community of countries signing and ratifying the Kyoto Protocol aimed at limiting the global production of greenhouse gasses. China signed on even though there are no limits on the amount of pollutants it produces, because it was classified as a developing country in 1997 when the Kyoto Protocol was presented. Estimates now have China becoming the leading emitter of greenhouse gasses and surpassing the United States in that category sometime in the 21st century.

SEE ALSO: Birth Control; Birth Rate; Coal; India; Three Gorges Dam; Urbanization.

BIBLIOGRAPHY. A.H. Amsden, *The Rise of the "Rest:" Challenges to the West from Late-Industrializing Economies* (Oxford University Press, 2003); P.J. Bailey, *China in the Twentieth Century* (Blackwell, 2001); N.N. Chen, *China Urban: Ethnographies of Contemporary Culture* (Duke University Press, 2001); Edward Friedman and Bruce Gilley, eds., *Asia's Giants: Comparing China and India* (Palgrave Macmillan, 2005); Alan Lawrence, *China Since 1919: Revolution and Reform: A Sourcebook* (Routledge, 2004); Dorothy Perkins, *Encyclopedia of*

China: The Essential Reference to China, Its People and Culture (Facts on File, 2000); Fulong Wu, trans., *Globalization and the Chinese City* (Routledge, 2005).

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Chipko Andolan Movement

THE CHIPKO ANDOLAN Movement originated in the Indian Himalayan region of Uttarkhand, in the state of current-day Uttaranchal. The Hindi term *Chipko* means to "hug" or "cling to" and refers to peasants demonstrating against government-led logging practices by circling and embracing trees. Though the movement officially began in the villages of Mandal and Gopeshwar, it quickly spread to other mountain regions of the Indian Himalaya. The story of the Chipko Andolan Movement has inspired similar movements around the world.

Prior to the Chipko Movement, residents in the area were already skeptical of government logging practices, drawing a connection between heavy deforestation and severe erosion. Villagers around Gopeshwar were therefore accustomed to protesting the illegal commercial contracting policies of the Forest Department, advocating instead for increased employment through local contracting opportunities.

These concerns were taken up by a local nongovernmental organization, the Daushali Gram Swarajya Sangh (DGSS) or Dasholi Society for Village Self-Rule. The first Chipko Movement protest took place in early 1973, when the DGSS's request for an allotment of ash trees was turned down by the government. During the same period, and just over 10 kilometers away near Mandal, a private enterprise was granted an allotment of ash trees for the production of commercial sporting goods. Led by Chandi Prasad Bhatt, the local villagers responded to this perceived injustice by circling and embracing the trees set for commercial logging. After many days of vigilance by Chipko members, the commercial interests moved elsewhere.

In 1974, the forest department again planned another logging venture, this time not far away near the village of Reni in the Alakananda Valley. Guara Devi, the head of a village women's group, mobilized a number of locals consisting primarily of women to prevent logging operations. The loggers were eventually forced to retreat, revealing the central role of women in the overall movement. The Chipko Movement is commonly reported as singly unified; however, it has been more of a conglomeration of distinct, somewhat smaller movements.

The Reni forest protests marked a shift in Chipko movement goals from a demand for forest products to supply local industries, to a new and much broader concern over the ecological control of forest resource extraction to guarantee dependable supplies of water and fuelwood to local residents. The Chipko Movement therefore came to represent a continuation of the colonial-era defense of traditional forest rights over state encroachment. Tactically, the Chipko Movement was a postcolonial extension of the Gandhian satyagraha—a nonviolent means of confronting exploitative powers.

REESTABLISHING FOREST PRACTICES

While the Chipko Andolan Movement is notable because of its ideological and organizational influence on environmental movements around the world, it also offers a valuable point of reflection on how environmentalists retell historical narratives. Some have characterized the Chipko movement as the accomplishment of women protecting the reproductive power of forests against exploitative commercial logging practices. Others present Chipko as a movement by local peasants seeking to preserve traditional forest practices and identities. Critics suggest both these narratives rely on overly romantic tropes of Himalayan history premised on conditions of ecological and social harmony. The goal of the Chipko Movement members in the mid-1970s was to reestablish, on their own terms, a set of preestablished profitable forest practices connected to broader market and state ventures.

SEE ALSO: Deforestation; Forest Management; Timber Industry.

BIBLIOGRAPHY. Ramachandra Guha, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya* (Oxford University Press, 1998); Haripri-

ya Rangan, *Of Myth and Movements: Rewriting Chipko into Himalayan History* (Verso, 2000); Paul Routledge, "The Chipko Movement," in *Terrains of Resistance* (Praeger Publishers, 1993); Vandana Shiva, *Staying Alive: Women, Ecology and Development* (Zed Books, 1998).

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Chlorinated Hydrocarbons

CHLORINATED HYDROCARBONS ARE organic compounds containing carbon, hydrogen, and chlorine. They are also called chlorocarbons, chlorinated organics, chlorinated insecticides, chlorinated synthetics, and organochlorides. There are thousands of chlorinated hydrocarbon compounds. Some occur naturally, and some are toxic to humans or to the environment. Chlorinated hydrocarbons are formed by the replacement of one or more hydrogen atoms with one or more chlorine molecules. Some chlorinated hydrocarbons are part of a class of chemical compounds called alkyl halides, in which a bromine, chlorine, fluorine, or iodine atom has been substituted for a hydrogen atom. Many chlorinated hydrocarbons have industrial, agricultural, and commercial uses. The simplest chlorinated hydrocarbons are chlorinated forms of methane or ethane. Tetrachloromethane (CCl_4), commonly known as carbon tetrachloride, is a colorless, volatile, and nonflammable liquid. It is made commercially from methane (CH_4) and chlorines. It is poisonous if breathed in excessive quantities. It has been frequently used in dry cleaning, metal cleaning, and for extracting oils from seeds.

Trichloromethane (CCl_3H) is commonly known as chloroform. Used in medicine as an anesthetic, it is a sweet-smelling, colorless liquid. It use has been restricted because it is a possible carcinogen. Dichloromethane (CCl_2H_2) or methylene chloride is used in many industrial processes. These include paint stripping, paint remover manufacturing, metal cleansing and degreasing, and in the making of pharmaceuticals. Dichlorodifluoromethane (CCl_2F_2) is the most important of the Freon group of compounds. Freon was used for many years in refrigerators and air conditioners. Freon is odorless, nontoxic, nonflammable, and easily liquefied from the gaseous state. It is manufactured from carbontetrachloride and hydrofloric acid (HF). The use of Freon has been banned because when it is released it rises in the atmosphere to the stratosphere. Ultraviolet light from the sun decomposes the Freon gas, in the process freeing the two fluoride atoms. These then react with ozone molecules in the ozone layer causing increases in environmental damage, eye damage, and skin cancers.

Ethylene dichloride is the older name of 1,2-dichloroethane ($C_2H_4Cl_2$). It has also been called ethane dichloride, Dutch liquid, and Dutch oil. It is used to make vinyl chloride, which is a precursor of PVC plastics. Tetrachloroethane ($C_2H_2Cl_4$) was used for a while in large amounts as a solvent and as a metal degreaser. It was also used in pesticides and paints. It is no longer used for these purposes. Breathing tetrachloroethane is very noxious. Today it is used in the United States and in a number of other countries as a chemical intermediate in the manufacturing of other chemicals. Trichloroethylene ($Cl_2C{=}CHCl$) has been used as an industrial solvent and for extracting oils from plants. It also supplanted chloroform for a while as a general anesthetic.

PESTICIDE PRODUCTION

Many chlorine hydrocarbons have been used in the production of pesticides. Many organochlorides are powerful insecticides. These include chlordane (clorinated cyclodiene); DDT ($C1_4H_9Cl_5$); dicofol (which is made from DDT); dioxin (2,3,7,8-tetrachlorodibenzo-p-dioxin); endosulfan ($C_9H_6Cl_6O_3S$), which is also used under the names thiodan and benzoepin; heptachlor ($C_{10}H_5Cl_7$); and pentachlorophenol (C_6HCl_5O), which is a synthetic fungicide. Still in use (banned in California) is lindane (gamma-Hexachlorocyclohexane). Among other uses, lindane is a treatment for lice and scabies. The bond between chlorine and carbon atoms is strong. This means that they do not degrade rapidly and continue to persist in the environment. When released into the environment they can create a long-term pollution problem that is not rapidly weathered or biodegraded. Some of them have entered the food chain with negative consequences for many species that were not the target of pesticide spraying, and for humans.

SEE ALSO: Chlorofluorocarbons (CFCs); Ozone and Ozone Depletion; Pesticides; Plastics.

BIBLIOGRAPHY. Bruce C. Alleman and Andrea Leeson, eds., *Natural Attenuation of Chlorinated Solvents, Petroleum Hydrocarbons and Other Organic Compounds* (Battelle Press, 1999); K. Kenne and Ulf G. Ahlborg, *Chlorinated Paraffins* (World Health Organization, 1996); Sita Ramamoorthy, *Chlorinated Organic Compounds in the Environment, Regulatory and Monitoring Assessment* (CRC Press, 1997).

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Chlorofluorocarbons (CFCs)

CHLOROFLUOROCARBONS (CFCS OR chlorofluormethanes) are a group of chemicals containing carbon, fluorine, and chlorine atoms. They were used extensively throughout the 20th century for various applications because of their general nontoxicity and stable chemical properties. However, CFCs are also extremely potent greenhouse gases and are primarily responsible for the destruction of stratospheric ozone (O_3). As of 2003, cumulative worldwide production of CFCs was estimated at 24 million metric tons (53 billion pounds), 96 percent of which has been released into the atmosphere.

CFCs were formally introduced to the world in 1928 by Thomas Midgley Jr. and colleagues with the synthesis of dichlorodifluoromethane (now known as CFC-12, CF_2Cl_2). Midgley's work was the answer to his assignment by General Motor's Frigidaire division to develop a nontoxic, noninflammable, and noncorrosive refrigerant. To this end, CFCs proved to be an excellent, if not perfect product. In 1930, DuPont began commercial production of CFC-12 under the trade name Freon. Soon after, CFC-11 ($CFCl_3$) entered production, and together with CFC-12, formed the bulk of all CFCs ever produced. During World War II, CFCs began to be used as aerosol propellants and as key components in the production of packing, insulating, and buoyancy foams. CFCs were also used as solvents in the dry-cleaning and electronics industries. In particular, CFC-113 ($CF_2ClCFCl_2$) was used extensively for these purposes. Additional CFC varieties were produced (most notably CFC-114 and CFC-115) but accounted for only 3 percent of total CFC production.

In 1973, a study by Jim Lovelock and colleagues revealed the existence of CFCs and other halocarbons in the atmosphere over the Atlantic Ocean. The authors highlighted the practical role of these chemicals as inert tracers of atmospheric processes and described them as constituting "no conceivable hazard." The following year, Mario J. Molina and F.S. Rowland reported that the most important sink for atmospheric CFCs is likely the dissociation of chlorine atoms by ultraviolet light in the stratosphere (Molina and Rowland received the Nobel Prize for their work in 1995). They suggested that free chlorine atoms catalytically destroy ozone molecules through the following reactions:

$$Cl + O_3 \rightarrow ClO + O_2 \quad \text{and} \quad ClO + O \rightarrow Cl + O_2$$

Once stripped from a CFC molecule, a single chlorine atom can catalyze the destruction of up to 100,000 ozone molecules before it is eventually incorporated into "chlorine reservoirs" such as HCl or chlorine nitrate ($ClONO_2$).

Molina and Rowland raised significant concerns about the continuing rise of atmospheric CFCs and the importance of stratospheric ozone. In 1978, as evidence of CFCs' threat to the ozone layer strengthened, the United States banned the manufacture and sale of CFCs as aerosol propellants in spray cans (by then, the predominant use of CFCs).

By the mid-1980s, extensive research had confirmed a dramatic reduction of the ozone layer over Antarctica and attributed it to CFCs. The 1987 Montreal Protocol and subsequent amendments required industrialized nations to phase out CFC production by 1996, and by 2010 for developing nations. Although worldwide production of CFCs today is a small fraction of what it once was, the long residence times of CFCs in the atmosphere implies a slow recovery of stratospheric ozone.

While CFCs are more widely known as a threat to ozone, they also significantly contribute to the anthropogenic greenhouse effect. Over the course of 100 years, one pound of CFCs emitted to the atmosphere will reradiate as much heat as 4,600 to 14,000 pounds of carbon dioxide (CO_2). Because of this property, even the relatively small concentration of CFCs in the atmosphere (about 1 part per billion by volume) is considered to be a major contributor to global warming. Hydrofluorocarbons (HFCs) are replacing CFCs in many applications because of their benign effects on ozone. However, HFCs are also potent greenhouse gases and are recognized as such in the Kyoto Protocol.

SEE ALSO: Global Warming; Greenhouse Gases; Montreal Protocol; Ozone and Ozone Depletion.

BIBLIOGRAPHY. Alternative Fluorocarbons Environmental Acceptability Study, www.afeas. org (cited April 2006); Stephen O. Andersen and K. Madhava Sarma, *Protecting the Ozone Layer: The United Nations History* (Earthscan Publications, 2004); Mark Z. Jacobson, *Atmospheric Pollution: History, Science, and Regulation* (Cambridge University Press, 2002); J.E. Lovelock, R.J. Maggs, and R.J. Wade, "Halogenated Hydrocarbons in and over the Atlantic," *Nature* (v.241, 1973); Mario J. Molina and F.S. Rowland, "Stratospheric Sink for Chlorofluoromethanes: Chlorine Atom-Catalysed Destruction of Ozone," *Nature* (v.249, 1974); Richard P. Wayne, *Chemistry of Atmospheres* (Oxford University Press, 2000).

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Chlorophyll

CHLOROPHYLLS ARE A class of chemical pigments found in many types of plant life, and are necessary for the process of photosynthesis. Chlorophylls absorb light in particular parts of the electromagnetic spectrum, meaning that they have a very vivid green color, which is characteristic of their presence and encourages industrial applications as well as health promotion.

Photosynthesis is the process by which sunlight is converted into chemical energy within plant cells through organic carbon compounds. It is possible that chlorophyll or a similar substance was a vital link in the evolution of life. The 1997 Pathfinder mission to mars found some evidence that substances similar to chlorophyll might be present in Martian soil.

The five types of chlorophyll (a, b, c, d, and e) are found in the higher plants and different forms of algae; bacterio-chlorophyll is found in some types of bacteria. Chlorophylls consist of a magnesium atom surrounded by a porphyrin ring containing nitrogen and with a carbon-hydrogen chain also attached. This structure is quite similar to that of hemoglobin, which is the vital substance within blood that transports oxygen. Since chlorophyll tends to hide other colors present within plants and especially their leaves, it is when light is reduced that other colors emerge, such as during autumn, when the leaves of many deciduous trees change from green to red, yellow, or brown. The use of chlorophyll fluorescence has become a tool of considerable importance for plant physiologists and ecophysiologists, who are able to use the various techniques involved in diagnosing not just the rate of photosynthesis, but also considerable amounts of information about the health of the plant concerned and its reactions to its environment. In particular, it is useful in measuring environmentally induced stress.

Chlorophyll-bearing vegetables have been the subject of investigation in the hope that they will inhibit the growth of some cancer cells. Spinach is indicated by some research as an important dietary item that may assist with this prophylaxis.

SEE ALSO: Carbon Dioxide; Deciduous Forest; Decomposition; Joint Forest Management.

BIBLIOGRAPHY. F. Galvano, A. Piva, A. Ritieni, and G. Galvano, "Dietary Strategies to Counteract the Effects of Mycotoxins: A Review," *Journal of Food Protection* (v.64/1, 2001); Bernhard Grimm, Robert J. Porra, Wolfhart Rüdiger, and Hugo Scheer, eds., *Chlorophylls and Bacteriochlorophylls: Biochemistry, Biophysics, Functions and Applications* (Springer, 2006); Kate Maxwell and Giles N. Johnson, "Chlorophyll Fluorescence: A Practical Guide," *Journal of Experimental Biology* (v.51/345, 2000).

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Chromosomes

THE GENETIC INFORMATION encoded in DNA and carried in cells is normally packaged in molecules called chromosomes: long strands of DNA and associated proteins that carry many genes, regulatory elements, and nucleotide sequences. Merriam-Webster Online Dictionary defines *chromosome* as "one of the linear or sometimes circular DNA-containing bodies of viruses, prokaryotic organisms, and the cell nucleus of eukaryotic organisms that contain most or all of the genes of the individual." It is derived from two Greek words: *chroma,* meaning color, and *soma,* meaning body.

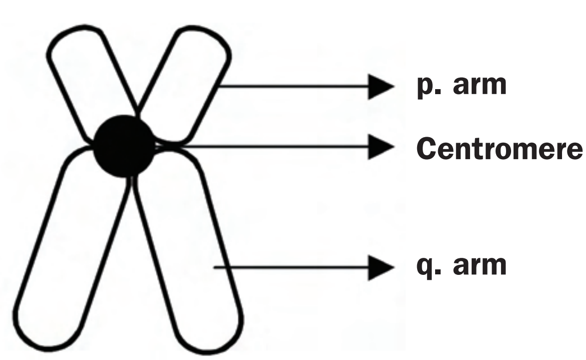
Chromosomes were first observed by a Swiss botanist, Karl Wilhelm von Nägeli, in 1842 in plant cells. Belgian scientist Edouard Van Beneden independently observed chromosomes in Ascaris worms around the same time. Walther Flemming, a German anatomist, in 1882 discovered mitosis (the process by which a cell separates its duplicated genome into two identical halves) and described the behavior of chromosomes in animals. In 1910, an American geneticist, Thomas Hunt Morgan, proved that chromosomes are the carriers of genes by studying the common fruit fly.

Chromosomes are present in every living being, whether it is bacteria, fungi, plants, insects, animals, or humans. However, each species has different number of chromosomes (see table), but normal members of a particular species all have the same number of chromosomes. The asexually reproducing species have one set of chromosomes, which is the same in all body cells. Chromosomes in bacteria are most often circular, but sometimes they are linear as well. Most sexually reproducing species contain two haploid sets of chromosomes (chromosomes are multiples of 2, and they are therefore mostly present in pairs, though there are some animal and plant species that have more than two sets of chromosomes; for example, tobacco or wheat) and are referred to as polyploid. Some wild as well as cultivated varieties of wheat have 14 (diploid) chromosomes, whereas common pasta and bread wheat are polyploid and have 28 (tetraploid) and 42 (hexaploid) chromosomes, respectively. In humans, there are 46 chromosomes that occur as 23 pairs—22 pairs of autosomes and 1 pair of sex chromosome. Each child inherits one strand from the mother and another from the father to form a pair. Aulacantha (protozoa) has largest number of chromosomes at 1,600.

Number of Chomosomes in Different Species of Plants and Animals

Species	# of chromosomes	Species	# of chromosomes
Ant	2	Fruit Fly	8
Ape	48	Guinea Pig	16
Butter-flies	3	Hare	46
Budding yeast	32	Horse	64
Cat	38	Human	46
Chicken	78	Maize	20
Cow	60	Mouse	40
Dog	78	Pig	38
Donkey	62	Rabbit	44
Dove	16	Rat	42
Earth-worm	36	Rye	14
Elephant	56	Sheep	54
Fern	1200	Snail	24

Each chromosome has two arms that differ in length and are referred to as a p (short arm) and q (long arm). The two arms are separated by a region called the *centromere* (see figure). The location of the *centromere* on each chromosome gives the chromosome its characteristic shape, and can be used to help describe the location of specific genes. Chromosomes are very small and are visible only by using an optical microscope.



The abnormalities in chromosomes can occur either by change in number, size, or structure of chromosomes. The change in chromosome structure could occur due to breakage or rearrangement—translocation, inversion, rings, or deletions—of some of the chromosome material. This leads to disorders such as Down's syndrome. During formation, an egg or sperm can sometimes have either an extra chromosome (24 chromosomes) or one less chromosome (22 chromosomes). When such an egg (or sperm) combines at conception with a normal sperm (or egg) with 23 chromosomes, the resulting embryo ends up with too few or too many chromosomes, i.e., 45 or 47 instead of the usual 46. These lead to disorders such as trisomy 21, XYY syndrome, and Klinefelter syndrome. Prenatal testing is available for the screening or diagnosis of the disorders of plants and animals.

SEE ALSO: Deoxyribonucleic Acid (DNA); Gene Therapy; Genetics and Genetic Engineering.

BIBLIOGRAPHY. R.J. Gardner, Grant R. Sutherland, and Gardner R. J. McKinlay, *Chromosome Abnormalities and Genetic Counseling* (Oxford University Press, 2003); K.F. Jorgenson, J.H. van de Sande, and C.C. Lin, *Chromosoma* (v.68, 1978); William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Sarah M. Ward, *Concepts of Genetics* (Prentice Hall International, 2005).

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Chronic Wasting Disease

CHRONIC WASTING DISEASE (CWD) causes nervous system degeneration in cervid animals (the deer family) in North America. CWD, like Creutzfeldt-Jakob disease (CJD) and bovine spongiform encephalopathy (so-called mad cow disease), belongs to a family of neurological diseases called *transmissible spongiform encephalopathies* (TSEs). TSEs are caused and spread by abnormal proteins called *prions* found in the central nervous system and the immune system. Prions are transmitted much like other infectious agents such as viruses and bacteria—mostly through direct contact between infected and healthy individuals, though prions may also persist in soil. Cervids that live in highly social herds and at high population densities are most likely to catch and transmit the disease. Infected animals develop lesions on the brain, lose body mass, and display behavioral abnormalities. All cases are fatal.

CWD was first observed among deer and elk in wildlife research facilities and game farms during the late 1960s, exclusively in the Rocky Mountain region. In subsequent years, cases appeared on game farms across the northern Rockies and the central plains of the United States and Canada. Wildlife pathologists discovered cases among free-ranging cervids in the Rockies in the early 1980s. By spring 2006, CWD had been detected in free-ranging cervids in 13 states and provinces, as far east as New York and as far south as New Mexico, and in captivity in several other states and provinces.

Wildlife pathologists have linked the spread of CWD with high population densities of cervids, as are found both on game farms and in regions where humans have intentionally and unintentionally created ecological conditions favorable for deer. As game farming blossomed in the 1990s, transport of infected animals between farms greatly aided the spread of CWD. CWD has killed up to 90 percent of game animals on some farms, and the United States Deparment of Agriculture has restricted the transport of animals between states. In regions such as the upper Midwest, where suburbanization and agriculture have facilitated high densities of white-tailed deer, CWD has spread rapidly among free-ranging deer. Furthermore, because of the cultural and economic importance of hunting, many residents favor a high deer population, and some tourist businesses maintain baiting stations—ideal sites for the spread of CWD. Illinois and Wisconsin have established additional hunting seasons to reduce deer populations within the area where the disease was most prevalent. Many states have enacted partial bans on deer baiting. These policies sparked controversy where hunting and game farms are economically important; some hunters and businesses dependent on hunting charge that wildlife managers exaggerate the extent of CWD. Many state wildlife management agencies also test all cervid animals killed during the regular hunting season as a surveillance measure.

CWD is most widespread in white-tailed deer, mule deer, and elk; it exists very rarely in free-ranging moose. Though bovine spongiform encephalopathy has been documented in humans as a variant of CJD, there are no known human cases of CWD. Neither have domestic livestock such as cattle contracted CWD. Many hunters, farmers, and taxidermists, however, have expressed fear that prions could spread through consumption of venison, contact between livestock and infected cervids, or handling of organs, brains, and spinal fluid.

SEE ALSO: Bovine Spongiform Encephalopathy; Deer; Hunting.

BIBLIOGRAPHY. National Wildlife Health Center, "Chronic Wasting Disease (CWD)," www.nwhc.usgs.gov (cited April 2006); Paul Robbins and April Luginbuhl, "The Last Enclosure: Resisting Privatization of Wildlife in the Western United States," *Capital Nature Socialism* (v.16, 2005); Elizabeth S. Williams and Ian K. Barker, eds., *Infectious Diseases of Wild Mammals* (Iowa State University Press, 2001).

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Circle of Poison

THE "CIRCLE OF poison" (COP) describes the linkage between an American-made pesticide that is banned in the United States, but which circles back into the food supply from a pesticide used in an underdeveloped country. The circle is complete when the pesticide returns via nature or by human actions. The pesticides in the circle of poison have carcinogenic or tetragenic properties (causing birth defects). Traces of banned, American-made pesticides have been found in the Florida Keys or in other locations, including the Great Lakes. Winds and ocean currents have delivered these traces. In other cases, the pesticide circle was completed through imports of foods.

The only pesticides allowed in the United States are those that are registered for use in the United States; however, export law does not prevent unregistered pesticides from being manufactured and exported. In the 1970s and 1980s, the United States began to ban the use of pesticides that were identified as environmentally destructive or identified as carcinogens. For example, the banning of DDT in the United States did not prevent its being exported to underdeveloped countries. The 1970s also saw the beginning of increased food imports to the United States. Countries in the southern hemisphere grew increasing quantities of crops that were exported to North America and Europe. Tomatoes from Mexico, fruits from Chile, and foods from underdeveloped countries increased in the food supplies of Americans, Canadians, and Europeans.

Proven instances of the circle of poison have been rare. In one case, residues of chlordane and heptachlor, which are made only in the United States, were found on beef imported into the United States. Since 1990, the United States Department of Agriculture has generally found that pesticide residues fall within acceptable limits. In 1991, the Food and Drug Administration (FDA) examined over 10,000 samples of imported fruits and vegetables. The sampling found that in 64% of imported food, there was no traceable pesticide residue. Only four percent of the foods sampled were outside of the accepted limits. However, the FDA inspects only a small fraction of the foods imported into the United States. Most critics find the very limited inspections conducted by the FDA to be woefully inadequate.

Consumer advocacy groups have lobbied Congress for circle-of-poison legislation that would prevent the exporting of unregistered pesticides from the United States. Senator Patrick Leahy (Democrat-Vermont) and Representative Leon Panetta (Democrat-California) have repeatedly been unsuccessful in getting circle-of-poison legislation adopted. Opponents of the regulation of pesticides argue that banning them would hurt not only American manufacturers, but also people in the Third World. Pesticide use in many tropical countries has reduced malaria and allowed expanded agricultural production. Opponents believe that banning American-made unregistered pesticides will not break the circle of poison, as Third World countries will simply find new supply sources for fighting both disease-bearing insects and destructive pests. In 2006, Congress was still allowing the export of unregistered pesticides, while the number of cases of pesticide poisoning in foreign countries was increasing.

SEE ALSO: Carcinogens; DDT; Pesticides.

BIBLIOGRAPHY. Sean L. Swezey and Rainer Daxl, *Breaking the Circle of Poison: The Integrated Pest Management Revolution in Nicaragua* (Institute for Food and Development Policy, 1983); David Weir and Mark Schapiro, *Circle of Poison: Pesticides and People in a Hungry World* (Institute for Food and Development Policy, 1981).

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Circuses

CIRCUSES ARE COMPANIES of entertainers who perform as acrobats, clowns, and animal tamers in a circular arena. Circuses may travel or be based in permanent facilities of entertainment. Some of the early modern circuses in London and other European cities were built for this purpose. Circus Circus, a gambling casino in Las Vegas, Nevada, also exhibits the world's largest permanently housed circus; performances are given free of charge daily. Often, traveling circuses perform in a large tent designed to accommodate the circus performers and the audience.

GREATEST SHOWS ON EARTH

In the late 19th century and in much of the 20th century, the arrival of the circus was a great event. In many small towns and cities, the "advance men" would arrive days before the circus and publicize the coming spectacle. The circus performers and their circus animals would parade down a main street to generate public interest. The excitement would help to draw a fee-paying crowd to the performances in the afternoon, and for the larger show in the evening. In many rural areas, the only opportunity most people had to view lions, tigers, leopards, camels, giraffes, elephants, performing horses, and exotic snakes was when the circus came to town. Smaller circuses would often arrive in a caravan of trucks decorated with circus images of animals, clowns, and other performers. Larger circus companies, such as the Barnum and Bailey Circus, often arrived on a train designed to carry the performers, with special cars for the animals.

The ancient Roman circuses were famous long before the end of the Roman Empire. Chariot races and the exhibition of exotic animals entertained the masses. Animal exhibitions are thought to have originated in shows of animals used by Egyptians or in the ancient Middle East. The most important circuses in ancient Rome were the Circus Maxentius, the Circus Flaminius, the Circus Nenonis, and the Circus Maximus, which was located between the Palatine and Aventine Hills. Archeologists have been able to develop detailed interpretations of the Roman circus world from these ruins. Schools for training circus performers were established and operated in Roman times.

In the Middle Ages, troubadours and other wandering entertainers kept alive a sense of the ancient circus. Training animals for exhibition as trick performers was common. In modern times, the circus began to revive in the 1700s when Briton Philip Astley began to operate both traveling and permenant circuses in Britain and Europe.

Some circuses have used animals and others have not. Chinese circuses usually featured amazing acrobatic performances. In others, the clowns have drawn keen attention. In most American circuses, lion tamers (both male and female) have entered cages with performing lions, tigers, and leopards. The lion tamer's only defense is a bullwhip. Over the decades, a small number of tamers have been attacked by the cats and on some occasions killed.

Russian circuses have often featured the Eurasian brown bear (*Ursus arctos*). In Russian mythology, bears have played a special role, which has encouraged Russians to train them to dance, box, or do other tricks. Many European circuses continue to thrive despite animal rights opposition. The European Union has adopted legislation accepting the classical circus with animals. Many animal rights activists have been able to gain adoption of local ordinances that hinder the exhibition of animals in circuses. The most common allegation is the charge of cruelty to animals. For many animal rights activists, the domestication and exhibition of animals is inherently cruel and a form of speciesism. Circuses are engaged in both legal and political campaigns to defend this ancient institution.

SEE ALSO: Animal Rights; Animals; Elephants.

BIBLIOGRAPHY. Roland Auguet, *Cruelty and Civilization: The Roman Games* (Barnes & Noble, 1998); Tony Babinski, *Cirque Du Soleil: 20 Years Under the Sun, an Authorized History* (HNA Books, 2004); Robert N. Manser, *Circus: The Development and Significance of the Circus, Past, Present, and Future* (Blackburn, 1987).

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Cities

NEARLY HALF THE world's population lives in towns and cities. Over the next quarter-century virtually all population growth will be in urban areas in less-developed countries. The environmental consequences of urban growth are considerable. Cities are prolific users of natural resources and generators of waste. They produce most of the greenhouse gases that are causing global climate change. They often also degrade local water quality, deplete aquifers, pollute the marine environment, foul the air and consume the land. Several movements are being organized today, some sponsored by the United Nations, to change city planning to address these concerns, to create "green cities."

Cities are places of concentrated human habitation. People live on almost all of the islands and continents of the world except for inhabitable places, such as Antarctica and some very small islands. In many places there are still nomads, such as the Laps and Eskimos in the Arctic, or the Bedouin in the Sahara or Arabia, or the nomads in Mongolia or India in contrast to whom are the teeming billions who live in the cities of the world.

Vast numbers of people have throughout history lived on farms and in small towns or villages; but it is in cities that most of the great achievements of human history have been accomplished, and it is in cities that ever greater numbers of human beings now live. Cities began in ancient times not long after the development of agriculture made permanent settlements possible. The first cities were in the river valleys of the Nile, Indus, Tigris, and the Yangze, among others. By modern standards these cities were usually small, although some did reach populations of over 100,000 people.

Cities have been places where humans were able to cultivate innumerable trades, crafts and practices because of the leisure that city life has afforded. Often the building of cities has meant the mining or quarrying of vast quantities of building materials. In some places these have left quarries that later filled with water or catacombs, such as those under Rome. In Rome, Paris, and other places these artificial caves have provided a place for burying the dead.

In order to build cities, supply them with goods and water, to defend them and to make them livable, architectural spaces were designed to provide water, sheltered spaces for worship, or for homes. Defenses for cities have included more than military defenses. Some cities are located in areas prone to flooding, while others experience regular threats from storms or freezing weather.

Defenses against the ravages of nature are just a part of the building concerns of city officials. In addition to aqueducts to supply water, and the establishment of marketplaces, such as the famous Agora in ancient Athens, people have found that they needed roads between cities and streets within. In the cities of world it has been necessary to provide clean sanitation facilities. In some cities, public baths have been built and used by the population. Marketplaces, water supplies, sanitation, are all necessary as are homes, open spaces and places of recreation or entertainment. In the Greek city-states an amphitheater was considered a necessity of the city. Gymnasiums were also a feature that has been adopted in modern cities.

Historically most cities have been located at ports, at river crossings, at sources of water, at crossroads or even at sacred sites. With the advent of the Industrial Revolution new industrial cities in Europe sprang up near coal supplies or on the fall lines of rivers, where water power could be used by damming local streams. With great improvements in sanitation and food production the population increased and with

Cities are prolific users of natural resources and generators of waste, producing most of the greenhouse gases that are causing global climate change. They often degrade local water quality and pollute the marine environment.

it the environmental impact of cities as they occupied ever more surrounding lands. At the same time urbanization also meant the abandonment of the countryside by increasing numbers of people.

Industrial cities at first were crowded, unsanitary and uninviting as increasing numbers of people were forced to earn a living working in factories. City planners, working with city administrators, helped to create clean, livable cities, but at times to the great disruption of large numbers of people.

In the 20th century urbanization so increased that cities became metropolises. After World War II, improved transportation allowed people to move to the suburbs in search of a taste of rural life, while remaining close to a city. As millions abandoned farms, vast rural areas returned to nature; but many rural areas have been re-occupied by suburbs, vacation homes and other luxury dwellings. The environmental impact of modern urban growth and sprawl has been increasingly destructive.

Around the world, mega-cities with populations of close to or more than 20 million people have sprung up since the end of World War II. Cities such as Mexico City, Shanghai, Tokyo, Manila, Lagos, Bombay and many others now are in this category. They present enormous challenges to city planners and administrations in the effort to create clean, safe, and wholesome living spaces that are sustainable in their environments.

SEE ALSO: Urban Ecology; Urbanization; Urban Planning; Urban Sprawl.

BIBLIOGRAPHY. Robert Bruegmann, *Sprawl: A Compact History* (University of Chicago Press, 2006); Matthew E. Kahn, *Green Cities: Urban Growth and the Environment* (Brookings Institution Press, 2006); William Lucy and David L. Phillips, *Tomorrow's Cities, Tomorrow's Suburbs* (American Planning Association, 2006); Voula Mega, *Sustainable Development, Energy and the City: A Civilization of Concepts and Actions* (Springer-Verlag, 2005); Kris Olds, *Globalization and Urban Change: Capital, Culture, and Pacific Rim Mega-Projects* (Oxford University Press, 2002); James B. Pick and Edgar W. Butler, *Mexico Megacity* (Perseus Publishing, 1999).

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Clean Air Act

THE CLEAN AIR Act is a federal environmental law in the United States that focuses on airborne pollutants known to present hazards to human health. It requires the Environmental Protection Agency (EPA) to design and enforce regulations that protect individuals from exposure to these hazardous airborne contaminants. Under the current structure of the law, the EPA sets limits on how much of an airborne pollutant can be in the air anywhere in the United States.

The Clean Air Act is actually a long series of federal laws and amendments that span a period of 50 years. The Clean Air Act of 1963 set emissions standards for stationary sources (such as factories and power plants) and encouraged the use of sulfur-removing technology and future research into the dangers of motor vehicle emissions. Eight years earlier, the Air Pollution Control Act of 1955 had been the first law regulating air pollution at the national level. It provided a relatively small appropriation ($5 million annually), but its larger significance had been to raise concerns about air pollution and to set the stage for federal regulation such as the Clean Air Act of 1963. Subsequent amendments in the 1960s strengthened and clarified the act by setting compliance deadlines, establishing detailed air quality standards, expanding local pollution control programs, and extending the act to cover mobile sources (such as automobiles).

EXPANDING REACH

The Clean Air Act of 1970 further strengthened the standards and regulations by establishing new standards for ambient air quality, setting new limits on emissions, and providing additional funding for research. Congress did amend the Clean Air Act in 1977, but in the 1970s and 1980s the EPA primarily implemented the policy outlined in the Clean Air Act of 1970 without making major changes. It was not until 1990 that the federal government again modified the Clean Air Act in any significant way. The Clean Air Act of 1990 not only strengthened existing regulations, but it also expanded the reach of the Clean Air Act to cover previously unregulated areas. It set new air quality standards and targeted motor vehicle emissions, toxic air pollutants, acid rain, smog, stratospheric ozone depletion, and interstate emissions. It also created a comprehensive pollution permit system, widely regarded as a great success for environmental economic policy.

During the 1990s, the EPA engaged in an extensive study to assess the effect of the Clean Air Act on the "public health, economy, and environment of the United States." In 1997, the EPA issued a report on the *Benefits and Costs of the Clean Air Act, 1970 to 1990*. The report found that emissions of criteria pollutants (sulfur dioxide, nitrogen oxides, carbon monoxide, particulate matter, ozone, and lead) had declined 30 to 100 percent. The report also found that these declines greatly increased intelligence quotient and reduced mortality, hypertension, and a number of other adverse health effects. They also improved visibility and avoided significant damage to agricultural crops. The report estimated a benefit-cost ratio of between 10.7 and 94.5, with a mean estimate of 42. This and other evidence indicate that the Clean Air Act has dramatically improved environmental quality and health in the United States, and that it has done so at relatively low cost.

WEAKENED STANDARDS

The most recent changes to the Clean Air Act were implemented with the Clear Skies Initiative, put forward in 2003 by the administration of President George W. Bush. This regulation weakened much of the Clean Air Act by raising emission caps, weakening regulation on older power plants, and delaying or hampering implementation of many Clean Air Act regulations. It also failed to address carbon dioxide emissions. The effects of these changes on actual enforcement or on environment quality are yet to be determined, but may very well be substantial.

Although it is a federal law, the Clean Air Act can be enforced by individual states. A state may submit a State Implementation Plan detailing how it will comply with the regulations. If the plan is approved, the state receives federal funding and takes on the responsibility for local enforcement of the Clean Air Act. Most states follow this procedure. State governments, with more detailed knowledge of their own geography, industry, and population, may be better equipped to regulate pollution efficiently and effectively within their own borders.

SEE ALSO: Sulfur Dioxide; Nitrogen Oxides; Carbon Monoxide; Lead; Bush, George W. Administration.

BIBLIOGRAPHY. Environmental Protection Agency, "The Clean Air Act," www.epa.gov (cited May 2006); Environmental Protection Agency, *Final Report to Congress on Benefits and Costs of the Clean Air Act, 1970 to 1990* (U.S. Gov. Printing Office, EPA 410-R-97-002, 1997); James P. Lipton, ed., *Clean Air Act: Interpretation and Analysis* (Nova Sciences Publishers, 2006); Tom Tietenberg, *Environmental Economics and Policy* (Pearson Addison Wesley, 2004).

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Clean Development Mechanism (CDM)

THE CLEAN DEVELOPMENT Mechanism (CDM), defined in Article 12 of the Kyoto Protocol, is one of three project-based flexible mechanisms authorized in the December 1997 Kyoto Protocol to the 1992 United Nations Framework Convention on Climate Change (UNFCCC). The overall aim of CDM is to provide for a more cost-effective way for industrialized countries (referred herein as Annex 1 countries) to meet their greenhouse gas (GHG) reduction targets they agreed to by ratifying the Kyoto Protocol. Article 12 of the Kyoto Protocol defines the purpose of the CDM as at least threefold: to help countries comply with their emission reduction commitments, assist developing countries in achieving sustainable development, and contribute to stabilization of greenhouse gas concentrations in the atmosphere.

In the experience so far with negotiating CDM projects, there have been issues with equity distribution of CDM resources, not unlike the equity issues that arise in other resource negotiations between developed and undeveloped countries. There has been limited involvement in the least-developed countries due to reasons such as high transaction costs of preparing a CDM project; lack of capacity to undertake a CDM project; and baseline energy scenarios that are mostly made up of biofuels such as fuelwood and other agricultural residues, which would make many projects ineligible under the CDM as compared to baseline scenarios made up of fossil fuels. A majority of CDM transactions have taken place in emerging markets such as China, India, and Brazil.

Another issue affecting equity distribution is the limitations that have been put on the land use, land-use change, and forestry (LULUCF) sector. LULUCF project activities in the CDM have been restricted to afforestation and reforestation projects only, so forest management and conservation activities are ineligible.

In the CDM context, inequities arise due to Annex 1 countries' interest in sequestering a maximum amount of carbon for the least amount of investment, and non-Annex 1 countries' vested interest in fostering sustainable development projects that not only sequester carbon, but also leave a legacy of training and long-term economic enrichment.

HOW IT WORKS

Governments and companies in Annex I countries purchase project-based greenhouse gas emission reductions in developing countries mostly to meet their obligations under the Kyoto Protocol or to trade them on the market for a potential profit. Some examples of CDM projects are renewable energy projects that include wind, solar hydro, biomass, and biofuels; methane reduction, mostly from landfill gas flaring; energy efficiency, including building efficiency; and bio-sequestration through afforestation and reforestation projects.

The money that flows to developing countries through CDM transactions is widely known as *carbon finance*. Carbon finance is basically a payment to a project entity for the emission reductions generated from that project, like a commercial transaction. The selling of emission reductions—or carbon finance—has been shown to increase the financial viability of projects by adding an additional revenue stream in hard currency, which reduces the risks of commercial lending or grant finance. Thus, carbon finance provides a means of leveraging new private and public investment into projects in developing countries that reduce greenhouse gas emissions, thereby mitigating climate change while contributing to sustainable development.

Emission reductions are calculated based on an established baseline scenario that must be explained within that project's Project Design Document (PDD), which will eventually need to be registered with the CDM Executive Board (EB), the body that regulates international project-based emissions trading under the Kyoto Protocol. The PDD, before becoming registered, must be approved by a Designated National Authority (DNA) in the project's host country and validated by an independent, third-party auditor called a *Designated Operational Entity (DOE)*. Designated Operational Entities are firms accredited by the CDM EB in order to assure that the baseline scenario is real and that the project is additional to business-as-usual practices. Once the project becomes operational, the project entity monitors the project based on a monitoring plan that is also included in the PDD. Throughout the life of the project, an accredited DOE will periodically visit; based on the monitoring plan and the data collected from the project entity, will verify that the emission reductions are actually happening and issue a report to the CDM EB stating that a certain amount of emission reductions have been generated. This will eventually lead to certification of those emission reductions and then, finally, issuance of the Certified Emission Reductions into the registries of those governments and private companies that have purchased the emission reductions from that project.

ONE CASE TO CONTEMPLATE

The world's first large-scale, forestry-based carbon offset project is the Innoprise–FACE Foundation Rainforest Rehabilitation Project (INFAPRO); its objective is to use enrichment planting and forest reclamation of indigenous tree species, fast-growing pioneers, and forest fruit trees to rehabilitate 25,000 hectares of degraded areas in Malayasia. INFAPRO is a cooperative venture between the FACE Foundation of the Netherlands—which is investing monetary resources to sequester carbon—and the Sabah Foundation, a semi-government forestry organization in the state of Sabah, Malaysia. The FACE Foundation committed a total of $15 million with expectations that the project will sequester at least 4.25 million tons of carbon.

Although there are many tangential and exacerbating issues related to the CDM, from a basic business standpoint, the system appears to be working. For example, in 2005, 374 million tCO2e (100 million tons of atmospheric CO2 equivalent), mainly of Certified Emissions Reductions (CERs), were transacted at a value of $2.7 billion with an average price climbing over $7.23. Many hope that the negative kinks in the system will be worked out over the course of time and experience; and that stakeholders on all levels will realize not only the ecological benefits of engaging in carbon trading and emissions reduction, but also the longer-term social, cultural, and biological benefits.

SEE ALSO: Kyoto Protocol; United Nations Framework Convention on Climate Change (UNFCCC).

BIBLIOGRAPHY. Margie Orford with Barry Kantor and Stefan Raubenheimer, *Climate Change and the Kyoto Protocol's Clean Development Mechanism* (Practical Action Publishing, 2004); Michael See, *Greenhouse Gas Emissions: Global Business Aspects* (Springer-Verlag, 2001); World Bank Carbon Finance website: www.carbonfinance.org

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Clean Water Act

THE CLEAN WATER Act (CWA) began as the 1972 amendments to the Federal Water Pollution Control Act, which was passed with the goal of restoring and maintaining "the chemical, physical, and biological integrity of the Nation's waters." Specifically, the act aimed to eliminate the discharge of pollutants by 1985, provide public funding for public waste treatment works, fund the technological advances necessary to reduce discharge, and clean up polluted water resources. While much of the act concerns the establishment of funding mechanisms for water quality improvement, there are two major regulatory components. The first is the National Pollutant Discharge Elimination System (NPDES), which establishes a permit system for "point-source" discharges into water (where a point-source is a discrete conveyance such as a pipe). The second is the 404 program, which requires permits for any dredging or filling in the nation's waters, including wetlands.

HISTORY OF FUNDING

The antecedent for the funding component of the CWA is the long series of amendments to the Federal Water Pollution Control Act (FWPCA), stretching back to 1948. These acts were concerned largely with sanitation and funded sewage treatment, but had no regulatory power to compel improvements in water quality. The importance of environmental conservation was noted, but execution of the act was in the hands of the surgeon general. The antecedent for the dredge-and-fill permitting program is the Rivers and Harbors Act of 1899 (RHA), which charged the U.S. Army Corps of Engineers with protecting the integrity of navigable waterways by establishing a permit program to regulate any dredging or filling of harbors or rivers.

The RHA permit program still exists, and many projects in coastal and riverine wetlands require both a CWA and RHA permit. There was no antecedent for the NPDES permit program. The name of the act was changed to the CWA with the 1977 amendments. Other changes included the addition of exemptions for agriculture and other activities from the 404 permit program, and clarification that CWA jurisdiction covers "waters of the United States" as defined by EPA.

Because the CWA empowers the Corps to require a permit for activities that impacts waters of the United States, it potentially represents a vast expansion of federal power: Many kinds of dryland activities eventually impact water. The CWA has thus been the source of much concern from property-rights advocates, who have argued against an expansive conception of "waters," and against the Corps' power to conduct an analysis of the secondary and cumulative impacts associated with proposed dredge-and-fill projects. This struggle has resulted in legal precedents that require a "significant nexus" between the activity and the integrity of navigable water in order for CWA jurisdiction to apply. The nature of this "nexus" is not currently clear, and will be the subject of future litigation.

The Corps' long experience in water resource permitting under the RHA, as well as the political resistance to allowing a potentially powerful regulatory program to be administered entirely by the EPA, led the act's authors to have the Corps administer the permit program. The EPA was given the power to veto permits, to set the environmental criteria by which permits would be issued, and to define "waters of the United States." The Corps resisted this arrangement strenuously throughout the 1970s, arguing that it was duplicative of the RHA, adopted a definition of "waters of the United States" that excluded wetlands, and often handed out permits without reviewing project plans. The *NRDC v. Callaway* decision in 1975 forced the Corps to adopt a definition of "waters" that was expansive (and was incorporated into the 1977 CWA), and the 1984 settlement in *NWF v. Marsh* forced the Corps to adopt EPA's guidelines on the environmental criteria for permit approval.

POSITIVE RESULTS

While the wetlands permitting program has been controversial, it has resulted in a reduction in net loss of wetlands, documented in five-year reports by the U.S. Fish and Wildlife Service. In fiscal year 2005, the Corps issued permits allowing approximately 20,000 acres of wetland impact, and required approximately 57,000 acres of compensation. In contrast, the EPA administers the NPDES permit program at the federal level, but the setting of water quality standards is performed by individual states, subject to EPA approval. The slow process of setting pollutant-specific effluent standards (Total Maximum Daily Loads) that are compatible with the state-determined designated use for each individual water body is still unfolding unevenly across the country. While the zero-discharge goal has proved unrealistic, the effect of point-sources has been reduced and the effect of nonpoint source pollution (such as agricultural runoff that is not regulated by the CWA) has been thrown into sharp relief. Nonetheless, the effect of the NPDES program is visible in the dramatic recovery of Lake Erie water quality and fisheries, the improvement of previously dead rivers in the industrial northeast, and the drive to develop the technology that allows polluters to meet or exceed required effluent reductions.

SEE ALSO: Nutrients (as contaminants of water); Pollution, Sewage and Sewer Systems; Total Maximum Daily Loads (TMDLs); Water; Water Law; Wetlands; Wetlands Mitigation.

BIBLIOGRAPHY. Robert Adler, Jessica Landman, and Diane Cameron, *The Clean Water Act 20 Years Later* (Island Press, 1993); Robin Kundis Craig, *Clean Water Act and the Constitution* (Environmental Law Institute, 2004); Mark Ryan, *The Clean Water Act Handbook* (American Bar Association, 2004).

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Clear-Cutting

CLEAR-CUTTING IS A logging method is which whole stands of trees are non-selectively harvested over a relatively large area. The goals of the technique are to maximize economic efficiency in harvesting or create conditions to re-establish stands of trees species that require sunlight for growth, or both. As an economic efficiency measure, it allows loggers to access and remove all of the valuable older trees without having to work around protected trees and younger trees of lesser value. As an ecological management tool, it allows large contiguous areas to be opened to sunlight and regrowth.

Clear-cutting has been controversial since World War II, when it became the dominant logging method in U.S. national forests; some foresters see it as a beneficial and legitimate logging method, while some environmentalists find clear-cutting to be environmentally detrimental. Silviculturists propose clear-cutting as a necessary practice for even-aged forest regeneration: to remove trees that have been impacted by disease and/or insects; to convert land to a new tree species through planting or seeding; to provide forest habitat for species that rely upon edge and high-density, even-aged stands; and to mimic the effects of large-scale, catastrophic wildfires or hurricanes.

Conservationists, on the other hand, point to the detrimental effects of clear-cutting, since the practice can result in fragmented landscapes, landslides, increases in flammable "slash" left on forest floors, watershed degradation, habitat degradation and loss, soil erosion, soil temperature increases, aesthetic blight, species extinction, and loss of a forest's age and species diversity.

DOMINANT METHOD OF LOGGING

Clear-cutting, while financially efficient, a useful management tool, and historically a standard practice, is often applied to forests that do not benefit from the practice. During the 1970s, it is estimated that clear-cutting took place on more than 250,000 acres each year, or an acre every two minutes. On June 4, 1992, the U.S. Forest Service, in response to the public outcry against clear-cutting, announced it would reduce clear-cutting by 70 percent from 1988 levels. Yet clear-cutting remains the dominant method used for logging the U.S. national forests. Many bills have been introduced unsuccessfully in Congress to ban the use of clear-cutting in national forests.

Temperate rainforests in both the United States and Canada have experienced extensive clear-cutting, and it remains the major method used to fell forests. For instance, in the Canadian province of British Columbia, government-sanctioned clear-cutting is the dominant method of timber extraction for industrial purposes and the main cause of species endangerment for northern spotted owls; 70 percent of Vancouver Island has been clear-cut.

In underdeveloped countries, legal and illegal clear-cutting goes on unchallenged. Clear-cutting of tropical rain forests for wood exports and non-native tree plantations in Brazil, Congo, Indonesia, Malaysia, and elsewhere contributes to global warming and reduces biological diversity. According to the Rainforest Action Network, the world has already lost 80 percent of old growth forests worldwide, and less than 5 percent remain in the United States.

According to the United Nations, at least 37.5 million acres of rainforests are lost annually, an area the size of Georgia. Despite the relatively small land area they cover, rainforests are home to about half of the 5–10 million plant and animal species on the Earth.

SEE ALSO: Deforestation; Endangered Species; Forest Management; Forest Service; Habitat Protection; Rain Forests; Timber Industry.

BIBLIOGRAPHY. Adela Backiel and Ross Gorte, *Clearcutting in the National Forests: Environment and Natural Resources Policy Division Report for Congress* (Congressional Research Service, 1992); Northwest Environment Watch, "Forest Scorecard," www. northwestwatch.org (cited March 2006); Rainforest Action Network, "Who We Are," www.ran.org (cited March 2006); Society of American Foresters, "Policy and Press," www.safnet.org (March 2006); Western Canada Wilderness Committee, "WCWC Calls for Clayoquot Scientific Panel," www.joyx.joensuu.fi (cited March 2006)

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Clements, Frederic E. (1874–1945)

FREDERIC CLEMENTS WAS A founding figure in ecology, whose theory of plant succession helped consolidate the discipline in the early 20th century and continues to influence both scholarly and lay thinking about vegetation dynamics to this day.

Born in 1874 in Lincoln, Nebraska, Clements studied under Charles E. Bessey at the University of Nebraska, where he earned a bachelor's degree in 1894 and a doctorate in 1898. Surrounded by the rapid conversion of prairie to farmland, he conducted exhaustive inquiries into native grasses in the Great Plains, pioneering the use of the quadrat as a method of quantitative measurement of vegetation. His *Phytogeography of Nebraska* (1898, coauthored with Roscoe Pound), *Development and Structure of Vegetation* (1904), *Research Methods in Ecology* (1905), and *Plant Physiology and Ecology* (1907) established him as a leading figure in the nascent field of ecology, and in 1907 he accepted the post of Professor and Head of the Department of Botany at the University of Minnesota.

Clements expanded his fieldwork to the entire western United States, and in 1916 he completed his magnum opus, *Plant Succession: An Analysis of the Development of Vegetation*. The publisher, the Carnegie Institution of Washington, hired him away from Minnesota the following year and employed him until his retirement in 1941. Throughout his Carnegie career he worked summers at the Alpine Laboratory below Pike's Peak in Colorado; he spent winters at the Desert Laboratory in Tucson until 1925 and subsequently at a coastal ecology laboratory he established in Santa Barbara, California.

The central idea of Clements' theory was that units of vegetation he termed *formations* are "complex organisms" with determinate life histories. Each formation passes through a fixed sequence of "seres," or seral stages—e.g., lichens, annual grasses, perennial grasses, and trees—on the way to climax, at which point equilibrium is obtained between the vegetation, soil, and climate. Succession was the process by which formations developed through their stages. *Plant Succession* opened with the claim that this theory was "of universal application" and that it "represents the only complete and adequate view of vegetation." Four years later Clements published *Plant Indicators,* a companion volume on how to apply the theory to practical matters of agriculture and range management. Both books contained descriptions of the formations of western North America.

Upon Clements' death in 1945, A.G. Tansley wrote presciently that a theory "may be overstated, it may contain flaws which make it unacceptable in its entirety; but if it also contains, as Clements's did, a general idea of the first importance on which subsequent advance can be based, its originator's name can never be forgotten." During his lifetime, Clements's ontological claim for formations as organisms was strongly disputed, most scathingly by Henry Gleason in a 1926 journal article, "The Individualistic Concept of the Plant Association."

The field of range science, heavily indebted to succession, has struggled mightily to find an alternate theoretical paradigm; and in recent decades Clementsianism has become almost synonymous with *equilibrium ecology*, now deemed anachronistic or at least inapplicable in many contexts. Yet it seems plant ecology cannot but rely on something like successional theory to organize its myriad observations of vegetation change.

SEE ALSO: Ecology; Plants.

BIBLIOGRAPHY. Frederic Clements, *Plant Succession and Indicators: A Definitive Edition of Plant Succession and Plant Indicators* (Hafner Press, 1973); William S. Cooper, "Sir Arthur Tansley and the Science of Ecology," *Ecology* (Vol 38, No. 4, 1957); Henry A. Gleason, "The Individualistic Concept of the Plant Association," *Bulletin of the Torrey Botanical Club* (53: 7-26, 1926).

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Climate

CLIMATE IS THE average of weather conditions over a period of time, usually over several years. Climate may be local, regional, or global. In contrast, weather is the condition of the air in the atmosphere of a local environment at any moment. The locality may be as small as the place where a person is standing, or it may be as large as a region affected by a giant air mass. The weather or atmospheric conditions may be hot or cold, dry or humid, rainy or dry, windy or calm, cloudy or clear in combination.

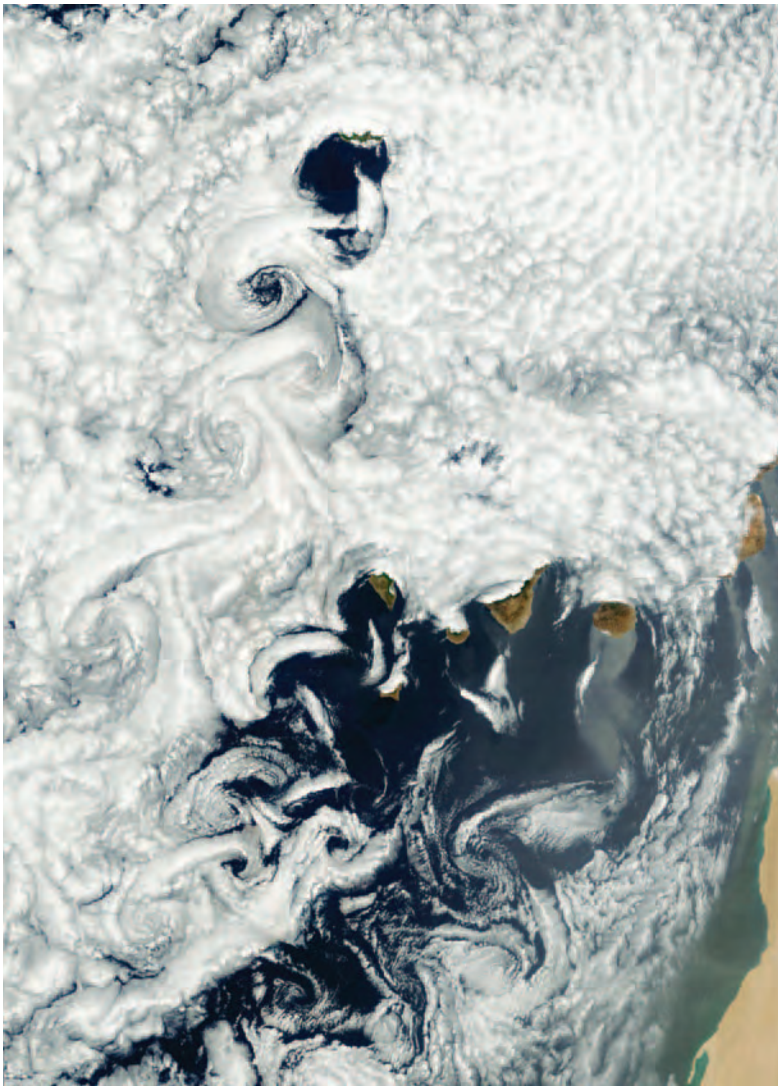
Climate is usually defined with two measures of atmospheric conditions: temperature and precipitation. Therefore, the climate of every country, land formation, region, town, continent, or even the whole planet is defined in terms of the amount of its average precipitation and its average temperature.

The characteristic atmospheric conditions of locations on the surface of the earth define its climate. A description of the long-term weather of an area (at least 30 years) defines its climate. The description should include the general pattern of weather conditions, seasons, weather extremes of storms—tornados, hurricanes, typhoons, cyclones, or blizzards—droughts, and rains over the climatic period.

Climate is affected by a number of factors. These factors include latitude; proximity to great lakes, seas, or an ocean; prevailing winds; type of vegetation; monsoon winds; mountain ranges; and the size of continents, versus an island or an island archipelago. The climate determines whether an area is a desert, forest, savannah, jungle, or tundra. Some areas have virtually the same climate year-round, such as the high mountains of Mexico and some tropical islands, both of which are near the equator. In other places, the climate varies with the season.

Temperature and precipitation varies with the season for most places on earth. It is, therefore, necessary to specify seasonal climate. For example, the winter climate of Ontario, Canada and its summer

Over the Canary Islands off the African coast, eddies create turbulent patterns called vortex streets.



climate are different: the winters are much colder than are the summers. While Ontario's daily and nighttime temperatures for every month of the year could be totaled and averaged, the results would probably not be very useful. More accurate would be averaging the temperatures for each separate season, which would give its winter climate in contrast with its summer climate. The same principle is used to describe the climate of every location on earth.

The climate in different locations is directly affected by the sunlight that reaches earth. The equator has about the same amount of sunshine year round, as it is perpendicular to the sun. The rest of the earth's surface receives varying amounts of sunlight from day to day throughout the year. This variation is a factor in the climate in different places around the world, and makes the seasons differ in their temperatures. Temperature affects winds, which bring or drive away moisture (usually from the oceans) and therefore the amount of precipitation. The variations in sunlight throughout the year make it summer in the northern hemisphere while it is winter in the southern hemisphere. Along with local conditions, sunlight variations contribute to the climate of localities and regions.

In 1900, Vladimir Koppen introduced what is now known as the Koppen Climate Classification System. It is widely used for classifying climate globally; most climate classification systems currently in use are based on it. Because climate is concerned with long-term weather patterns at the surface of the earth, Koppen organized the world's climate areas by their patterns of vegetation and soil.

CLIMATE CLASSIFICATION SYSTEM

Koppen's classification system has five major climate types that are based on the monthly and annual averages of temperature and precipitation: Moist Tropical Climates, Dry Climates, Humid Middle-Latitude Climates, Continental Climates, and Cold Climates. Moist Tropical Climates are designated with a capital *A* and have high temperatures almost every day as well as heavy rainfall. Dry Climates are designated with a capital *B* and are characterized by small amounts of rain and widely varying temperatures between night and day. This type of climate has two subtypes: semiarid (steppe) and arid (desert). The Humid Middle-Latitude Climate—designated with a capital *C*—is greatly influenced by land and water differences. The summers are warm and dry while the winters are cool and wet. Continental Climates are designated with a capital *D* and are located in the interior of large landmasses. Here, seasonal temperatures vary and precipitation is usually low. Finally, Cold Climates—designated with a capital *E*—are regions covered in permanent ice; these can be the polar regions, but may also be the tops of mountains. The Koppen system also used many sub-categories to classify variations in climate, which are designated with lowercase letters.

The major climate types around the world are polar, temperate maritime, Mediterranean, subtropical, desert with cold winter and hot summer, "Chinese," equatorial, tropical maritime, tropical, desert, temperate continentals, and polar. These climates types are so widespread, they can be referred to as climate zones.

Polar climates have long, cold winters with almost no daylight. The summers are short with very long days. They are characterized by permanent snow, ice packs, freezing temperatures, and extreme weather. The angle of the sun to the north and south poles is such that the sun's rays glance off the earth. Sunlight also has to travel through more of the atmosphere to reach the poles, which are at an angle to its rays, reducing the amount of sunlight that reaches the pole. In addition, the white ice cap reflects much of the sunlight, which adds to the lack of warmth.

Temperate maritime climates are humid year-round. The winters are not harshly cold, and the summers are warm to hot and humid. In temperate countries such as France, it is rare for the temperatures to be too hot or too cold. Moreover, the average precipitation usually varies no more than ten percent from year to year. The climate in France is complicated because it is at the junction of several climates. When the wind is from the north, the air is cool or cold and often clear, bringing a hint of polar climate. When the wind blows from the Atlantic Ocean, it brings moisture and usual rain and wind but mild temperatures. Western France has a temperate maritime climate. In general, the wind in France is westerly from the Atlantic, which gives the country a moderate and moist climate. When the wind in France is from the east, it brings a continental temperate climate. The winters in eastern France are longer and colder with more snow. In the summer, they are cooler with warm and rainy periods of thunderstorms. If the wind in France is from the south, the temperatures are usually hot and dry due to its Mediterranean climate found along its Mediterranean shores.

The Mediterranean climate, in which grapes and olives grow well, is found in Australia, California, Chile, and South Africa, as well as around the Mediterranean. The Mediterranean climate is mild and dry in summer and winter. It is wet in spring and prone to forest or brush fires in the summer. The autumn is moderate but may also be rainy. The Mediterranean climate is wet in the springtime, which causes vegetation to grow rapidly. However, the dry summer heat withers the vegetation and makes it prone to brush fires or to forest fires.

South of France and across the Mediterranean is a region of subtropical climate in North Africa. Along the Mediterranean coast, in North Africa, the Mediterranean climate soon gives way to the south to temperature increases in the subtropical climate that is usually dry.

To the south is the great Sahara Desert, which has a desert climate that is scorching hot in the day, but freezing cold at night. In winter, temperatures may be cold enough to freeze water. Cold desert climates such as that of Mongolia are cold in the winter and hot in the summer. Snow and rain occurs occasionally in winter and summer.

In contrast, across the Atlantic, the Gulf Coastal Plain of the southern United States has a moist subtropical climate that becomes more and more tropical as the equator is approached. This type of climate is sometimes referred to as a "Chinese" climate because the southeastern United States and China have mild, semi-dry winters with hot, moist summers.

The equatorial regions have in some places little change throughout the year. For example, the region of the Congo River is near the equator, where the sun shines directly overhead all year. The high moisture content and the constant temperature cause clouds year-round. However, equatorial climates have seasons that alternate between the wet season and dry season.

Tropical maritime climates are like equatorial climates because they have summer year-round. However, the rainfall pattern is different, and the trade winds moderate the temperature.

Climate varies with a number of factors besides the season or the latitude. One factor affecting climate is the elevation of an area.

MOUNTAINS AND VALLEYS

Mountain climates are not the same as the climate of a plain. In mountain zones, altitude causes a change in temperature. Climate is vertical: the higher the altitude, the thinner the air becomes. Thin air, especially thin dry air, holds less heat than warm moist air at sea level. So severe is the climate in mountain zones that nothing survives above 23,000 feet (7,000 meters). At that altitude and above, winds are usually fierce and temperatures so low that living cells are quickly frozen. Mountain zones occur all over the earth. There are mountains in the tropics—like Mount Kilimanjaro—which are near the equator, but are snow-covered on their summits all year long. The flora of mountain climates is different from those found at lower altitudes. Alpine plants have short stems that keep them hugging the ground out of the wind. Their leaves are small and waxy to prevent water loss, and they grow slowly because they grow only on warm days.

The climate of a valley below may also vary with their direction, in terms of the way in which sunlight is available or is blocked by a mountain. For example, one side of the valley may be shaded much more than the opposite side, giving the two sides of the same valley different climates. Valley climates can also be affected by winds from the ocean or by katabatic (down-slope) winds. The cooler, heavier air on top of a mountain can plunge rapidly down its slopes, bringing cold dry air to the valley below and forming frost hollows. The cold dry air of the katabatic wind can rob the plants in its path of moisture and stunt their growth. On the other hand, katabatic winds can cause fog by sending cooler air to the valley below, where the warm moist air is chilled to the dew point. In Greenland and on the Antarctic ice caps, katabatic winds have been clocked at 150 miles (240 kilometers) per hour. In temperate zones, katabatic winds can be an aid to agriculture. In Hungary and other regions where grapes are grown, katabatic winds at night can cool the grapes and promote their development. Otherwise, the nighttime heat would hinder viticulture.

Some mountain climatic zones have anabatic winds, which move up the slopes of mountains because the warm air in the valley is a sunny slope that warms quickly, sending warm air up the mountain.

Plate tectonics is one reason for global climate changes over the geological eras. These moving plates have carried the continents through different climate zones over the eons. Volcanic eruptions can also affect the weather for long periods, creating climate changes when enormous volumes of volcanic gas and ash are blown into the atmosphere, creating nuclear winters. These changes are similar to those believed to have been caused by an enormous meteorite or asteroid that hit the earth next to the Yucatan peninsula about 65 million years ago. The nuclear winter that it produced is believed to have been responsible for the extinction of the dinosaurs as well as a great number of other species.

In the last 400,000 years, it is believed that there have been five Ice Ages. Over the last 1 million years, there have been many more periods of global freezing. During Ice Ages, the earth was on average 5 degrees F (3 degrees C) cooler. This was cold enough for glaciers to form and cover half of North America. Glaciers also covered New Zealand and the Alps in Europe. Major Ice Ages include the Gunz Ice Age, 580,000 years ago; the Mindel Ice Age, 430,000 years ago; the Riss Ice Age, 240,000 years ago; and most recently, the Wurm Ice Age, which lasted 100,000 years and ended 20,000 years ago. There have also been "little ice ages." Between 1430 and 1850, the temperatures in northern Europe dropped enough to cause crop failure and starvation; the River Thames froze over every winter. However, there were also periods of sudden warming.

Interglacial periods have usually been shorter than glacial periods; the shortest lasted only 15,000 years. The present interglacial period has lasted about 9,000 years. In contrast, the shortest Ice Age lasted 60,000 years.

Long-Term Weather Cycles

The length of time of the average weather of a location, region, or of the whole earth is very important. It can last for a year, but usually the average weather is for a 30-year period. This may seem a long time in human experience, but it is an instant in geologic time. Periods of warming and cooling occur in a yet unpredictable pattern; it's very possible that the weather of a location or region experiences cycles of warming and cooling over a 30-year period. In fact, Between 1900–40, there was a warmer period with warmer winters, followed by a cooling period in North America from the early 1940s to the early 1970s. Scientists were concerned that another Ice Age was coming. However, after the mid-1970s, the climate began to warm again.

Descriptions of the climate based upon current weather records are weak. Accurate records of the weather have been kept for only about 150 years, and it is possible that weather cycles that form the climate move in 200-year cycles. Sensational journalism about the climate is usually based on inadequate averages. These overstated stories are prone to committing the fallacy of over-generalization, because they claim too much knowledge from too small of a sample. Statistical analysis of the climate is difficult simply because the data is limited.

The history of the climate of the earth begins at least three or four billion years ago, with the earth cooling enough to acquire an atmosphere. The atmosphere then was chemically quite different.

Evidence for climate changes has been found in tree rings and in the pollen record or other information found in core samples of ice drilled from glaciers such as those in Greenland. Fossil records show that there were ages in which the seas covered much more of the continents than they do today. There is evidence from fossilized pollen that some areas were warmer and others were wetter or dryer. Deposits of vast sand dunes point to areas that had a desert climate, when today the climate of that area is different. For example, fossils found in Antarctica suggest that it had a much warmer climate than its current polar climate.

The earth's climate is also affected by the long-term orbit of the sun. Revolving on its axis once a day and around the sun every 365 days (plus a bit more), the earth makes an ellipse. In addition, as the earth rotates, it is tilted from perpendicular by 23.5 degrees. The tilt is what makes the sun shine on the earth in varying ways so that it is heated unevenly, causing winds and seasons. The spinning earth on its axis in space is pointed in a particular position in the sky, a position that changes in a circular pattern. The pattern, which repeats itself every 26,000 years, is called *precession*.

A theory regarding the cause of the Ice Ages maintains that they all seem to have started and finished gradually. On the other hand, there is counter-evidence from Siberia where mammoths have been found quick-frozen while chewing flowers. This suggests that the Ice Ages started catastrophically, which may have been due to a shift in the tilt of the earth.

In addition to the earth's climate being influenced by its axial tilt, its orbit, which is affected by gravity, is a contributor. As the earth moves in 180 cycles in relation to the other planets' gravitations, influences may affect its speed enough to affect the lengths of summer and winter.

A COMPLICATED PROCESS

Climate change is a complicated process. For the climate to change, a combination of events must occur. There must be changes in the ocean temperature, the amount of clouds worldwide, the extent of polar ice, the amount of sunlight striking the earth, the position of the earth's orbit around the sun, and human activities. Human activity is the only factor that people can really control.

Clouds reflect sunlight, but they also retain heat. How much of a cooling effect by blocking sunlight and how much of a warming effect by retaining heat that clouds have is very difficult to determine. In addition, increases in moisture that the sun is evaporating over the vast oceans should lead to more clouds. However, with an increase in cloud cover, will the climate grow warmer or cooler?

Drought and winds can add dust to the atmosphere, which will block sunlight. The effect is often similar to the reflecting actions of clouds. However, if the dust includes metallic elements, it can reflect sunlight. On the other hand, it may absorb sunlight and promote climate warming. Volcanoes and great meteorites can contribute dust to the earth's atmosphere. The eruption in 1815 of the Indonesian volcano Tambora threw enough volcanic dust into the atmosphere to cause the "year without a summer" in 1816. Thousands starved because of the crop failures that were the result of very abnormal summer weather.

THE COMPONENTS OF THE ATMOSPHERE

The atmosphere is the envelope of gasses surrounding the earth. It comprises four layers: the troposphere, the stratosphere, the mesosphere, and the thermosphere. The term *atmosphere* comes from the Greek word *atomos*, meaning vapor. Atmospheric pressure is the weight of the air pressing against the earth at any given point. At sea level, the weight of the air is 14.7 pounds per square inch (1.03 kilograms per square centimeter) of surface. At places below sea level such as the surface of the Dead Sea, the atmospheric pressure is greater than one atmosphere. On mountaintops, the atmospheric pressure is less. This natural feature of the weight of the atmosphere at various places on the earth's surface is an important feature in the weather and in the climate. The gases in the atmosphere contain nitrogen (78 percent), oxygen (21 percent), argon (0.01 percent), water vapor (0.04 percent), and traces of neon, helium, krypton, and hydrogen. In addition, there are traces of ozone and carbon dioxide.

Ozone is produced in the atmosphere by lightening, and, as a greenhouse gas, is important for trapping heat in the atmosphere. If the amount of ozone in the atmosphere increases then it will have a warming effect. The ozone layer, which is very high in the atmosphere at a height of 18.5 to 31 miles (30–50 kilometers), is also important because it blocks ultraviolet light, which can cause harmful burns and eye damage and can promote skin cancer.

Carbon dioxide is a colorless, odorless gas that has an indirect effect on the weather. Small changes in the amount of ozone and carbon dioxide can have significant weather effects, mainly due to the greenhouse effect.

For human activities to affect the climate, it is likely that the changes needed would be those that affect the content of the atmosphere. However, whether human-caused changes in the atmosphere can produce predictable effects is a very hotly disputed issue. For example, chlorofluorocarbons, which were widely used in aerosol sprays and as refrigerants, have been found to be destructive of the ozone in the atmosphere. Human use of fluorocarbons appears to have damaged the ozone layer by creating a hole in the layer over the South Pole, which could have a dramatic cooling effect on the earth.

In the view of many people, the climate is in crisis. It is believed that current global warming is not completely natural, and responsibility is being assigned to human activities. The use of carbon fossil fuels since the late 1700s and the beginning of the Industrial Revolution has led to enormous quantities of wood, coal, natural gas, and petroleum being burned for heating, manufacturing, transportation, and other reasons, which has increased the amount of carbon dioxide in the atmosphere. Consequently, the increased carbon dioxide levels are believed to have caused the increase in the temperature of earth's climate—1 degree F over the last 100 years.

When fossil fuels are burned, they produce gases, the largest percentage of which are carbon dioxide. While this is a naturally occurring chemical, it is now believed to be contributing to global warming because of the greenhouse effect. Greenhouse gasses can come from sources other than just the burning of fossil fuels or wood. Methane can be produced by rice fields, garbage dumps, cattle, and pig wastes. It is 20 times stronger than carbon dioxide as a greenhouse gas.

The amounts of carbon dioxide and ozone in the atmosphere are normally relativly small. However, these gases retain energy from the sun, which keeps energy in the atmosphere. It eventually causes the surface of the earth to warm and contributes to the "greenhouse effect," which is a natural phenomenon of the earth's atmosphere. Without this effect, the biosphere of earth would not exist because the earth's climate would be too cold.

One theory of global warming argues that variations in the amounts of greenhouse gases in the atmosphere contribute to global warming and global cooling. While the burning of fossil fuels increases the amount of carbon dioxide in the atmosphere, a reverse process occurs when plants lock up carbon dioxide in plant material. If enough carbon dioxide were removed from the atmosphere, global cooling and another Ice Age could occur.

Concerns over global warming are about more than temperatures. A great number of species could become extinct. In addition, melting polar ice should cause sea levels to rise, flooding port cities, and inundating vast areas of the earth. In addition, the number and severity of tropical storms could greatly increase. Moreover, humans and livestock could undergo enormous stress from the increased heat and even starve if droughts caused crop failures.

Some scientists have predicted that global warming will increase by between 2–4 degrees F (2–5 degrees C) by 2030 unless the volume of carbon dioxide is drastically reduced. Other scientists have estimated that the amount of carbon dioxide in the atmosphere has increased 30–50 percent since 1900, and that it will continue to increase unless significant reductions are made in carbon dioxide emissions.

Deforestation is an indirect contributor to the increases in carbon dioxide in the atmosphere. Plants take up carbon dioxide for use in photosynthesis, and expel oxygen. Reductions in the number of trees globally has a deleterious effect on the atmosphere.

A region's climate is the factor that determines which plants and what animals will inhabit it. The world's biomes are a fabric woven from climate, plants, and animals. Global warming will drastically affect these biomes, destroying species and possibly causing drastic food losses and the death of billions of people. To stop the increase in carbon dioxide in the atmosphere, reductions in fossil fuel emissions, other emissions, and deforestation will be needed.

SEE ALSO: Atmosphere; Carbon Dioxide; Global Warming; Ozone and Ozone Depletion; Policy, Environmental; Precipitation; Weather.

BIBLIOGRAPHY. Edward Aquado and James Burt, *Understanding Weather and Climate* (Pearson Education, 2006); Greg Carbone, *Exercises for Weather and Climate* (Pearson Education, 2006); Brian M. Fagan, *Long Summer: How Climate Changed Civilization* (Basic Books, 2005); Tim Flannery, *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth* (Grove/Atlantic, 2006); Ross Gelspan, *Boiling Point: How Politicians, Big Oil and Coal, Journalists, and*

Activists Are Fueling the Climate Crisis—and What We Can Do to Avert Disaster (Basic Books, 2005); Al Gore, *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (Rodale Press, 2006); Dennis L. Hartmann, *Global Physical Climatology* (Elsevier Science & Technology Books, 1994); Elizabeth Kolbert, *Field Notes from a Catastrophe: Man, Nature, and Climate Change* (Bloomsbury Publishing, 2006); Eugene Linden, *The Winds of Change: Climate, Weather, and the Destruction of Civilizations* (Simon & Schuster, 2006); Bjorn Lomborg, *Skeptical Environmentalist: Measuring the Real State of the World* (Cambridge University Press, 2001); David M. Ludlum, *National Audubon Society Field Guide to North American Weather* (Alfred A. Knopf, 1998); J. Douglas Macdougall, *Frozen Earth: The Once and Future Story of Ice Ages* (University of California Press, 2004); Patrick J. Michaels, *Meltdown: The Predictable Distortion of Global Warming by Scientists, Politicians, and the Media* (Cato Institute, 2005); William F. Ruddiman, *Plows, Plagues, and Petroleum: How Humans Took Control of Climate* (Princeton University Press, 2005); Vincent J. Schaefer and John A. Day, *A Field Guide to the Atmosphere* (Houghton Mifflin Co., 1981); John H. Seinfeld and Spyros N. Pandis, *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change* (John Wiley & Sons, 2006); S. Fred Singer and Dennis Avery, *Unstoppable Global Warming: Every 1,500 Years* (Rowman and Littlefield, 2006); James Gustave Speth, *Red Sky at Morning: America and the Crisis of the Global Environment* (Yale University Press, 2005); Arthur N. Strahler, *Elements of Physical Geography* (John Wiley & Sons, 1984); Noriko J. Yokoi and Richard J. Chorley, *Atmosphere, Weather, and Climate* (Taylor & Francis, Inc., 2003).

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Climate Modeling

CLIMATE MODELING USES simple to highly complex mathematical formulas and computing power to simulate climate system processes. Climate-related processes often occur beyond the physical or temporal scale for laboratory experiments. Climate events such as *El Nino* occur over millions of acre-feet of water, or the retreat of entire continental ice sheets may take hundreds of years. Climate modeling simulates the behavior found in climate processes using state-of-the-art computer technology to provide timely results for analysis. The analyses of the climate model outputs use observed climate data (i.e., temperature or ice-core records) for comparison and basic knowledge of the climate system to understand the results. Climate modeling is used to understand past and current climates, or to predict future climates.

Essential components of climate modeling are *boundary conditions* (initial conditions), which are derived from observed climate data such as sea surface temperatures. Climate modeling uses *forcing* where the boundary conditions are changed (i.e., sea surface temperatures increased or mountain ranges removed) to simulate how a climate system will respond to these changes. The simulations and climate forcing use equations based on the known physical laws that drive climate. For example, increasing land-surface snow cover will increase the reflection of incoming solar radiation contributing surface cooling in the model output. A final step in climate modeling is the analysis of the climate data from the model output and a comparison of the results to a research hypothesis.

CHALLENGES TO CLIMATE MODELING

A challenge with climate modeling is that in the real world, many processes of the climate system occur on different spatial or temporal scales. For example, the uplifting of mountain ranges may occur over millions of years while land–surface heating and cooling occur over seasonal and diurnal periods. In order to deal with different spatial and temporal scales, researchers must determine what type of climate model to apply to simulate the climate processes and time period of interest. To simulate a climate process such as a monsoon, researchers may run the model for a time scale of several months or 100 years over specific geographic region. To simulate changes with significant movements of the continents, researchers may run the model to simulate for millions of years for the entire globe.

Climate modeling became a researching tool in the mid-1960s. The most simple climate models are zero-dimensional models, or *radiative equilibrium models*. These models are used to gain an idea of a planet's radiative temperature based on an assumed constant amount of incoming solar radiation and the planet's mass. For earth, these models calculate a radiative surface temperature of 255 K (0 degrees F). These models omit some of the known climate processes such as warming from greenhouse gases, hence the actual average surface temperature for earth is actually 288 K (59 degrees F).

There are two general types of one-dimensional climate models: *radiative-convective models* and *energy balance models*. The radiative-convective models were developed in the mid-1960s to analyze the thermal equilibrium of the atmosphere. These models calculate the temperature for each layer of the atmosphere based on the incoming solar radiation, surface temperatures, surface reflectivity, cloud cover, atmospheric pressure, and moisture content. Radiative-convective models are useful to our understanding of climate processes of temperature decreases with altitude or local temperature inversions. They are also useful in understanding local climate processes such as thunderstorm development. Energy balance models were developed in the late 1960s to calculate the amount of solar radiation absorbed or reflected by clouds and the earth's surface. These calculations are based on the amount of incoming solar radiation, cloud cover, and reflectivity at different latitudes. Energy balance models demonstrate how temperature decreases with increasing distance from the earth's equator.

In the early 1970s came the development of *two-dimensional climate models*. These models were a combination of radiative-convective models and energy balance models to simulate more realistic climate processes of the atmosphere. Two-dimensional climate models can represent a horizontal area representing the earth's surface or a horizontal and vertical surface representing a cross-section of the atmosphere. The two-dimensional climate models simulate climate processes of energy transport from the equator to the poles and the patterns of quasi-stationary high pressure and low pressure systems.

The climate models that aim to represent the spatial dimensions of the entire climate system are the *general circulation models* (GCMs). Boundary conditions for GCMs are set at points over a horizontal and vertical grid, representing the earth's surface and atmosphere. When simulations are run, mathematical equations relating to climate processes are solved for each point. The GCMs consider combinations of conditions related to climate such as seasonal incoming solar radiation, surface friction, cloud formation, coastlines, and mountain ranges. Although GCMs have more realistic simulations for the climate system, they do have limitations, such as the computational power for the simulation of model runs. The calculation of millions of numbers at grid points in a timely manner is a challenge for even the fastest computers. Advancements in computer technology at the world's leading atmospheric research institutions address these limitations.

The first GCMs were being developed concurrently with other early climate models of the 1960s. The early GCMs were derived from the numerical models used in the 1950s for short-term weather forecasting. A fundamental addition to GCM climate modeling was the development of *ocean GCMs* (*OGCMs*). The outputs from OGCM simulations are sea surface temperatures, sea-ice extent, and salinity, which provide boundary conditions for atmospheric GCMs. There has also been the development of atmosphere–ocean GCMs or *AOGCMs*, which combine the dynamic ocean processes (i.e., currents, temperature, and sea ice) with climate system processes to simulate climates over the globe. Because there are many other physical components and processes such as oceans that significantly affect climate, other types of models have been developed to be incorporated with GCMs. *Vegetation models* can simulate the impact a rainforest or deforestation has on local, regional, or global climates. *Ice-sheet models* can provide boundary conditions for the simulation of GCMs for glacial and inter-glacial periods for earth's climate history or future climate scenarios.

SEE ALSO: Climate; Climatology; Weather.

BIBLIOGRAPHY. R.G. Barry and R.J. Chorley, *Atmosphere, Weather and Climate,* 8th ed. (Routledge, 2003). M. Beniston and M.M. Verstraete, *Remote Sensing and Climate Modeling: Synergies and Limitations* (Kluwer Academic Publishers, 2001); M. Beniston, *From Turbulence to Climate: Numerical Investigations of the Atmosphere with a Hierarchy of Models*, (Springer, 1998);

V. P. Dymnikov, *Mathematics of Climate Modeling* (Basel, 1997); C. N. Hewitt and A. V Jackson, *Handbook of Atmospheric Science: Principles and Applications* (Blackwell Publishing, 2003); W. A. Robinson, *Modeling Dynamic Climate Systems* (Springer, 2001); W.F. Ruddiman, *Earth's Climate: Past and Future* (W. H. Freeman and Company, 2001); K.E. Trenberth, *Climate System Modeling* (Cambridge University Press, 1992); W.M. Washington, *An Introduction to Three Dimensional Climate Modeling* (University Science Books, 2005).

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Climate, Arctic and Subarctic

THE EARTH'S ARCTIC and subarctic climates are located over the highest latitudes of the globe, typically poleward of 50 degrees latitude. Because these climates are located at high latitudes, they are mostly driven by a dramatic seasonal shift of incoming solar radiation. The summer season consists of long daylight hours, while the winter season has long nighttime hours. Locations poleward of 70 degrees have 24 hours of daylight during their respective summers and 24 hours of night during the winter.

Subarctic climates are largely continental and unique to the northern hemisphere, due to the existence of large land masses between 50–70 degrees. Most of Canada and the interior regions of Siberia have subarctic climates, which can be distinguished by the presence of extensive coniferous forests with hardy deciduous trees such as aspen and larch intermixed. A key characteristic of subarctic climates is an annual temperature range greater than any other climate zone on earth. Winters typically have minimum temperatures between –50 and –30 degrees C (–32 and –22 degrees F), while summer maximum temperatures are as warm as 15–25 degrees C (59–77 degrees F). Subarctic climates tend to be moderately dry with total annual precipitation between 30–50 centimeters (12 and 20 inches). Winter snowfall is heavy, ranging from 150–300 centimeters (59–118 inches), with higher amounts occurring over locations near coastal areas such as eastern Canada or eastern Siberia.

Ice cap climates have subfreezing temperatures year-round. Snow pack and ice are permanent features.

Polar climates occur over oceans and land masses typically poleward of 60 degrees latitude. They exist where the warmest month of the year has a mean temperature less than 10 degrees C (50 degrees F). Polar climates exist over the Arctic Ocean, Antarctica, and far northern areas of Asia and North America (including Greenland). Despite perpetual daylight hours during the summer season, the sun's low angle and significant cloudiness (60–90 percent) permits only moderate surface warming. Polar climates have two climate subtypes, tundra and ice cap.

Tundra climates are distinguished by landscapes lacking forests, but covered in flowering plants, moss, lichen, and some shrub species. An additional characteristic for tundra climates is the existence of permafrost, a permanent, impermeable layer of frozen earth below the surface. Summers are short (6–10 weeks) and are defined by daytime temperatures between 0–10 degrees C (32–50 degrees F) providing just a long enough period for snow to melt and the upper layers of soil to thaw. Winter temperatures are cold, but can vary significantly depending on the proximity to certain coasts. Tundra environments in northern Scandinavia have winter minimum temperatures between –10 and –5 degrees C (14–23 degrees F), while in northern Alaska they are between –33 and –28 degrees C (–28 and –18 degrees F). Total snowfall and annual precipitation is slightly lower in tundra climates than in subarctic climates.

Ice cap climates have persistent subfreezing temperatures year-round. Although less snowfall occurs here than in tundra or subarctic climates, snow pack and ice are permanent features of the landscape. The ice cap climates occur over the Arctic Ocean, interior portions of Greenland, and 97 percent of Antarctica. High atmospheric pressure dominates over these locations; however, the climate is made severe by year-round wind storms and surface blizzards. The Antarctic boasts the earth's coldest recorded temperature of minus 89 degrees C (minus 129 degrees F).

SEE ALSO: Antarctica; Arctic; Tundra.

BIBLIOGRAPHY. E. Aguado and J.E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); J.C. King and J. Turner, *Antarctic Meteorology and Climatology* (Cambridge University Press, 1997); P.E. Lydolph, *The Climate of the Earth* (Rowman and Allanheld, 1985); D. Philips, *The Climates of Canada* (Minister of Supply and Services, Canada, 1990); R. Przybylak, *The Climate of the Arctic* (Kluwer Academic Publishers, 2003); W. Schwerdtfeger, *Weather and Climate of the Antarctic* (Elsevier, 1984); H.E. Wahl, D.B. Fraser, R.C. Harvey, and J.B. Maxwell, *Climate of Yukon* (Canadian Government Publishing Centre, 1987).

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Climate, Arid and Semi-Arid Regions

ARID AND SEMI–ARID climates exist where more surface moisture is lost to evaporation than gained from precipitation. Arid and semi-arid climates cover 30 percent of earth's land surface, a larger land area than any other climate. These climates have low annual precipitation, abundant sunshine, and high evaporation rates. The difference between the maximum daytime and nighttime minimum temperatures is wide, ranging from 15–20 degrees C (27–36 degrees F). Low precipitation in arid and semi-arid climates is influenced by the presence of semi-permanent, subtropical high-pressure areas located across the globe around 30 degrees latitude. These high-pressure zones are large areas of descending air aloft, limiting cloud development and precipitation.

Subtropical arid climates, such as the Sonoran Desert, Rub al-Khali, Sahara, and the Australian Outback, are located at lower latitudes within subtropical high-pressure areas. These areas have very low annual precipitation between 25–150 mm (1–6 inches), and experience extremely hot summers, with temperatures commonly over 45 degrees C (113 degrees F). The world's hottest, near-surface air temperature was 57.8 degrees C (136 degrees F) recorded at El Azizia, Libya in the northern Sahara.

Mid-latitude arid climates are defined as arid regions that have more than four months with mean temperatures cooler than 10 degrees C (50 degrees F). The Gobi and the Taklimakan Deserts of central Asia and the Great Basin Desert of the United States have mid-latitude arid climates. Mountain rain shadow effects are a common influence on mid-latitude arid climates. For example, in Asia, the Himalayas block the northward flow of Indian Ocean moisture from reaching the Gobi and the Taklimakan Deserts. Summers are cooler than subtropical arid climates, and winters can be below freezing. Kashi, China, in the Taklimakan Desert, has a winter minimum temperature of minus 11 degrees C (12 degrees F) and summer maximum temperature of 33 degrees C (91 degrees F).

The world's coastal arid climates are mainly located along the west coasts of South America (Atacama Desert) and southern Africa (Namib Desert). These climates typically have mild temperatures due to the adjacent cold ocean currents. The cold ocean waters limit convection and significant precipitation. Although overcast skies and coastal fog are frequent, these climates are phenomenally dry. On average there is only 10–20 mm (0.4–0.8 inches) of total annual precipitation.

The temperatures in semi-arid climates are generally similar to those of adjacent arid climates, but annual precipitation is higher. The largest areas of subtropical semi-arid climates are found in northern Mexico, the Sahel of North Africa, the Kalahari of southern Africa, and parts of the Australian Outback. Subtropical semi-arid climates average 500 mm (20 inches) of annual precipitation, which usually occurs during pronounced wet seasons. The vegetation in subtropical semi-arid climates consist of drought tolerant grasses, shrubs, and widely dispersed trees. The mid-latitude semi-arid "steppe" climates are found over central Asia and western North America. Annual precipitation ranges from 250 to 500 mm (10 to 20 inches) and cooler temperatures reduce the amount of moisture evaporated from the surface. The mid-latitude semi-arid climates are able to support significant low-lying vegetation consisting of bunch grasses and shrubs.

SEE ALSO: Australia; Climate; Kalahari Desert.

BIBLIOGRAPHY. E. Aguado and J.E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); R.G. Barry and R.J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003); A.S. Goudie, *Great Warm Deserts of the World: Landscapes and Evolution* (Oxford University Press, 2002); P.E. Lydolph, *The Climate of the Earth* (Rowman & Allanheld, 1985); B.A. Portnov and A.P. Hare, *Desert Regions: Population, Migration, and Environment* (Springer,1999).

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Climate, Continental

CONTINENTAL CLIMATES HAVE minimal influence from marine sources due to their location in continental interiors or upwind of coastal areas. In the humid mid-latitude regions of the Northern Hemisphere, continental climates are a buffer zone separating mild, subtropical climates from the severe sub-arctic climates. Continental climates are influenced by both arctic and tropical weather systems, where severe winters and hot, humid summer days both occur. The mid-latitude jet stream frequently flows over continental climate regions and drives mid-latitude storm systems accompanied by warm fronts and cold fronts.

Continental climates are similar to sub-arctic climates in that there is wide range in the annual temperature with cold winters and warm, occasionally hot summers. What makes continental climates unique is the day-to-day variability in weather and temperature. Winters are generally cold and sometimes severe; however, dry winds from the western mountains, occasionally bring temporary mild conditions. The Chinook winds of North America descend from the Rocky Mountains during the passage of dry weather systems and these winds can increase the temperature 15–25 degrees C (27–45 degrees F) in a matter of minutes. Even with occasional mild weather, winters in continental climates are more often cold and severe, as cities such as Moscow have experienced temperatures below –40 degrees C (–40 degrees F). Summer temperatures in continental climates are generally warm and humid; however, occasional subtropical influences can create extremely hot and humid conditions lasting 1–3 weeks. Chicago, for example, has an average July maximum temperature of 29 degrees C (84 degrees F), but summer temperatures over 40 degrees C (104 degrees F) with high humidity have occurred.

Precipitation in continental climates is higher than in sub-arctic or semi-arid climates. There is typically between 500–1000 millimeters (20–40 inches) of precipitation annually, which falls as snow in the winter and as rain showers throughout the rest of the year. Continental climates usually have more precipitation during the summer, and this characteristic is most pronounced in the continental climates of east Asia. In cities such as Shenyang, China, 400 mm (16 inches) of precipitation falls in the summer and 30 millimeters (1.2 inches) falls in the winter. Precipitation is also higher in continental climates located upwind of coastal areas in places such as New York City where 1100 millimeters (43 inches) of annual precipitation falls. The precipitation in continental climates support mixed deciduous/evergreen forests or a mix forests and grasslands in the drier regions.

Continental climates are found in Eurasia and North America. These climates are generally not found in the Southern Hemisphere due to the substantially higher ocean-to-land surface ratio and a more prevalent marine influence on climates. In Eurasia, continental climates can be found from eastern Europe and southern Scandinavia eastward through Russia. There are also continental climates found in Manchuria (northeastern China), North Korea, and northern Japan. In North America, continental climates begin east of the Rocky Mountains in the United States and southern Canada and extend east through the Great Lakes Region to the Atlantic Ocean. Some of the renowned world cities such as Stockholm, Moscow, Toronto, Chicago, and New York City have continental climates.

SEE ALSO: Climate; Climate, Arctic, sub, and Polar; Rocky Mountains;

BIBLIOGRAPHY. E. Aguado and J.E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); R. G. Barry and R.J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003); P. E. Lydolph, *The Climate of the Earth* (Rowman & Allanheld, 1985).

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Climate, Humid Subtropical

HUMID SUBTROPICAL CLIMATES are located in the lower mid-latitude regions of the northern and southern hemispheres. These climates typically have long humid summers and short, relatively mild winters. During the summer, humid subtropical climates are influenced by neighboring tropical zones and warm oceans. In humid subtropical climate zones, the subtropical jet stream is present in the summer, often bringing abundant moisture and thunderstorms. During the winter, humid subtropical climates are influenced by weather systems originating in tropical or continental climate zones. Occasionally, weather systems from subarctic regions can penetrate into subtropical regions, bringing severe cold lasting 2–3 days. The mid-latitude jet stream frequently moves over humid–subtropical climate regions in the winter, bringing mid-latitude storms and highly variable day-to-day weather.

Humid subtropical climates have shorter annual temperature ranges than those found in continental climates; however, these climates do have distinct seasons defined by temperature and, occasionally, precipitation. In cooler, humid subtropical locations, temperatures below freezing occur frequently in the winter, but in locations closer to the equator, temperatures below freezing may not occur every year. For example, winter nighttime and daytime temperature averages in Memphis, Tennessee are 0 and 10 degrees C (32 and 50 degrees F), respectively. In warmer humid subtropical locations such as Hong Kong, China winter nighttime and daytime temperature averages are 14 and 19 degrees C (57 and 66 degrees F), and temperatures below freezing are rare. Summer temperatures in humid subtropical climates are warm-to-hot with high humidity. Summer nighttime and daytime temperature averages in Brisbane, Australia are 22 and 29 degrees C (72 and 84 degrees F) and in Dallas, Texas, they are 23 and 36 degrees C (73 and 97 degrees F).

Precipitation in humid subtropical climates is typically high due to the proximity of warm oceans and tropical influences; however, droughts do occasionally occur. There is typically between 900–2000 millimeters (35–79 inches) of precipitation annually in humid subtropical locations. Precipitation also defines seasons in these locations, where a monsoon season is a significant climate feature. The seasonality of precipitation is present in the humid subtropical locations of south and east Asia. In New Delhi, India, October through May, on average, receives only 140 millimeters (5.5 inches) of precipitation, while June through September receives about 660 millimeters (26 inches), or 80 percent of the annual precipitation. Due to this variability of precipitation, both droughts and flooding can occur in humid subtropical climates. Coastal locations of humid subtropical climates are often impacted by tropical cyclones and hurricanes. The temperature and precipitation in humid subtropical climates support a mix of evergreen and deciduous forests or subtropical mixed forest and grassland in drier regions. Humid subtropical climates are located in the southeastern United States, southern Brazil, and northeastern Argentina. In Asia, humid subtropical climates are located in central India, southeastern China, and southern Japan. There are also locations with humid subtropical climates in eastern South Africa, and northeastern Australia. Major cities located in subtropical climates include Houston, Atlanta, Buenos Aires, Sao Paulo, Shanghai, and Tokyo.

SEE ALSO: Climate; Climate, Tropical; Hurricanes.

BIBLIOGRAPHY. E. Aguado and J.E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); R.G. Barry and R.J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003).

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Climate, Marine West Coast

MARINE WEST COAST climates are located in the mid-latitudes, usually on the west coast of continents along the Atlantic Ocean and Pacific Ocean. Specifically, marine west coast climates exist in Europe from northern Spain to southern Norway, including the British Isles, the west coast of North American from California to Alaska, and the southern coast of Chile in South America. Other locations include the east coast of South Africa, the southeast coast of Australia, and the islands of New Zealand and Tasmania. Major world cities located in marine west coast climates include Seattle, Vancouver, London, Paris, and Berlin.

Marine west coast climates have relatively cool, mild temperatures and receive frequent precipitation most of the year. Marine west coast climates include frequent precipitation and overcast skies, due to the proximity of these climates to the ocean and semi-permanent low-pressure areas. These low-pressure areas include the Aleutian Low of the North Pacific and the Icelandic Low of the North Atlantic. The low-pressure areas are most intense in the winter and are the origin of mid-latitude storms traveling eastward. In the Southern Hemisphere, the marine west coast climates are also located in the direct path of eastward-moving, mid-latitude storms.

A key characteristic of marine west coast climates is the moderating effect the ocean has on air temperature. Frequent cloudiness and overcast skies also moderate temperatures. In the summer, daytime maximum temperatures range from 15–25 degrees C (59–77 degrees F) and nighttime temperatures are usually 10–15 degrees C (50–59 degrees F).

Winters are mild; however, more poleward marine climates have colder winter temperatures and heavy winter snow. Depending on location, winter daytime temperatures may range from -4 to 10 degrees C (25–50 degrees F), and nighttime temperatures can range from –9 to 4 degrees C (15–40 degrees F). The warmest marine west coast climates are in South Africa and Australia, where freezing temperatures are rare. The coldest marine west coast climates are in southern Alaska and southern Norway, where winter temperatures are below freezing. In marine west coast climates, precipitation is more evenly distributed throughout the year than in neighboring Mediterranean climates. Some marine climate locations receive significantly high annual precipitation. For example, Dublin, Ireland, on average receives about 730 millimeters (29 inches) of precipitation annually, while Quillayute, Washington, receives about 2,600 millimeters (102 inches). Most marine west coast climates are wet; however, the variance in actual precipitation relates to the orographic features, which promote increased precipitation on their windward side and decreased precipitation on the leeward side.

Provided there are good, nutrient-rich soils and a sufficient growing season, many marine west coast climates are suited for agriculture. The natural vegetation biome types commonly occurring in west coast climates include deciduous, mixed, and evergreen forests. The coolest marine west coast climates such as those found in Norway and Iceland consist of subarctic-type grasses, sedges, and are treeless in some locations. The wettest marine west coast climates in the U.S., Canadian, and New Zealand west coasts have temperate rainforests with evergreen conifers and dense vegetation over the forest floor.

SEE ALSO: Climate; Climate Modeling; Climate, Continental; Climate, Mediterranean.

BIBLIOGRAPHY. E. Aguado and J. E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); R. G. Barry and R. J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003); P.E. Lydolph, *The Climate of the Earth* (Rowman & Allanheld, 1985).

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Climate, Mediterranean

MEDITERRANEAN CLIMATES ARE named after the type of climate along the Mediterranean coast in southern Europe, northern Africa, and the Middle East. However, Mediterranean climates also exist outside of this region in the coastal locations of southern Australia, western South Africa, coastal Chile, and California. Major world cities located in Mediterranean climates include Los Angeles, Rome, Santiago (Chile), Jerusalem, Cape Town (South Africa), and Adelaide (Australia). These climates are defined by relatively mild temperatures year-round, dry summers, and wet winters. Mediterranean climates are usually adjacent to the earth's subtropical deserts and come under the same influence of semi-permanent high pressure zones located over the Pacific, Atlantic, and Indian oceans. During the summer, the high-pressure zones that keep the earth's subtropical deserts dry also keep the locations with Mediterranean climates very sunny and dry. During the winter, the intensity of the high-pressure zones reduces, and these climates are subject to mid-latitude storms and precipitation. Mediterranean climates have cool winters, but rarely experience extreme cold or heavy snow.

Both the diurnal and the annual temperature range in Mediterranean climates decreases closer to coastal areas. This is mainly due to mild sea surface temperatures ranging from 15–25 degrees C (50–77 degrees F), which have a moderating influence on coastal land temperatures, especially in the summer. For example, in California, the coastal city of San Francisco and the inland city of Sacramento both have Mediterranean climates. The temperature during the winter for these two cities is similar; however, temperatures during the summer are much warmer inland, with daytime temperatures around 22 degrees C (72 degrees F) in San Francisco and 35 degrees C (95 degrees F) in Sacramento. The marine influence also makes coastal fog a common but short lasting occurrence in these climates. Mediterranean climates can be subject to rare but intense summer heat waves associated with winds from desert locations. These winds are called Santa Ana in southern California and Sirocco or Leveche from the Sahara.

Mediterranean climates are typically dry, but long growing seasons and winter precipitation enables the production of drought resistant crops such as grapes, dates, and olives. There is usually between 250–600 millimeters (10–24 inches) of precipitation annually in these climates with the majority of precipitation during the cooler months. In Athens, Greece approximately 370 millimeters (14.5 inches) of precipitation is received annually; however, 300 millimeters (12 inches), or 80 percent, is received from October through March. Precipitation in these climates can have significant inter-annual variability. Locations with Mediterranean climates can be subject to flooding during excessively wet winters or persistent drought, when winter precipitation is below average. The temperature and precipitation Mediterranean climates support chaparral, a vegetation biome consisting of scattered evergreen oak trees, shrubs, and grasses found in Mediterranean climates, and adapted to droughts and wildfires. Some of the most common vegetation include date palms, fan palms, eucalyptus trees, and cedar trees.

SEE ALSO: Climate; Climate, Continental.

BIBLIOGRAPHY. E. Aguado and J. E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); R. G. Barry and R. J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003); P. E. Lydolph, *The Climate of the Earth* (Rowman & Allanheld, 1985).

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Climate, Tropical

TROPICAL CLIMATES ARE located along the earth's equatorial belt between the latitudinal belts of the Tropic of Cancer and the Tropic of Capricorn. It is over these latitudes where the solar energy from the sun enters the atmosphere more directly than in higher latitudes throughout the year. There is also less of a seasonal shift in the solar energy coming into tropical areas than seasonal shifts that occur over higher latitudes. This means throughout the year, solar energy is high, and both the ocean and land surfaces over tropical latitudes are warm year-round.

Tropical climates, especially over oceans, have the lowest annual range in temperature than any other climate on earth. It is often the case that the diurnal temperature range in tropical climates exceeds the annual temperature range, which is usually only 3–6 degrees C (5-10 degrees F). Throughout the year, nighttime temperatures are usually between 21–27 degrees C (70–80 degrees F), while daytime temperatures are 30–35 degrees C (86–95 degrees F). Temperatures below 16 degrees C (61 degrees F) or above 38 degrees C (100 degrees F) are rare. High humidity and warm nights can make some days uncomfortable, although excessively high temperatures are rare. Much cooler temperatures, however, can be found within the tropical belt at higher elevations, especially in locations such as the Andes Mountains in South America.

In most tropical locations closest to the equator, the precipitation is high and some have a monsoon climate.

Tropical climates are also the most humid climates found on earth. These climates cover the highest amount of ocean surface than any other climate, and the intense amount of solar energy over tropical oceans creates a high amount of evaporation and cloud convection. Precipitation is frequent and heavy over tropical oceans and land areas, with an annual precipitation range usually between 79–157 inches (2,000–4,000 millimeters). Generally, in most tropical locations closest to the equator, the precipitation is high each month of the year, and there is no particular dry season. The world's tropical rainforests are found in these types of climates.

In tropical climates found in slightly higher latitudes, annual precipitation is high; however, there is usually a wet season and a dry season. Some tropical locations even have a monsoon climate. Often, areas of tropical climates with wet and dry seasons are the savannah areas between wet tropical and drier subtropical locations. Locations of wet and dry season tropical climates are found in the southern Mexican pacific coast, Venezuela, Brazil, the African savannah regions, India, southeast Asia, and northern Australia. The tropical monsoon climates have the greatest wet-to-dry precipitation regime. These climates are most prevalent on the African tropical west coast and tropical southeast Asia. In some locations, precipitation during the wet season amounts to more than 197 inches (5,000 millimeters). The tropical monsoon climates occur where there are seasonal changes in the surface heating of the land and the oceans. During the season when more solar energy is directed over the oceans, dry air flows over the land toward the ocean, where convection occurs and the land areas remain dry. When the season changes and more solar energy is directed over the land surface, the winds shift and bring moisture from the ocean surface over the land, where convection and precipitation occur.

SEE ALSO: Monsoon; Climate, Humid Subtropical; Savanna; Brazil; Venezuela.

BIBLIOGRAPHY. E. Aguado and J.E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999);

R.G. Barry and R. J. Chorley, *Atmosphere, Weather, and Climate* (Routledge, 2003); P.E. Lydolph, *The Climate of the Earth* (Rowman & Allanheld, 1985).

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Climatology

CLIMATOLOGY IS A branch of the atmospheric sciences that focuses on long-term (monthly and longer) patterns of weather and atmospheric circulation, in contrast with meteorology, which focuses on understanding and predicting short-term weather phenomena. While climate is often described as the "average weather" of a place, it is better considered as the aggregation of all the statistical properties of the atmosphere, including averages as well as measures of the expected variability and persistence over time of atmospheric elements such as temperature, rainfall, or humidity. In other words, climate includes not just averages, but is the total picture of the behavior of the atmosphere for the globe or a region. Climatologists seek to understand the mechanisms within the earth system that produce spatial patterns in climate, as well as the causes and implications of climate variations over time scales ranging from months to millennia and longer. In recent decades, a particularly important focus within climatology has been the question of whether and how human activities have caused changes to the climate system.

The climate system refers to all of the various boundary conditions that influence global and regional climates. Examples include the brightness of the sun, the configuration of the continents and ocean basins, the tilt of the earth on its axis, the shape of the earth's orbit, and the concentration of greenhouse gases in the atmosphere. These boundary conditions change at a variety of time scales, both naturally and due to human actions, and the interaction of these factors produces complex variations in climate patterns over space and at a wide range of time scales.

Within climatology, there are many subfields, each of which approaches the study of the climate from a unique perspective. One of these fields is paleoclimatology, which attempts to reconstruct past climate patterns from the evidence of ice cores, ocean sediments, tree rings, and other types of geophysical evidence that provides a look into how global and regional climates varied over millions of years. Paleoclimatology has a great deal of applicability to the field of anthropology, as climate variations likely played a role in the cultural development and movement of our human ancestors. In addition, paleoclimatology is useful in the modeling of future climate change, as past climates provide examples of the kinds of climate patterns that are possible given particular configurations of boundary conditions.

Climatologists are also interested in identifying and explaining the spatial patterns of climates across the earth's surface. Climate classification schemes use variables like temperature and rainfall to identify particular climate types (such as tropical, arid, or polar), which can then be explained in terms of climate-controlling factors like latitude, elevation, proximity to the coast, or atmospheric circulation patterns. One of the most famous of these classification systems is the Koeppen System, which divides climates into five general categories based on temperature and moisture patterns. Climate classification provides useful descriptions of large-scale climate conditions, which is valuable in understanding spatial patterns of biomes as well as the types of human activity (such as agriculture) that are likely in particular areas.

Synoptic climatology is the study of persistent atmospheric circulation patterns and the ways in which these patterns influence regional climates. Synoptic climatologists identify patterns in the atmosphere that have a tendency to recur on a regular basis, and statistically analyze how these patterns influence regional weather. Of particular importance are *teleconnections patterns*, in which widely separated parts of the earth's surface are linked together through atmospheric circulation. For example, the El Niño—Southern Oscillation links temperature and precipitation in the United States to sea surface temperatures in the tropical Pacific Ocean.

A final major focus of climatology is the development of sophisticated computer models of the global climate. These models use current knowledge of the climate system and the physical laws controlling the movement of mass and energy through the system to produce scenarios of how the climate might respond to particular boundary conditions over decades and centuries. Introducing variations into the model, such as increasing or decreasing the concentrations of greenhouse gases, allows climatologists to understand how the climate may respond to human activities, and to therefore assess the long-term risks of such issues as global warming.

SEE ALSO: Atmosphere; Climate; Climate, Arid and Semiarid; Climate, Continental; Climate, Humid Subtropical; Climate, Marine West Coast; Climate, Mediterranean; Climate, Arctic and Subarctic; Climate, Tropical; Climate Modeling; El Niño–Southern Oscillation; Global Warming; Greenhouse Gases; Ice Core; Paleoclimatology.

BIBLIOGRAPHY. Edward Aguado and James E. Burt, *Understanding Weather and Climate,* 3rd ed. (Prentice-Hall, 2004); Richard B. Alley, *The Two-Mile Time Machine* (Princeton University Press, 2000); Reid A. Bryson, "The Paradigm of Climatology," *Bulletin of the American Meteorological Society* (v.78/3, 1997); Brian Fagan, *The Long Summer: How Climate Changed Civilization* (Basic Books, 2004); Greg O'Hare, John Sweeney, and Rob Wilby, *Weather, Climate, and Climate Change: Human Perspectives* (Prentice-Hall, 2005).

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Climax Communities

A CLIMAX COMMUNITY is an idealized assemblage of plant species that represents the most advanced stage of development that can be reached for a given climate and given enough time free from disturbance. The idea was originally formalized by Frederic Clements in 1916, and went on to form the basis of the superorganic worldview of nature, community ecology, synecology, and homeostatic equilibrium models of ecosystems.

The basic premise behind the climax community is that climate is the primary determinant of vegetation communities. The community forms over long time periods, with the member species evolving in competition, and in the final climax stage, having coevolved to the point of being mutualistic. In this sense, every species in the community plays a vital role in the whole community, which acts as a single organism with constituent species comprising the organs. This analogy, whereby nature is viewed as a single living being or a fellow being to humans, is called the superorganic model. Lovelock's Gaia Hypothesis, in which the entire biosphere is viewed as a single organism, is an expression of the superorganic model. Clements's climax communities, however, included only plant species. Animals were excluded, as were their various competitive interactions. Clements, by focusing exclusively on the causal role of climate in forming climax communities, thus overlooked the importance of trophism, which includes herbivory and is now well understood to be an important factor in the formation of vegetation communities.

Clements viewed disturbance to natural ecosystems as an undesirable anomaly. Any disturbance, whether anthropogenic or natural, alters the structure and composition of a community, and hence removes it from the climax state. Clements termed such a disturbed community a *disclimax*. Any vegetation community not in its climax state would undergo a series of changes, termed *succession,* until it reached that final climax. Each stage of succession was expressed by a distinct assemblage of plant species. For example, the earliest stages of succession would exhibit a high occurrence of pioneer species (typically sun-loving, shade-intolerant species with high rates of reproduction, produce numerous propagules, disperse widely and have short life cycles). As the community approached its climax, shade-tolerant species with longer life spans characterize these assemblages. These distinct communities associated with the various successional stages were termed *seres*.

SEE ALSO: Biome; Biosphere; Climate; Disequilibrium; disturbance; Equilibrium; Plants; Species; Succession.

BIBLIOGRAPHY. Frederic E. Clements, *Bio-ecology* (Chapman & Hall, 1939); Michael A. Huston, *Biological Diversity (Cambridge Studies in Ecology)* (Cambridge University Press, 2002); William Cronon, ed., *Uncom-*

mon Ground: Rethinking the Human Place in Nature (W. W. Norton & Company, 1996).

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Clinton, William Administration

WILLIAM JEFFERSON CLINTON (b.1946) was the 42nd president of the United States and served from 1993–2001. Al Gore, former U.S. senator from Tennessee, served as his vice president. The leading priorities of the Clinton administration included equality for all Americans, increased safeguards of the environment, and the international spread of democracy.

The popularity of these policies with the American public, combined with strong economic times, led to Clinton's high approval ratings throughout his presidency. Despite his popularity, he experienced several setbacks during his years as president. During the 1994 mid-term elections, the Republicans gained both houses of Congress. Many believed that the Republican wins were attributed to the strong turnout of religious conservatives who opposed Clinton's policies and questioned his ethics and moral behavior. The Republican-led Congress presented legislative roadblocks for Clinton. The agenda of conservatives clashed with the more liberal-leaning policies of the Clinton administration.

As a result of this political divide, legislative battles ensued, making it difficult for Clinton to push his policies through Congress. In the greatest showdown of his presidency, the Republican-dominated Congress tried to impeach Clinton for his questionable conduct with a former White House intern and accusations of perjury; however, the impeachment atempt failed.

Clinton held the presidency during a unique time in American history. With the recent collapse of the Soviet Union and its policies, the United States found itself in a new leadership role in the post-Cold War era. Clinton seized this opportunity to forge new consensus between government, business, and society. His policies ranged from helping poor Americans to promoting greater free trade globally. Another Clinton political priority was to find a viable, nationally based health care policy, which turned out to be a failure. Despite this setback, he forged ahead with other policies.

Clinton had particular success with environmental issues. For example, he campaigned to protect the environment through the Clean Air and Clean Water Acts. The Clinton administration further set environmental policies by empowering special interest groups in their quest to achieve their goals. Supported by the strongly pro-green vice president, Al Gore, the Clinton team pursued a variety of environmental goals that often came into conflict with the interests of big business.

The explosion of the Internet and mobile communications during the Clinton presidency led to the mobilization of social and nongovernmental groups. These groups used the new technologies to organize grassroots movements to galvanize support for certain policies in a swift and efficient manner—something that had not occurred before. Environmental groups, for instance, greatly benefited from the growing technology and used it to promote their agenda in new ways. Their efforts gave prominence to such issues as recycling, oil spill prevention/clean up, and land conservation. Global warming and the release of greenhouse gases into the environment were addressed through the adoption of the Kyoto Protocol, which aimed to limit emissions on an international basis. Clinton favored the use of market-based initiatives rather than government-sponsored regulation in managing environmental change.

SEE ALSO: Clean Air Act; Global Warming; Gore, Al; Kyoto Protocol.

BIBLIOGRAPHY. Neil Carter, *The Politics of the Environment: Ideas, Activism, Policy*, (Cambridge University Press, 2001); Bill Clinton, *My Life*, (Arrow Books, 2005); Douglas Trevor Kuzmiak, "America's Economic Future and the Environment: Shaping Tomorrow Through an Awareness of Yesterday," *Managerial Auditing Journal*, (v.10/8, 1995); William J. Clinton Presidential Library and Museum, www.clintonlibrary.gov (cited November 2006).

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Cloning

ARTIFICIAL CLONING IS the process of using a single cell from an organism and its genetic information to produce an identical duplicate organism. The procedure relies on asexual reproduction, thus assuring that the new organism is genetically identical to its single "parent" cell, and not a merging of two sets of genetic information (as in sexual reproduction). While the process of cloning occurs naturally and is essential for life, for example among many plants, the concept and practice of artificial cloning has become of considerable interest and controversy as modern technology has made it possible to clone larger animals and potentially even people. The ability to clone cells of nearly all living creatures in embryo form has become a mature form of technology that may be conducted in a large number of laboratories and in vitro fertilization (IVF) clinics around the world. Frogs were cloned in the 1950s and mice in the 1980s using such techniques as transferring DNA material from the cell of one specimen into an egg cell to be born from another after the original genetic material had been removed from that egg cell.

Artificial fertilization techniques, with re-implantation of externally cultured eggs, have made this a comparatively straightforward process. However, the ability to clone cells from an adult organism is significantly more difficult because the cells have divided and differentiated into a very large variety of specialized forms and, even though genetic material such as DNA is present in those cells, it is difficult to clone the cells and cause them to grow into other forms of specialized cells. The team led by the British scientist Ian Wilmut, who cloned the sheep Dolly, achieved this, and some startling successes have subsequently been reported. However, the importance of the technology and the value of its commercial potential have persuaded a number of scientists to falsify their results. The now disgraced South Korean cloning expert Dr. Hwang Woo-Suk is perhaps the most well known of these frauds.

Human cloning has become a very controversial subject, which has been lent additional urgency by imminent improvements in technology. Proponents of cloning point out its potential value in providing replacement tissue and organs for transplants or for combating disease. The techniques also make it possible to tackle genetic diseases. However, opponents of cloning argue from a variety of religious and ethical perspectives, claiming that obtaining the material that is to be worked upon can only be achieved through methods that are immoral. This is connected with the widely held belief that it is dangerous for scientists to manipulate genetic material, because it gives humanity power over life that should only be wielded by God.

ARGUMENTS PRO AND CON

It would be possible, according to this argument, for scientists to identify sets of people who are, and are not, considered acceptable. This troubles people who believe that all life is sacrosanct, and who fear Nazi-like programs of eugenics. Following the idea that the use of genetic manipulation might be used to improve the physical condition of people able to pay for the treatments, those who could not pay would remain in an inferior physical condition. Some argue that the technology will not halt at simply replacing damaged organs or other tissue, but will also have cosmetic functions, and this is considered unacceptable. These techniques would be particularly useful in livestock industries, especially once technical difficulties have been solved.

Much of this controversy is not directly related to human cloning, but also to developments that might arise from it. There has been much debate within the United States on the use of human stem cells in research. Research concerning public perceptions of this subject suggests that a modest majority is in favor of the research, apart from the Kingdom of Saudi Arabia and the United States, where the majority is opposed to it. Some state governments find their policy toward research to be motivated in part by the possible location of large research facilities and the financial rewards that would follow successful cloning breakthroughs.

SEE ALSO: Gene Therapy; Genetic Diversity; Genetically Modified Organisms (GMOs); Genetics and Genetic Engineering.

BIBLIOGRAPHY. Arthur Caplan and Glenn McGee, eds., *The Human Cloning Debate* (Berkeley Hills Books, 2006); Arlene Judith Klotzko, *A Clone of Your Own? The Science and Ethics of Cloning* (Oxford University Press, 2004); Ian Wilmut, and Roger Highfield, *After Dolly: The Uses and Misuses of Human Cloning* (Norton, W. W. & Company, 2006).

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Cloud Forests

CLOUD FORESTS (ALSO known as tropical montane cloud forests) are a rare and highly threatened type of evergreen forest found in the mountains of the tropics. Their name is derived from the fact that they are frequently enveloped by clouds and mist and are persistently wet. Cloud forests are mountain rain forests. The vegetation is characterized by dense canopies, reduced tree stature, and a high proportion of biomass as epiphytes, including an abundance of ferns, mosses, and bromeliads. Cloud forests cover less than 1 percent of the earth's land area, and just 2.5 percent of all tropical forests. They are found at elevations of 2,000–3,500 meters (6,500–11,500 feet) in large inland mountain systems, and as low as 500 meters (1,600 feet) in coastal mountains and tropical islands (such as Hawaii and Fiji). Sixty percent of cloud forests are in Asia (primarily in Indonesia, Papua New Guinea, and Malaysia). Twenty-five percent are in Latin America (Mexico, Central America, and Andean South America), and 15 percent are located in Africa (notably in the uplands of the Congo and east Africa).

Despite their scarcity, cloud forests are of great ecological and economic importance. The varied topographic and climatic conditions of mountain regions provide for a multiplicity of microhabitats. Cloud forests have high rates of biodiversity (total number of species) and endemism (species found nowhere else), reflecting their immense biological wealth, and yet most species are still unknown to science. Cloud forests cover only 1 percent of Mexico, but contain 12 percent of its plant species. Andean cloud forests make up 3.2 percent of the South American land area, but harbor 65 percent of the continent's endemic mammals. There are more than 1,000 species of orchids in the cloud forests of Peru. Cloud forests provide habitat for some of the earth's rarest and most threatened species, including mountain gorillas in Africa and the *quetzal* bird of Central America.

NATURE'S WATER TOWERS

Cloud forests have an important watershed function. Because they are frequently covered in clouds, they intercept and capture water that condenses on the vegetation. This cloud stripping ability can enhance net precipitation 20–60 percent beyond normal rainfall amounts. Feeding the headwaters of streams, they provide a year-round source of unpolluted freshwater for irrigation, urban water supplies, and hydroelectric power. Because cloud forests are located on steep slopes, they also protect the soil from erosion. Cloud forests are an important source of timber and fuelwood for local peoples, as well as food in the form of fruit and game. They also contain many medicinal and ornamental plants. Cloud forests draw tourists because of their beauty, unique mountain environments, and rare birds. They may also play a role in monitoring climate change because they are very sensitive to atmospheric variation.

Ninety percent of cloud forests are gone, making those that remain among the world's most threatened ecosystems. Yet, they have received much less attention than lowland tropical rainforests. As economies grow, human migrations to frontiers increase, land values rise, and demands for marginal land intensify, people increasingly encroach on this important, fragile, and unique resource. The biggest threat is land use conversion for subsistence and commercial agriculture.

Cattle grazing in Latin America and Africa, vegetable production in parts of Asia, and drug cultivation in the Andes and in southeast Asia are problematic. Timber harvest, especially in Asia, is a grave threat. In Africa, hunting, mining, and fires are concerns. Road building is another serious threat to cloud forests because roads provide access and permit deforestation and resource extraction. Roads also contribute to habitat fragmentation, which breaks up large areas of forest into smaller, biologically less productive patches, as well as accentuating the edge effect. Forest edges are subject to drying and are vulnerable to predators and invasive species. Cloud forests increasingly exist as islands in a sea of human-impacted areas.

Immediate action is required to protect cloud forests. The Mountain Cloud Forest Initiative was launched in 1999 under the auspices of the United Nations Environment Program (UNEP). Protected areas such as national parks are the main means of conserving cloud forests. More parks, as well as better management of existing areas, are needed. Many private reserves are being created, such as Monteverde in Costa Rica. Because local people frequently live in and around cloud forests and depend on them for their livelihoods, they need to be included in the management of cloud forests. Promoting sustainable farming systems can also help. Some landowners even receive payments for so-called environmental services that cloud forests provide. Finally, ecotourism can be a benefit because people will pay to see protected forests and the wildlife they support.

SEE ALSO: Climate, Tropical; Ecosystems; Ecotourism; Edge Effect; Habitat Protection; Rain Forests; Soil Erosion.

BIBLIOGRAPHY. Philip Bubb, Ian May, Lera Miles, and Jeff Sayer, *Cloud Forest Agenda,* (UNEP–World Conservation Monitoring Centre, 2004), www.unep-wcmc.org/forest/cloudforest (cited March 2006); Steven Churchill, Henrik Balslev, Enrique Forero, and James Luteyn, eds., *Biodiversity and Conservation of Neotropical Montane Forests* (New York Botanical Garden, 1993); Lawrence Hamilton, James Juvik, and F. Scatena, eds., *Tropical Montane Cloud Forests* (Springer-Verlag, 1995); John Roach, *Cloud Forests Fading in the Mist, Their Little Known Treasures* (National Geographic News, 2001).

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Club of Rome

THE CLUB OF Rome is an international think tank that includes a collection of scientists, entrepreneurs, civil servants, and former heads of state who contribute their collective experiences to foster a better understanding of diverse issues facing the globe. The group grew out of an April 1968 meet-

Aurelio Peccei

Aurelio Peccei was born in 1908 in Turin, Italy, and graduated with a degree in economics from the University of Turin in 1930. He went to study at the University of Paris, the Sorbonne, and then started working for the car manufacturer Fiat. In 1935 he led a successful Fiat mission to China. During World War II, Peccei became a convinced anti-Fascist—he had visited the Soviet Union as a student—and worked with the Italian underground until he was arrested in 1944. Peccei was tortured and nearly executed, but survived until the end of the war.

Returning to work for Fiat as divisional manager in 1946, Peccei took over their operations in Latin America, moving to Buenos Aires, Argentina in 1953. There he established the local subsidiary Fiat-Concord, which became one of the most successful automobile firms in South America, and served as chairman of the board of directors. He then returned to Italy, worked for Italconsult in Rome from 1957, and in 1964 became the president of Olivetti. In the following year he gave a speech at a meeting for an international consortium of bankers; this caught the attention of Dean Rusk, the U.S. Secretary of State. It also came to the notice of Jerman Gvishiani, the son-in-law of the Russian leader Alexei Kosygin. Independently, they made approaches to Peccei, which were to lead to the establishment of the Club of Rome in April 1968.

Throughout the 1970s, Peccei helped organize international meetings with a North-South summit held at Salzburg, Austria, in February 1974. he was Chairman of the Economic Commission for the Atlantic Institute in Paris, France. The last meeting he organized was for Development in a World of Peace, which was held in Bogota, Colombia, in December 1983. He died four months later in Rome, Italy.

ing of a similarly diverse collection of people from across the globe convened by Dr. Aurelio Peccei, an Italian industrialist, at the Accademia dei Lincei in Rome. Initial meetings for the Club of Rome culminated in the decision to study and offer policy alternatives on a varying array of problems, including poverty, environmental degradation, demographic issues, and urban expansion, to name a few. The Club of Rome considered conventional analyses to fall short of offering more complete explanations for what it called the *world problematique* or the social, political, economic, and environmental problems plaguing the world. Instead, it sought to understand these global issues by recognizing their complexity and interdependence. It further recognized that these problems were long-standing and required solutions that were holistic in approach, global in reach, and long term.

The Club of Rome is headquartered in Hamburg, Germany, and its membership includes active, associate, honorary and institutional members. There are no more than 100 active members representing a variety of backgrounds with a recognized history of work in the international sphere. They are elected for five-year renewable terms by the Club of Rome's Executive Committee. H. R. H. Prince El Hassan bin Talal of Jordon is the Club of Rome's current (2006) president, while other well-known current active members include Fernando Cardoso, Saskia Sassen, and Wolfgang Sachs. Honorary members include eminent world leaders, including Mikhail Gorbachev, Vaclav Havel, Juan Carlos I of Spain, Wangari Maathai, and Eduard Shevardnadze, whose global reputation can help forward the club's overall mission. Additionally, the club has national associations that coordinate the implementation of its policy and provide advice to decision makers in countries across the globe.

The club holds an annual conference to help stimulate research and interaction amongst its members and generate debate around pressing global issues. It commissions reports on issues of concern, and these also offer solutions and policy alternatives. The Club of Rome is perhaps best known for *The Limits to Growth* report published in 1972, which was eventually translated into about 30 languages. Among other issues, this book considered the effect of expanding human populations on resources. *Limits to Growth* was criticized by some for raising the Malthusian specter of resource scarcities and limits to economic growth, while critically acclaimed by others who considered it to jump-start debate on resource use and environmental change. More recent reports commissioned by the Club of Rome include discussions on the future of energy resources, oceans, and poverty and underdevelopment among others. In 2001 the Club of Rome also initiated the tt30 group. This affiliated think tank includes individuals around the age of 30 who are committed to helping solve current global challenges and are interested in providing new solutions and supporting the work of the Club of Rome.

SEE ALSO: Germany; Maathai, Wangari.

BIBLIOGRAPHY. Club of Rome website, www.clubofrome.org (cited July 8, 2006); D.H. Meadows, D.L. Meadows, J. Randers and W. W. Behrens III, *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind* (New York: Universe Books, 1972); Gunter A. Pauli, *Crusader for the Future: A Portrait of Aurelio Peccei, Founder of the Club of Rome* (Elsevier Science, 1987).

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Coal

THE INDUSTRIAL REVOLUTION in 18th-century Europe and North America was propelled by a black rock called coal. Modern industrial civilization still continues to depend heavily on this rock. The word *coal* is of Anglo-Saxon origin from the word *col,* which means charcoal. Historians note that coal was already under use during the Bronze Age (around 2000 B.C.E.) in Britain. By 200 C.E., coal was being widely traded in Britain and used for fires to heat villas and military forts and also to dry grain. However, before 1000 C.E., the trade and use of coal was on a small scale. It was not until 1000 C.E. that coal began to be a prominent commodity in Britain. Initially, exposed coal seams were exploited, but by the 13th century these were exhausted, necessitating the development of underground mining from shafts.

Coal is a fossil fuel formed from prehistoric vegetation that originally accumulated in swamps and peat bogs and then consolidated between other rock strata. Silt and other sediments buried these swamps and peat bogs at great depths. This subjected the plant matter to high temperatures and pressure, which in turn transformed the vegetation into peat and then into coal. It is believed that coal formation began during the Carboniferous period about 360–290 million years ago. In Europe, Asia, and North America, the Carboniferous coal was formed from tropical swamp forests, which are sometimes called the *coal forests*. Southern hemisphere Carboniferous coal was formed from the Glossopteris flora, which grew on cold periglacial tundra when the South Pole was far inland in Gondwanaland.

Through the process of coal formation (coalification) over millions of years, various states of coal have been formed, resulting in different types of coal and coal seams that can be extracted via deep or underground mines or open pit mining. There are four main types of coal that range from high water content to high carbon content: peat (lignite or brown coal), sub-bituminous, bituminous, and anthracite. Peat and sub-bituminous coal are ranked as low coal, as they have high water content and low carbon content, while bituminous and anthracite are ranked as hard coal with a very high carbon content and therefore high energy output. The term *dirty black rock* comes from the highly ranked hard coal with a black luster, while the low-ranked coal is softer with a brown or earthy appearance.

Carbon accounts for more than 50 percent by weight and more than 70 percent by volume of coal, depending on the rank. Highly ranked coals contain 95 percent purity of carbon with less hydrogen, oxygen and nitrogen. Coal also contains incidental moisture, which is why coal is mined wet and stored wet. Low-ranked coals, such as lignite, contain considerable amount of moisture and other volatile materials known as *macerals*. These macerals are byproducts of the long process of coal formation from carbohydrate material into carbon over millions of years. Examples of macerals are vitrinite (fossil woody tissue, often charcoal from forest fires); fusinite (made from peat); exinite (fossil spore casings and plant cuticles); resinite (fossil resin and wax); and alginite (fossil algal material). Coal may also contain other mineral matter such as silicate, carbonate minerals, iron sulfide minerals, and sulfate minerals. Methane gas is also a major valuable byproduct for natural gas, but also an extremely dangerous component, as it often causes coal seam explosions in underground mines. The presence of these extraneous materials in coal seams determine the chemical composition of coal and therefore its utility for various tasks.

Large coal deposits can be found in 70 countries, such as Pakistan, where these lode car rails lead into a Quetta mine.

The different types of coal are used for various purposes. For example, lignite, the lowest rank of coal, is used largely for steam-electric power generation. Sub-bituminous coal, whose properties range from those of lignite to those of bituminous coal, are used primarily for steam-electric power generation and for other industrial purposes such as cement manufacturing. Bituminous coal, a coal that is usually black and dense with well-defined bands of bright and dull material and is highly ranked, is often used for steam-electric power generation, the manufacturing of cement, and other industrial uses. More importantly, it plays an essential role in the production of iron and steel as a metallurgical coking coal. The highest-ranked coal, anthracite, is harder, glossy, and black in character and is primarily used for residential and commercial space heating. It is preferred for domestic use due to its smokeless characteristics.

Coal is primarily used as a solid fuel for the generation of electricity and heat through combustion. To generate electricity, coal is usually pulverized and then burned in a furnace with a boiler. The furnace heat converts boiler water to steam, which is then used to spin turbines, which in turn create electricity. Coal accounts for more than 40 percent of electricity production in the world.

About 66 percent of the world's steel production is based on coal. Coke is a solid carbonaceous residue derived from low-ash, low-sulfur bituminous coal from which the volatile constituents are driven off by baking in an oven without oxygen at temperatures as high as 1,832 degrees F (1,000 degrees C) so that the fixed carbon and residual ash are fused together. To make iron and steel, the raw materials—iron ore, coke and fluxes—are fed into the top of the 2,192 degrees F (1,200 degrees C) blast furnace. The burning coke produces carbon monoxide, creating a chemical reaction that reduces iron ore to molten iron.

Coal can also be readily converted into a variety of fuels (gas and liquids), with a number of key advantages such as fuels that are sulfur-free, low in particulates, low in nitrogen oxides and low in CO_2 emissions. As the world demand for petroleum-based fuels has increased due to the escalating use of automobiles, the coal-to-liquids industry is becoming a more viable alternative. South Africa has produced commercial coal to liquids fuels since 1955. It is estimated that about 30 percent (160,000 barrels per day) of South Africa's gasoline and diesel requirements are produced from locally available coal.

The process of converting coal into liquid fuels can be done through direct or indirect liquefaction. Direct liquefaction involves dissolving the coal in a solvent at high temperature and pressure, and then further refining the liquid products to achieve high-grade fuel characteristics. Indirect liquefaction involves gasifying the coal to form a *syngas*, which is a mixture of hydrogen and carbon monoxide. The syngas is then condensed over a catalyst to produce high quality, ultra-clean products. Through these processes, various other products can be produced from coal, including ultra-clean petroleum and diesel, synthetic waxes, lubricants, and alternative liquid fuels such as methanol and dimethyl ether. Liquefaction of coal into fuel liquids has great potential for countries that heavily depend on imported oil but have large reserves of unused coal. It is one of the backstop technologies that could potentially limit the escalation of oil prices and mitigate the effects of transportation energy shortages. Projects to utilize these benefits are currently underway in import oil-dependent countries such as China, India, Australia, and the United States.

CEMENT AND OTHER INDUSTRIES

Another major use of coal is in the cement industry, in a process that requires large amounts of energy. Approximately 16 million tons of cement are used globally every year. The manufacturing of cement involves the mixing of limestone, silica, iron oxide, and alumina. This mixture is heated by coal to very high temperatures of more than 2,642 degrees F (1,450 degrees C), transforming the mixture into a pebble-like substance called *clinker*, which is then mixed with gypsum and ground to a fine powder to make cement. It is estimated that for every 900 grams of cement produced, 450 grams of coal are used. There are other byproducts that are derived from the burning of coal, such as fly ash, bottom ash, boiler slag, and flue gas desulferisation gypsum. These can be recycled as primary raw materials to replace or supplement cement in concrete.

Coal is also used in other important industries such as alumina refineries, paper manufacturers, and the chemical and pharmaceutical industries. Several chemical products can be produced from the byproducts of coal. Refined coal tar is used in the manufacture of chemicals, such as creosote oil, naphthalene, phenol, and benzene. Ammonia gas recovered from coke ovens is used to manufacture ammonia salts, nitric acid, and agricultural fertilizers. From this "dirty black stone," thousands of different products are manufactured, including soap, aspirins, solvents, dyes, plastics, and fibers such as rayon and nylon. Coal is also an essential ingredient in the production of specialist products such as activated carbon (used in filters for water and air purification and in kidney dialysis machines); carbon fiber (an extremely strong but lightweight reinforcement material used in construction, mountain bikes, and tennis rackets); and silicon metal (used to produce silicones and silanes, which are in turn used to make lubricants, water repellents, resins, cosmetics, hair shampoos, and toothpastes).

GREATEST USE: ELECTRICITY

While coal may have multiple uses, its greatest use—about 75 percent of all mined coal (about 5.8 billion tons)—may be in the generation of electricity. The United States, China, and India consume 2.8 billion tons every year (48 percent of annual global consumption). With China's growing economy, India and China alone may soon need about 3 billion tons annually. As of 2005, estimates indicated that there are more than 909 billion tons of proven coal reserves throughout the world. The largest reserves of coal are found in the United States, Russia, China, and India. It can also be found in sizable quantities in 66 other countries. Fossil fuels are finite; however, with current usage levels, the lifetime for coal could be extended 157 years and beyond through new discoveries, advances in mining techniques, and efficiency improvements.

However, there is a dark, flip side to the use of coal as a source of energy. The burning of coal produces many byproducts that are harmful to human and environmental health. The use of coal produces carbon dioxide (CO_2) and nitrogen oxides (NO_x), along with varying amounts of sulfur dioxide (SO_2). Sulfur dioxide reacts with oxygen to form sulfur trioxide (SO_3), which then reacts with water to form sulfuric acid, which falls to the ground as acid rain. Emissions from coal-fired power plants represent the largest source of carbon dioxide emissions, now known to be the primary source of global warming gases. Coal mining and abandoned mines also emit methane, another cause of global warming. Other coal waste products, including fly ash, bottom ash, boiler slag, and flue gas desulferization, contain heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, cadmium, barium, chromium, copper, molybdenum, zinc, selenium, and radium. These heavy metals are extremely dangerous to human, animal, and plant health when spewed into the environment. Other impurities include low levels of uranium and thorium, which could potentially lead to radioactive contamination. U.S. environmental groups claim that coal power plant emissions are responsible for tens of thousands of premature deaths annually in the United States alone. Technologies to mitigate the harmful effects of coal burning are available, but these are rarely installed in power plants as they would add to their building costs and make them less profitable.

The useful aspects of coal notwithstanding, this fascinating, simple black rock that has shaped our modern civilization now threatens it. It is undeniable that coal has transformed societies, expanded our frontiers, and sparked social movements, and continues to power electric generation. However, coal's world-changing powers have come at a tremendous price, including centuries of blackening skies and lungs, particularly the lungs of those involved in its mining. Many believe that the increasing burning of coal in power generation plants around the world is resulting in global warming and is changing the earth's climate. Scientists caution that before we plunge ourselves into reviving the coal industry as an alternative to oil from the Middle East, we need to take a step back and carefully examine the tragic legacy of coal that has claimed millions of lives and ravaged the environment. Due to the proven deleterious environmental consequences of coal, *The Economist* recently dubbed the burning of coal "Environmental Enemy No. 1."

SEE ALSO: Fossil Fuels; Global Warming; Industrial Revolution; Industrialization.

BIBLIOGRAPHY. James C. Cobb and C. B. Cecil, *Modern and Ancient Coal-Forming Environments* (Geological Society of America, 1993); Barbara Freese, *Coal: A Human History* (Perseus Publishing Co., 2003); Ross Gelbspan, *Boiling Point: How Politicians, Big Oil and Coal, Journalists, and Activists Are Fueling the Climate*

Crisis—and What We Can Do to Avert Disaster (Basic Books, 2004); John Gillingham, *Coal, Steel, and the Rebirth of Europe, 1945–1955: The Germans and French from Ruhr Conflict to Economic Community* (Cambridge University Press, 1991); Jeff Goodell, *Big Coal: The Dirty Secret Behind America's Energy Future* (Houghton Mifflin Co., 2006); Angus M. Gunn, *Unnatural Disasters: Case Studies of Human-Induced Environmental Catastrophes* (Greenwood Press, 2003); Bruce E. Johansen, *Global Warming in the 21st Century* (Praeger Publishers, 2006); Duane Lockard, *Coal: A Memoir and Critique* (University Press of Virginia, 1998); Patrick J. Michaels, *Meltdown: The Predictable Distortion of Global Warming by Scientists, Politicians, and the Media* (Cato Institute, 2004); Chad Montrie, *To Save the Land and People: A History of Opposition to Surface Coal Mining in Appalachia* (University of North Carolina Press, 2003); Peter Nolan, *China and the Global Business Revolution* (Palgrave, 2001); Dan Rottenberg, *In the Kingdom of Coal: An American Family and the Rock That Changed the World* (Routledge, 2003); Crandall A. Shifflett, *Coal Towns: Life, Work, and Culture in Company Towns of Southern Appalachia, 1880–1960* (University of Tennessee Press, 1991); World Coal Institute, "Info Coal," www.worldcoal.org (cited December 2006).

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Coastal Zone

THE COASTAL ZONE constitutes 8 percent of the global ocean surface. Most scientific definitions of coastal zones are based on coastal processes or landform. The International Geosphere–Biosphere Program defines a coastal zone as "extending from the coastal plains to the outer edge of the continental shelves, approximately matching the region that has been alternately flooded and exposed during the sea level fluctuations of the late Quaternary period." This space includes the foreshore, the beach area and natural coastal protection systems such as sand dunes and mangroves.

While the coastal zone can be divided into many types, Inman and Nordstrom devised a classification system for coasts based on plate tectonics, dividing the coastal zone into collision coasts, trailing edge coasts and marginal sea coasts. Other coastal zone types include hard rock-cliffed coasts, hard rock coastal plains, soft rock coasts, tide-dominated sediments, plains, and wave-dominated sediment.

Many natural processes influence the integrity and environment of the coastal zone. For example, the lithosphere—which incorporates plate tectonic settings, bedrock geology, coastal topography, and sediments—affect the structure and form of the coastal zone. The coastal zone is also affected by processes within the hydrosphere, which includes all marine processes such as waves, tides, ocean currents, regional currents, sea temperature and sea-level change; the atmosphere, including climate change, annual climate, precipitation, temperature, wind; and the biosphere, which includes all coastal flora and fauna.

Scientific definitions of the coastal zone are not always appropriate for the purposes of management. Definitions located within policy frameworks often differ from scientific interpretations. For example, the Commonwealth of Australia's Coastal Policy states that the "the boundaries of the coastal zone extend as far inland and as far seaward as necessary to achieve the policy objectives, with a primary focus on the land/sea interface." In Canada, the definition of the coastal zone is "the coast itself, coastal watersheds and the lower limits of large drainage basins, and the area seaward to the limit of the zone of influence of land-based activities." Coastal managers in Canada are advised that the definition should be interpreted flexibly to ensure that all activities and issues having a bearing on the planning area are addressed. The Organization for Economic Cooperation and Development argues that the definition of the coastal zone should vary depending on the nature of the problem being examined and objectives for its management.

Many nations across the world have implemented an integrated coastal area management (ICAM) process to manage the many uses and activities along and within the coastal zone. The United Nations (U.N.) Educational, Scientific and Cultural Organization (UNESCO) define ICAM as an interdisciplinary activity where natural and social scientists, coastal managers, and policy makers, focus on how to manage the diverse problems of coastal areas in the long term. The U.N. Environment Program has identified key principles for integrated coastal zone management, including: the coastal area is a unique resource system that requires special management and planning approaches; water is the major integrating force in coastal resource systems; coastal management boundaries should be issue-based and adaptive, be protected from damage from natural hazards and conservation of natural resources should be combined with integrated coastal zone management programs; that all levels of government within a country must be involved in coastal management and planning; and that conservation for sustainable use should be a major goal of coastal resources management.

Key global initiatives to achieve these management goals have included the UNESCO Coastal Regions and Small Island Platform, the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities, Clearing House and the Integrated Coastal Area Management Program. At the World Summit on Sustainable Development in Johannesburg in September 2002, the Global Forum on Oceans, Coasts, and Islands was created to address global development issues.

Many countries are implementing their own coastal management strategies. In Canada—which has the world's longest coastline, where 23 percent of its population live—has implemented the Oceans Act of 1996, which included the development and implementation—with stakeholders—of plans for the integrated management of activities in or affecting estuaries, coastal and marine waters.

SEE ALSO: Beaches; Canada; Currents, Ocean; Oceans.

BIBLIOGRAPHY. J.R. Clark, *Integrated Management of Coastal Zone,* (FAO 1992); N. Harvey and B. Caton, *Coastal Management in Australia* (Oxford 2003); D. Inman and K. Nordstrom, "On the Tectonic and Morphological Classification of Coasts," *Journal of Geology* (vol. 79 1979).

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Cocaine

COCAINE IS A natural plant alkaloid produced by the coca plant (*Erythroxylon spp.*), a shrub native to the lower eastern Andean slopes and domesticated by Andean farmers. Benezoylmethyl ecgonine ($C_{17}H_{21}NO_4$), or cocaine, comprises .5 to 2 percent of coca leaves. While the genus *Erythroxylon* contains 17 species, only two (*E. coca* and *E. novogranatense*) produce sufficient cocaine to process into street drugs. Most coca for traditional use and the drug industry is grown in Colombia, Peru, and Bolivia.

Coca leaves have been an important part of Andean cultures for over 3,000 years. Inca state and religious rituals used coca leaves. Today, Andean people chew coca by holding a wad mixed with alkaline lime or ash in their jaw. Coca leaves are a mild stimulant and appetite suppressant. They provide critical nutrients and cure digestive and respiratory ailments. Tourists drink coca tea to combat altitude sickness. In Andean communities, sharing and chewing coca is an important social ritual. Leaves are used in religious divination and offerings to mountain spirits.

A WELCOME DRUG TURNS SOUR

German chemists first isolated and extracted cocaine in the 1850s. It soon was added to medicinal tonics, wine, and a new drink, Coca-Cola. Scientists discovered that cocaine could be a surgical anesthetic, and Sigmund Freud advocated using it to treat medical and psychological problems. Tests also proved that the drug increased endurance. By the turn of the century, the chemical company Merck was producing around three tons of cocaine annually. The U.S. and European governments urged Andean countries to increase production and exported coca to grow in Javanese plantations.

The early 1900s saw a quick shift in the United States toward condemnation and illegalization of cocaine, as doctors diagnosed numerous cocaine addictions and negative side effects. In 1914, the Harrison Narcotics Tax Act prohibited cocaine use except as an anesthetic. Under the 1970 Controlled Substances Act, cocaine became a Schedule II substance, making it illegal to sell, buy, or possess without a medical license or prescription.

Today, cocaine production, trafficking, and retail is associated with drug cartels and street gangs. Latin American coca is shipped to Colombia to extract cocaine, a multistep process that uses sodium bicarbonate, kerosene, and sulfuric acid to produce cocaine powder. Drug traffickers smuggle powder into consumer countries, where it is "cut" with fillers such as cornstarch before being sold for $50 to $150 per gram. Cocaine users snort powder, allowing mucus membranes to absorb the salt *cocaine hydrochloride*. Consumers also dissolve powder in water and inject it. Within consumer countries, cocaine powder may be processed further to produce freebase or crack, base forms of cocaine. Crack costs $5 to $20 to for a .1 to .5 gram "rock." Freebase and crack are smoked. Heat vaporizes the cocaine, which consumers inhale. Crack gets its name from the crackling sound the rock makes when heated.

COCAINE AND THE NERVOUS SYSTEM

Cocaine stimulates the central nervous system by interfering with dopamine cycling. Dopamine stimulates neurons in the brain, allowing people to experience pleasure. Normally, dopamine is active only briefly before being carried away by a dopamine transporter. Cocaine binds to dopamine transporters, so dopamine continues to stimulate neurons and drug users experience prolonged euphoria. Smoking crack produces an intense high that lasts 5 to 10 minutes. Snorting cocaine powder produces a less intense high that lasts 15 to 40 minutes. Signs of cocaine high include hyperactivity, decreased appetite, and dilated pupils.

Cocaine is a neuropsychologically rather than physiologically addictive stimulant. Its short euphoria may be followed by depression and an intense craving to experience the high anew. Persistent users build up tolerance, requiring greater doses at more frequent intervals. However, they also develop sensitivity to side effects. Excessive dosage or prolonged use can cause irritability, paranoia, and hallucinations. Cocaine can cause death by heart attack and stroke. An estimated 34.9 million Americans over the age of 12 have used cocaine at least once in their lifetime, including 2.7 million chronic users. Currently, there is no pharmacological addiction treatment. Social impacts of cocaine use include devastated families, drug trade violence, risk of disease from needle sharing, and associated theft and prostitution as users try to pay for their habit.

Cocaine production causes environmental and social problems in Andean countries, as well. Illegal coca farms have little long-term stability combined with a strong incentive for maximizing productivity. Resultant environmental impacts include forest cover loss, soil erosion, and water pollution from processing chemicals. Drug cartels in Colombia are associated with violence and political corruption.

Drug control in the United States involves border patrols, seizing cocaine stashes, and mandatory yet unequal drug sentencing. Possessing five grams of crack incurs the same five-year sentence as possessing 500 grams of cocaine powder. The justification for this policy is the greater violence associated with the crack trade. Detractors complain of racial and class discrimination, as crack use is associated with minorities and low-income neighborhoods.

In Andean countries, cocaine control has involved downing suspected drug planes, destroying processing labs, eradicating coca fields, and promoting substitute crops. These efforts are costly and may have little impact on cartel leaders. In coca eradication, crop-dusters spray herbicides over coca fields. Collateral damage includes food crops and biodiversity destruction. Crop substitution has not been successful, since producing coca earns households many times more than substitute crops such as coffee or pineapple. Moreover, many farmers produce coca under threat of violence. Controlling drug trade and cocaine addiction while maintaining Andean cultural heritage rights to traditional coca use has been difficult to accomplish.

SEE ALSO: Deforestation; Drugs; Soil Erosion; War on Drugs.

BIBLIOGRAPHY. Celerino III Castillo, Dave Harmon, Dave Harmon, *Powderburns: Cocaine, Contras and the Drug War* (Mosaic Press, 1994); Paul Gootenberg, *Cocaine: Global Histories* (Taylor & Francis, 1999); Roger D. Weiss, Steven M. Mirin, *Cocaine* (Random House, 1987).

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Coffee

COFFEE, *COFFEA SP.*, is a perennial shrub that has taken on social and ecological significance for several reasons. First, coffee grows in humid, mountain cloud-forest environments of conservation importance. Coffee growing areas are found in tropical zones of over 50 countries located in five continents, generally above 1000 meters for *Arabica* varieties, less for *robusta*. The more valuable *arabica* varieties require areas of high rainfall, typically formed by orographic precipitation and occurring in mountainous zones surrounded by drier lowlands. This results in a geographic dispersion that makes coffee areas important stopovers for long-distance bird migrations and favors high rates of endemic species. Coffee agro-forests often form areas of relatively high quality ecological *matrix* that surrounds, connects, and supports conservation reserves. For these reasons, coffee-producing areas have become important to international conservation strategies.

LABOR-INTENSIVE CROP

From a social standpoint, coffee is a labor-intensive, high-value crop that provides cash income to millions of families the world over, whether as small farmers or wage laborers. Well over 6 million metric tons of coffee are produced each year—approximately one kilo for each person on earth. This remarkable social and economic reach is matched only by the violence of price fluctuations that yearly shake coffee markets and impoverish these same millions of primary product producers. Since the end of the International Coffee Agreement in 1989—a Cold War-inspired global production pact, sponsored by northern consuming countries—coffee producers have become subject to sharply lower real prices and intense price fluctuations. This long-term real price decline was accelerated by a 1990s World Bank initiative to foster *robusta* production in Vietnam, the success of which placed additional downward pressure on coffee prices. Price stagnation has fostered declines in coffee production and a population exodus from high-cost coffee-producing areas—particularly in Latin America, where production costs (outside of Brazil) are relatively high—and increases in lower-cost production areas in Africa and Asia.

From a commodity-chain standpoint, the global coffee trade links relatively poorer, rural producers in the global south with wealthier First World consumers. The coffee commodity chain is relatively simple; tracing product from fields to cafés and homes is relatively straightforward. Studies of coffee data have demonstrated ways in which primary commodity production serves to enrich every actor in the commodity chain except farmers and wage workers, furthering our understanding of how wealth accumulation and impoverishment are linked, and how this linkage figures in environmental declines. These studies show that coffee producers receive only 6 percent of the price of "cupped" coffee sold in cafés. The vast majority of the profit accrues at the upper reaches of the commodity chain, in the hands of wholesalers and retail venues. Even in terms of coffee in beans, farmers receive only 10–30 percent (the later figure if the coffee is processed on-farm) of the final sales price. Even more troubling is that as consumers have begun to pay higher prices for premium gourmet coffees (since the mid-90s), the farm share of the total price has declined.

This separation between farm prices and final prices becomes even more troubling when considering what goes into producing a top-grade coffee, which is no easy matter. First, the ripe beans need to be selectively picked, thus necessitating multiple passes through the coffee plot. Then the pulp must be delicately removed, and the beans fermented for an exact length of time. Finally the product is dried and sorted: lower quality beans, often a large percentage of the crop, must be set aside to increase the percentage of export-grade product. As the relative return to the farmer declines, her labor increases (research shows that on many family farms, women comprise the bulk of labor inputs). Total labor time per kilo comes to between 2–3 hours for poorer farmers without capital-intensive, labor-saving technology so that, after costs, farmers are likely earning under 50 cents per hour.

Commodity-chain studies also show why the World Bank-financed expansion of *robusta* coffee production in Vietnam had such a significant impact on *arabica* coffees grown in highland areas. In an effort to squeeze greater profit out of cupped coffees, cafés have learned to mix *arabica* and *ro-*

busta coffees in prepared drinks; *robusta* varieties, though lacking in flavor and aroma, provide body and have significantly more caffeine than *arabica* coffees. This provides an extra kick to coffee drinks at a lower price, thus reducing demand for—and the market price of—*arabica* varieties. The declining real price of coffee has resulted in a changing global geography of coffee production. Production in high-cost (higher wage) countries in Latin America has stagnated, and lower-wage countries in Africa and Asia (e.g., India and Ethiopia) have sharply increased production.

These three factors—conservation, economic marginalization, and clear-cut commodity flows—combine to make coffee an important commodity for contemporary grassroots initiatives (fair trade, organic, and biodiversity conservation), governmental programs (both national and international), and action-oriented research activities. Of these, the most important are alternative trade networks (ATOs) grouped under the Fairtrade Labeling Organization (FLO), and under organic and shade-grown coffee labels. The boundary between nongovernment and governmental action is often blurred, since coffee producers form an important constituency of national antipoverty and conservation programs. The aim of these ATO initiatives has been to establish a grassroots market network that guarantees coffee producers a minimum price; this price varies by continent, but has been substantially above world market prices in recent years. Fair-trade coffee, often produced under organic standards, has substantially increased the welfare of the more than half a million farmers who have become fair-trade certified since 2005, promoting both increased family incomes and strengthened local organizations that can provide access to health care, education, financial help, and other benefits.

However, the fair-trade ATO model is under stress due to four factors. First, less than 20 percent of fair-trade certified coffee is sold in fair-trade markets. The expansion of fair-trade production has outstripped demand among fair-trade consumers. This is partly due to coffee quality issues, since consumers will pay high prices for gourmet quality coffee, but primarily it reflects the power of large corporate retailers over food distribution. Second, large corporate entities such as Starbucks, Sainsbury's, Carrefour, and Utzkapeh have set up their own "responsible" and/or "sustainable" brands in competition with other fair-trade and certified-organic labels. Third, corporate entities working within FLO have offered to purchase fair-trade coffee on the condition that they receive a volume discount (e.g., Nestles); in other words, lowering the price below the present floor. Fourth, neither fair trade nor organic price premiums have increased in nearly ten years, leading to a declining participation and quality level in areas with higher production costs, such as Mexico and Central America. The percentage of final sales price received by fair-trade certified farmers—about $2 per kilo—is not much greater than that of noncertified farmers. It takes from 1.3 to over 2 kilos of farm-grade coffee to

Certified-organic and shade-grown coffee production standards provide a practical conservation regimen.

obtain 1 kilo of export-grade "prima lavado" (prime washed) coffee; thus, the fair-trade plus certified-organic price of approximately $3 per kilo is reduced to around $2.00, even before marketing costs are discounted. With high-quality roasted coffees retailing for at least four times this price, returns to farmers may hover around 30 percent range of conventionally-traded coffees. From this perspective, adoption of fair-trade coffee by mainline retailers such as Wal-Mart may be seen as much a function of low fair-trade prices as a turn toward social responsibility by retail giants.

COFFEE AND CONSERVATION

With respect to conservation, fair-trade and conservation market initiatives are interlinked—most buyers now require both fair-trade and organic certifications—such that both initiatives are at risk. To expand on the conservation strategy that underlies certified-organic and shade-grown coffees, the goal of both is to establish an organizational structure that promotes decentralized, nonterritorial conservation (conservation work undertaken outside of, and complementing, parks or reserves). Coffee biodiversity initiatives encompass areas of high conservation value. Certified-organic and shade-grown coffee production standards provide a practical regimen of conservation activities (no agrochemicals, soil and water conservation, encouragement of a biodiverse shade tree layer). These initiatives also provide an important technical extension system that includes crop inspectors and conservation workers, who oversee conservation-oriented crop practices to protect these areas, providing a high-quality environment that protects and buffers existing areas, and helps to prevent conversion of coffee farms to pastures.

The agricultural "matrix" provided by coffee farms surrounding parks and nature reserves is important for maintaining species diversity. If areas surrounding reserves become incapable of supporting movement of species to and from a particular nature reserve, then species abundance within the reserve will decline due to an inability to maintain intra-specific genetic diversity or replenish in the event of local extinction. Organic coffee, a diverse, multi-layered agro-forest cover, has been found to provide an environment, or matrix, suitable to the propagation of diverse species, such as frogs and birds, by allowing them to move freely through coffee farms from reserve to reserve. This is particularly true when coffee farms are compared against alternatives such as pastures.

Despite these conservation advantages, certified-organic coffee has, like fair-trade coffee, met with recent difficulties. The additional organic premium (currently $15 above the fair-trade price) does not cover production costs in high-cost production areas. In addition, contemporary certification schemes have become both costly and difficult to manage. The layers of inspections and technical extension (village-level and external) required to meet ISO certification standards are quite costly. Small producers, often those living in the areas of particularly high conservation value, find it necessary to join in cooperatives in order to cover certification costs. These village-level organizations reduce individual costs, but must undertake additional work and costs to cover village-level recordkeeping and technical assistance expenses. Aside from cost, these activities require skilled workers who can perform documentation and inspections activities at the village level. In the event of emigration, conservation networks dependent upon these certification schemes are easily disrupted.

Confronting poverty and encouraging conservation practices via alternative trade initiatives is at the crossroads. Given current fair-trade and certified-organic price premiums, high-cost production areas in Latin America are unable to sustain production or coffee quality levels. The cost issue is less pressing in lower-cost production areas in Asia and Africa, yet without higher prices, it will be difficult to sustain village-level conservation organizations necessary to grassroots ATOs.

SEE ALSO: Cash Crops; Commodity Chains; Trade, Fair; Trade, Free; Organic Agriculture.

BIBLIOGRAPHY. R. Fitter, R. Kaplinsky, "Who Gains from Product Rents as the Coffee Market Becomes More Differentiated?" *IDS Bulletin* (v.32, 2001); A.A. Gonzalez, R. Nigh, "Smallholder Participation and Certification of Organic Farm Products in Mexico," *Journal of Rural Studies* (v.21, 2005); M.D. Johnson, "Effects of Shade-

Tree Species and Crop Structure on the Winter Arthropod and Bird Communities in a Jamaican Shade Coffee Plantation," *Biotropica* (v.32, 2000); P. Moguel, V.M. Toledo, "Biodiversity Conservation in Traditional Coffee Systems of Mexico," *Conservation Biology* (v.13, 1999); T. Mutersbaugh, "Women's Work, Men's Work: Gender, Labor Organization, and Technology Acquisition in a Oaxacan Village," *Environment and Planning D: Society and Space* (v.16, 1998); T. Mutersbaugh, "Serve and Certify: Paradoxes of Service Work in Organic-Coffee Certification," *Environment and Planning D—Society & Space* (v.22, 2004); I. Perfecto, R.A. Rice, R. Greenberg, M.E. VanderVoort, "Shade Coffee: A Disappearing Refuge for Biodiversity," *BioScience* (v.46, 1996); E. Pineda, G. Halffter, "Species Diversity and Habitat Fragmentation: Frogs in a Tropical Montane Landscape," Mexico *Biological Conservation* (v.117, 2004); S. Ponte, P. Gibbon, "Quality Standards, Conventions and the Governance of Global Value Chains," *Economy and Society* (v.34, 2005); L. Raynolds, D. Murray, P. Taylor, "Fair Trade Coffee: Building Producer Capacity via Global Networks," *Journal of International Development* (v.16, 2004); M.C. Renard, "Quality Certification, Regulation and Power in Fair Trade," *Journal Of Rural Studies* (v.21, 2005); J. Talbot, *Grounds for Agreement: The Political Economy of the Coffee Commodity Chain* (Rowman and Littlefield, 2004); J. Vandermeer, R. Carvajal, "Metapopulation Dynamics and the Quality of the Matrix," *American Naturalist* (v.158, 2001).

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Cogenerators

COGENERATORS USE WASTE heat from one activity to supply heat or energy to at least one other activity. They have the capacity to reduce the amount of energy used (especially energy derived from fossil fuels) to accomplish more work without sacrificing convenience and comfort. Cogeneration is also called combined heat and power (CHP). Cogeneration technologies were given a major boost in the United States with the passage of the Public Utilities Regulatory Policies Act of 1978, which allowed competition in the generation of electricity. Public utilities were required to purchase electricity from alternative sources, which included solar power, wind power, or cogeneration. The policy goal was to increase the amount of electricity generated in the United States, while reducing the costs along with the nation's dependence upon large coal and nuclear power plants. A further benefit was decentralization.

Hydroelectric power plants use water to generate electrical power. Thermal electrical power plants burn either a fossil fuel—natural gas, oil, or coal—or they use nuclear fuel. Whole trainloads of coal are millions of cubic feet of natural gas are burned, which heats water to very hot steam. The steam, under pressure, is used to turn the blades of a turbine fan. The fan blades drive magnets around electric wires, which generate electric current and heat. Even the most efficient of engines or production systems is unable to convert all of the fuel expended into energy. There is always some waste with the entropy described by the Second Law of Thermodynamics.

Historically, the heat was a by-product that was not used. It was dispersed with cooling towers, gas flues, or by other means. Cogeneration captures the waste heat and uses it for other purposes, greatly improving the efficiency of the whole operation. Waste heat may be used in a cogeneration system to power a second furnace that produces smaller amounts of electricity. In cold climates, the heat may be piped to heat homes, offices, and other buildings. Scandinavian and continental European countries have used cogeneration extensively because of their higher fuel costs.

Cogeneration can be used most efficiently when the secondary application is close physically to the primary use. Large operations such as hotels, universities, wastewater treatment plants, industrial plants, or other facilities that consume large quantities of fuel for lighting and heating are natural locations for cogeneration. A common example of cogeneration is the use of the automobile heater in wintertime. The heat from the engine cannot be used to power the automobile; however, it is used to heat its interior for comfort of the passengers. Futuristic visions of new cities use cogeneration extensively. Waste heat would be used not only for further energy production, but also for growing crops in the city's greenhouses.

SEE ALSO: Electrical Utilities; Electricity; Energy.

BIBLIOGRAPHY. Philip Kiameh, *Power Generation Handbook: Selection, Applications, Operation, Maintenance* (McGraw-Hill, 2002); F. William Payne, *Cogeneration Management Reference Guide* (Fairmont Press, 1997); Neil Petchers, *Combined Heating, Cooling & Power Handbook Technologies & Applications: An Integrated Approach to Energy Resource Optimization* (Fairmont Press, 2003); Alan Thumann and D. Paul Mehta, *Handbook of Energy Engineering* (Marcel Dekker, 2001).

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Collective Agriculture

COLLECTIVE AGRICULTURE IS the practice of several farm households or villages working together in a food production system, often under state control. Collective agriculture is often associated with Communist economies—such as the former economies of Hungary, Czechoslovakia, and the former Soviet Union—in which collectivization was historically compulsory and imposed. The theory behind agricultural collectivization in the former Soviet Union was to replace small, unmechanized, inefficient farms with larger-scale, mechanized farms that would produce food more efficiently, and to free poor peasant workers from oppression by wealthy farmers. After the lukewarm response to voluntary participation in collectives in the late 1920s, Stalin imposed collectivization during the 1930s by seizing millions of acres of privately owned land and setting up a system of state-controlled agricultural collectives called *kolkhozes* (collective farms) and *sovkhozes* (state farms). The Soviet government controlled wages and dividends, production output, and distribution to ensure compulsory deliveries first and foremost to the state. Combined with major droughts in the early 1930s, tight government controls on production and distribution initially led to severe famine, especially in the Ukraine. Since the fall of the Soviet Union, more than half of all collective farms have been privatized and registered as companies; however, for complex political and economic reasons, many agricultural households and communities have resisted decollectivization.

Compulsory agricultural collectivization in the People's Republic of China began under Mao Zedong in 1955, in theory to free up labor and capital needed to expand the industrial sector of the communist economy. Agricultural collectives in China were broader reaching than those in the Soviet Union, as they embodied industrial and social infrastructures as well as agricultural production. Production and management inefficiencies, natural disasters, and heavy state diversion of output led to widespread crop loss and famine, and ultimately to subsequent reforms. These reforms decentralized management of the commune system, and in the late 1970s—after the death of Mao Zedong—individual households were granted more freedoms to make independent management decisions about their production decisions.

Collectivization in other countries has been voluntary and relatively successful, although not widespread. For example, in Israel collectivization has taken the form of various collective socio-agricultural economies such as the *kibbutz*, which has been the most economically important collective model in the country. In a *kibbutz*, all property except select personal items is collectively owned, planning and work are collective, living is communal, work is distributed based on ability, and goods are distributed based on need. Currently about 3 percent of Israeli citizens are members of a *kibbutz*.

Collective agriculture has not been popular in North America; however, a number of voluntary communities were established in the 19th century by both secular and religious groups including the Shakers, Mormons, Mennonites, Hutterites, and Fourierists. These communities were oriented to different degrees around shared food production, and were often broadly communal in their social, educational, and industrial infrastructures. The Hutterites have established the most successful and long-lasting collective in North America; this agricultural Christian group immigrated with Mennonite groups to South Dakota in 1874 to escape persecution in central Europe. Today, approximately 35,000 Hutterites live communally in over 430 colonies throughout North America, primarily in the Dakotas, Montana, Minnesota, Washington, and the Canadian provinces of Manitoba, Saskatchewan, and Alberta.

SEE ALSO: Agriculture; China; Soviet Union.

BIBLIOGRAPHY. Columbia University, *The Columbia Electronic Encyclopedia* (Columbia University Press, 2006); Robert William Davies and Stephen G. Wheatcroft, *The Years of Hunger: Soviet Agriculture, 1931–1933* (Palgrave MacMillan, 2004); Mieke Meurs, *Many Shades of Red: State Policy and Collective Agriculture* (Rowman & Littlefield Publishers, 1999).

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Colombia

WITH THE HIGHEST number of living species per area in the world, Colombia is arguably the most biodiverse country on the planet. Yet, Colombia suffers the world's longest-running civil conflict. Fueled by illicit drug production, guerilla groups, paramilitary militias and the army battle each other for control of territory. More than 100,000 civilians have been killed since 1980, and, in 2005, at least three million people were internally displaced. No part of the country is untouched by the war.

Colombia is geographically unique in the Latin America and the world. It is the only South American country with a Caribbean and Pacific coastline. The Chocó region of the Pacific northwest is the rainiest place on earth and has one of the highest rates of endemism and biodiversity on the planet. The Sierra Nevada range in the northeast is the highest coastal mountain range in the world, and the Guajira Peninsula is a unique coastal desert in the Caribbean. Three large Andean ranges traverse the Pacific side of the country and contain several exceptional tropical highland ecosystems known as *páramo*. Colombia's eastern expanse is lowland rainforest and tropical savanna, and covers 50 percent of the national territory.

Following a constitutional reform in 1991, a Ministry of the Environment was created. The Min-

Pablo Escobar

Pablo Emilio Escobar Gaviria (1949–1993) began his career as a petty thief stealing cars in Medellin, the second city of Colombia. It is also claimed that he stole and then sold gravestones from the local cemetery.

In 1971, Pablo Escobar graduated into selling cocaine. His criminal activities soon triggered him to kill a well-known dealer, Fabio Restrepo, and take over his network. By the early 1980s, Pablo Escobar was believed to control the cocaine trade selling from Colombia to the United States, Canada, and Mexico. Many of the drugs were routed through Puerto Rico, the Dominican Republic, and later the Bahamas.

To escape prosecution in Colombia, Escobar variously bribed, intimidated, and even killed law enforcement officials and judges. His Medellin Cartel then became involved in a large gangland war with the Cali Cartel. Also going into local politics, Pablo Escobar built soccer stadiums in Medellin, sponsored soccer teams and gave money to worthy causes. This made him a hero to many in Medellin, making it harder to do anything against him. At one stage, Escobar was estimated by *Forbes* magazine as being the seventh-richest man in the world.

Pablo Escobar has also been accused of involvement in the killing of three presidential candidates, and bombing Avianca Flight 203 and a security building in Bogota in 1989. Some writers also suggest that he may have been behind the killing of half the judges on the Colombian Supreme Court by left-wing guerillas.

In 1991 Escobar turned himself in to the authorities to prevent extradition to the United States. He built his own luxury prison and promised that, in return for a five-year prison sentence, he would stop selling drugs. When it appeared that Escobar was using the "prison" for further business activities, and the government planned to move him to a new location, Escobar fled into hiding but was killed in a shootout in Medellin after being cornered by the Colombian National Police.

istry oversees 46 protected areas and 33 National Parks containing one tenth of the country's total area. Meanwhile, 24 percent of Colombia's land is held as indigenous reserves, and another 5 percent is held by black communities on the Pacific slope. Concentrating in the southern Andes, the Pacific, the Amazon and the coastal deserts of the northeast, the number and size of these collective properties are unique in Latin America and hold out some promise for environmental conservation, sustainable land use, and social justice in the future.

Wartime conditions sap energy and resources, and augment environmental problems. Water pollution is particularly pronounced. The massive Magdalena River drains 18 of Colombia's 32 departments but receives 200 tons of domestic waste each day, and this does not even include chemical seepage from agricultural industries like African Palm, bananas, coffee, sugar, beef, and cut flowers. It is estimated that 50 percent of mangrove forests along the Caribbean coast and on the islands of Providencia and San Andrés have been cleared since the early 20th century. Aquaculture along the southern Pacific coast makes Colombia the 12th largest shrimp producer in the world, but threatens the very mangroves upon which the industry depends. An aggressive agricultural and cattle frontier is expanding eastward from the Andean piedmont. These environmental problems are well known to an educated and conscientious population, who find the war diverts limited resources.

Colombia is now the world's leading coca bush grower (producing 430 metric tons of cocaine in 2004), and is an important global producer of opium poppies. Drug traffickers control up to 10 percent of all agricultural lands in Colombia, a number that does not bode well for long-term sustainable land use and soil conservation. Indeed, armed conflict and areal spraying have pushed small growers up steep hillsides and into ever more remote areas, including national parks. Millions of gallons of chemicals used in eradication, coca growing, and in cocaine processing are dumped into the ecosystem each year. Drug profits also fuel money laundering schemes that expand cattle ranches and monocropping on the frontiers. Ten years ago, the Pacific slope was virtually untouched by the civil war and drug production, but now it has both problems.

BIBLIOGRAHY. Frank Safford, and Marco Palacios, *Colombia: Fragmented Land, Divided Society* (Oxford University Press, 2001); Instituto Geográfico de Colombia (IGAC), *Atlas de Colombia* (IGAC, 2003); Astrid Ulloa, *The Ecological Native: Indigenous Peoples' Movements and Eco-Governmentality in Colombia* (Routledge, 2005).

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Colonialism

COLONIALISM IS A system of global relationships where one nation extends its sovereignty beyond its own territorial borders, either directly controlling the population of a foreign state/location or displacing it altogether. This system of international power relations is further commonly supported by a paternalist ideology, which holds that colonized places need and benefit from colonial dominance. Though historically associated with the age of European expansion (1500–1900), colonialism persisted in a formal sense until the early 1980s, when the last states of Africa were decolonized. The legacy of colonialism is, therefore, still quite recent and arguably quite potent, and scholars continue to point to colonialism and contemporary neocolonial relationships to explain global inequalities and environmental change. Several theories of uneven development and ecological problems, therefore, involve the role of colonialism in some way.

THEORETICAL EXPLANATIONS

Modernization theory asserts that the reason some countries suffer from greater rates of poverty is that they have resisted modernizing or that their institutional and infrastructural framework is too poorly developed to lead to *take off*—a state of self-directed and sustained development. Many modernization theorists often point to colonial heritage as an important historical component for setting these conditions for poor institutional and infrastructural conditions, and favor international support and investment in modernization, mimicking the systems of the developed world. Less developed nations must then work to develop infrastructure and technologies more like the West if they wish to decrease inequalities and, by extension, reduce environmental problems. Because of their underdeveloped technology, developing countries utilize less sustainable methods of agriculture and are less likely conduct activities that prevent environmental damage. Further, modernization theorists might say that developing countries need to modernize their governmental structures in order to create and enforce more effective environmental laws.

Critics of this theory suggest that this model of modernization is in itself colonial, in that modernization essentially requires the imposition of extraterritorial controls and institutions on foreign states, typically following the same geographic patterns as historical colonialism (e.g., flowing from the United States to the Philippines or the United Kingdom to Ghana). This is accompanied by similar paternalistic attitudes, they further assert, in an ideology that holds such impositions are essential and desirable for underdeveloped nations.

By contrast, dependency theory asserts the opposite—that colonial powers exploited lesser powers, creating dependent relationships that persist to the present. World systems theory is a more elaborated analysis of the same condition, which posits that the dawn of colonialism in 1500 set into motion a change in the global network of economic relationships, establishing a persistent system of flows, extractions, and exchanges that continues into the era of globalization. According to both theories, there exist core or high-income nations, middle-income or semi-peripheral nations, and low-income or peripheral nations. European powers and the United States are core nations whose position has been maintained by a division of exchange and labor established in the colonial era, in which peripheral states became providers of raw materials and primary goods (e.g., cotton) that was exported to core states to be processed into higher-value finished goods (e.g., textiles). During the colonial era, such relationships were regulated by force. Indian textile production was disbanded under British colonial authority, for example, and cotton production emphasized. This provided both a cheap supply of cotton for British textile mills and a ready-made market for finished textiles in India. Dependency and world systems theorists maintain that these flows of labor, raw material, and finished goods remain in motion today, under their own momentum and an ideological assumption that they are either natural or inevitable.

ECOLOGICAL IMPLICATIONS

Environments were dramatically transformed by colonialism through heavy overexploitation of native resources, displacement of indigenous land covers, and by the imposition of new systems of economic and political systems that led to dramatic changes in land use. In some obvious examples, African elephants were overhunted to meet British demands for ivory, and in New Zealand, Europeans overhunted whales, then seals. In Australia, European interference with rivers stripped beaches and formed sand banks in the water. Rivers were dammed for water supply, spreading salt to land. Swamps were drained in coastal and inland river valleys, polluting streams.

European colonialists in North America cleared forests on a large scale, as they saw it as a form of improvement, clearing the land and utilizing the timber for construction and fuel. Estimates are that over 46 million hectares (450 billion square meters) of land were cleared by 1850. Similar forest clearing by European colonialists is documented in Australia, Canada, and New Zealand.

More indirectly, colonial powers typically focused on extracting a handful of export commodities for the convenience of the colonial powers' industrial production systems and global supply chains. This not only impaired the indigenous peoples' ability to grow their own food, it also had implications for the ecosystem. Perhaps the best example is in the colonization of Africa, where development of single crops for export led to over development of some areas of land and under utilization of others.

The most fertile lands in Africa—in parts of Angola, Zambia, Zimbabwe, Mozambique, Botswana, Swaziland, and South Africa—were divided up for plantation agriculture, and cash crops replaced native flora and fauna. Roads and railroads were built to transport the new cash crops for export, destroying land and displacing people. Excessive mining operations, notably for diamonds and gold in South Africa, also depleted the African environment. As the promise of riches in gold spread, more people migrated to the area, straining the environment terribly. Efforts to mine minerals for export displaced people into less-hospitable agricultural lands. For instance, approximately 55 percent of the population of Zaire is living in an area about 60 kilometers wide on each side of a railroad built for commercial and industrial purposes.

The introduction of European systems of economics and taxation led indigenous peoples to practice forms of environmental degradation once foreign to them. Historically, the peoples of South Africa generally practiced slash and burn forms of agriculture, where land was used for a particular crop for two or three years, then left fallow for 20–30 years. The time left fallow allowed the soil to become healthy with minerals once more, rather than become severely depleted and unusable. Other South Africans practiced floodplain agriculture, where crops were only planted after floodwaters subsided. Colonialism brought changing property rights and demands for cash in household economies that resulted in use of highly marginal lands and intensification of land uses without replenishment of soils, which led to severe degradation.

In western Africa, French colonial taxation policies forced peasants to devote increasingly large areas to cultivation of groundnuts, which in turn forced food production into areas that were once used for animal grazing, accelerating desertification. Further, the Senegalese took out loans to create refineries for groundnuts. Most of the profit from the exports goes toward paying off the loan instead of developing more environmentally friendly policies and practices. Cultivating and refining groundnuts has so depleted the soil that not only can farmers not make nearly enough to pay off the debts, the land is not usable for other purposes either.

Colonialism also spreads flora, fauna, animals, and insects from colonizing powers to colonized locales. In many cases, the new species of plants displaced native ones. The homogenization of the world's biology and ecology caused by colonialism has proven problematic. New insects and animals spread diseases that devastated the land as well as the populace, as evidenced in the example of colonization of the United States. In the Canary Islands, Europeans spread diseases, including dysentery and a form of pneumonia, as well as venereal diseases, that virtually eliminated the local Guanch population. Colonizers intentionally brought some animals, like horses and cattle, but others, like rats, were accidentally brought to colonized lands. Reports of European colonization in Peru describe the rapid breeding of rats, who then destroyed the crops and plants. Similar reports are documented in Buenos Aires and in Australia.

Once Europeans arrived in the Canary Islands, they introduced new plants and animals popular in Europe. Sugar crops prompted much social and ecological change. Slave labor was imported to work in fields and mills, and forests became cane fields. Trees were destroyed to create buildings for the new industry and were used for fuel to boil the fluid squeezed from the sugar cane. Deforestation created erosion.

Imported weeds took over large areas of the West Indies and Mexico, forests were destroyed for timber, and herd animals overgrazed. Bartolome de las Casas, who documented the exploits of Christopher Columbus, described large herds of cattle eating native plants to the roots, which was followed by the spread of ferns, thistles, nettles, and nightshade.

Colonizing authorities also had environmental knowledges conditioned in their home countries and inappropriate for the new contexts in which they found themselves. Unable to fully grasp the ecological dynamics in the areas they colonized, they tended to assume native practices were in need of improvement. For example, forest islands around villages in West Africa, cultivated by local practice over long periods, were incorrectly imagined by French colonial authorities to be the remnants of vast forests "destroyed" by natives. The use of fire by local people to foster pasture development and other resources was seen as environmentally irrational and destructive by colonial officials, and illegalized.

Conversely, colonial ideologies sometimes cast native people in a grossly romantic light, imagining them to be "noble savages" with no human impact on the landscape. While colonial authorities coming to the New World imagined a vast, unused "wasteland," in fact the land uses of native cultures (among many others) were historically highly intense, and had transformed much of the continent prior to the arrival of Europeans. While the view that the lands were "waste" enabled colonizers to justify their acquisition, the changes in management they brought to these lands often inadvertently disturbed already-existing systems of cultivation and management.

NEOCOLONIALISM AND ECOLOGY

Critical theorists maintain that colonial relationships persist into the present. Wealthy nations today, it is argued, often export the environmental consequences of the goods and services they consume, in the form of wastes and pollution. Dominant or core countries may have little incentive to assist colonized or peripheral countries in addressing environmental concerns, as they are benefiting from the existing arrangements and the generally lax environmental regulations in peripheral countries.

Contemporary conservation efforts in Africa, for example, have been based on preconceptions about traditional forms of African wildlife management and have prompted paternalistic efforts to create national parks with little consultation with local people. For instance, the creation of national parks in Tanzania has displaced tribes from their homelands and impoverished them. At the same time, these parks draw tremendous numbers of tourists, which often has a negative impact on the environment.

Another modern form of colonialism with environmental implications is *corporate colonialism,* in which corporations, rather than nations, reinstate historical exploitative relationships. While refining oil in Nigeria has made Royal Dutch Shell more than $30 billion, the native Ogoni people have received little financially. The impact on the environment has been extremely high, however. Shell operates in more than 100 countries, yet 40 percent of all its recorded oil spills are in Nigeria. Between 1982 and 1992, 1,626,000 gallons of oil were spilled in 27 different instances. Oil refining has destroyed trees and dried up yam and cassava crops. Spills have destroyed the land and killed fish, as well as introduced acid rain to the region.

Another "new" form of environmental colonialism is patenting of genetic materials of domesticated and wild species in the underdeveloped worlds. Today, people in South America buy seeds manufactured in the north from genetic material collected on their land in the 1970s, just as South Americans imported wool and leather made from their own animals in the 1770s. One-third of the known plant species in Brazil have been patented by transnational corporations. Labs in Europe and the United States have patented the medicinal properties of 5,000 of the 13,000 plants used in traditional indigenous medicines of Latin America and the Caribbean.

On the other hand, modernization and market enthusiasts maintain that without the flow of capital, support, and technology from the developed world to the developing world, rates of poverty and environmental degradation would be even higher than they are now. Global corporations, it is argued, can spread more advanced technology and techniques to minimize environmental disruptions. Increased incomes created by globalization can potentially be used for environmental programs. The mid-twentieth century "Green revolution," it has been maintained, provided technology that put an end to famines in places like India, which had been persistent for centuries. Debates about colonialism and the environment are as timely as ever, decades

Colonialists entering the New World perceived a vast "wasteland"; however, native land use was already intense.

after the last colonial officials packed their bags and went home.

SEE ALSO: Biopiracy; Bioprospecting; Cash Crops; Deforestation; Desertification; Genetic Patents and Seeds; Global Warming; Globalization; Greenhouse Gases; Hunting; Indigenous Peoples; Invasive Species; Justice; Oil Spills; Overfishing; Overgrazing; Poverty; Shifting Cultivation; Soil Erosion; Weeds.

BIBLIOGRAPHY. Ken Conca and Geoffrey Dabelko, eds., *Environmental Peacemaking* (Woodrow Wilson Center Press, 2002); Alfred Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900,* rev. ed. (Cambridge University Press, 2004); T. Griffiths and L. Robin, eds., *Ecology and Empire* (University of Washington Press, 1997); James Speth, *Red Sky at Morning* (Yale University Press, 2004); James Speth, ed., *Worlds Apart* (Island Press, 2003).

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Colorado River

THE HEADWATERS OF the Colorado River are located in Rocky Mountain National Park in north central Colorado. Its drainage area extends into seven western states: Wyoming, Utah, Colorado, Nevada, Arizona, New Mexico, and California. The river's 1,450-mile course through the arid southwest to its delta on the Gulf of California has it descending from 9,000 feet to approximately 100 feet. The river runs southwest across Colorado from its origin, continues through southwest Utah, crosses into northern Arizona through the majestic Grand Canyon, and then heads south along the border with both Nevada and California before entering Mexico between Baja California and Sonora. Seven states and part of Mexico all share in the water delivered by the Colorado River. In some years, there is barely a trickle of water as the river enters the Mexican area. In drought years, the riverbed is literally dry miles short of the delta.

In Utah the river becomes the natural sculptor of the uplifted Colorado Plateau. The unique landforms found in Arches National Park, Dead Horse Point State Park, and the Canyonlands National Park is attributed to the work of the Colorado River and its tributaries. In Colorado, the Glen Canyon Dam was constructed to provide hydroelectric power to the local area. Page, Arizona, a new town adjacent to the dam site, came into being as a result. Lake Powell, the reservoir behind the dam, began filling in 1966 and reached its maximum capacity in the mid-1980s. Since that time, due to long-term drought conditions in the Southwest, Lake Powell has receded more than 20 feet from its high point.

Just below its confluence with Nevada's Virgin River, the Hoover Dam was constructed. Behind this giant structure is Lake Mead, which supplies water to thriving metropolitan Las Vegas. Two additional dams are located along the Arizona–California border: the Palo Verde Diversion Dam and the Imperial Dam. They were built to provide irrigation water for agricultural activities in the remote stretches of desert. The Imperial Valley in southern Arizona receives its water from the All-American Canal, a channel constructed to divert Colorado River water to this exceptionally fertile but excessively dry agricultural area.

A potentially serious environmental situation involving the accumulation of radioactive mining tailings near Moab, Utah, was resolved in 2005. Uranium has been mined in the region for 40 years, and the pilings were stored a mere 800 feet from the Colorado River. Although no river pollution has been reported, there was concern over the years that the river could be degraded if seepage occurred from the accumulated pilings. In July 2005, the Department of Energy formalized a plan to transfer the uranium pilings to Crescent Junction, 20 miles northwest of its present site and safely away from any potential contamination of the Colorado River.

Allocation of Colorado River water was an early concern shared by the seven states in the region. On November 24, 1922, representatives signed the Colorado River Compact, an agreement which apportioned water between upper and lower river basin states. The upper basin included Wyoming, Colorado, Utah, and New Mexico. The lower basin states are California, Nevada, and Arizona. According to the plan, each basin was scheduled to receive 7.5 million acre-feet of water per year. The amounts of water specified implied availability during years of normal precipitation. There have been a significant number of years since inception that lower amounts of precipitation were received. In years of deficit, legal entanglements and disputes have emerged, especially among the states in the lower basin.

To simplify the allocation situation, each basin was authorized to determine the amount of water for each of its states. In the upper basin, a contract signed in 1948 assigned each state with the following percentage allocation: Colorado: 52, Utah: 23, Wyoming: 14, and New Mexico: 11. Development in the upper basin has proceeded at a much slower rate than in the three states to the south. Consequently, none of the upper basin states have used their full allocation of Colorado River water. At the end of the allocation chain is California, the state using the greatest amount of water from the Colorado River. California's population is expected to increase significantly over the next two to three decades virtually assuring greater draw on the limited water delivered by the Colorado River.

SEE ALSO: Grand Canyon; Hoover Dam; Lakes; United States, California; Water Demand.

BIBLIOGRAPHY. Frederick S. Dellenbach, *The Romance of the Colorado River* (Dover Publications, 1998); Richard F. Fleck, *Colorado River Reader* (The University of Utah Press, 2000); P. Fradkin, *A River No More: The Colorado River and the West* (Berkeley, University of California Press, 1996); Stephen Whitney, *A Field Trip Guide to the Grand Canyon*, (Mountaineers Books, 1996).

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Columbian Exchange

THE COLUMBIAN EXCHANGE is the transfer—both intentional and unintentional—of biological material across the Atlantic. It began with the first voyage of Christopher Columbus from Europe to the Americas in 1492. This voyage initiated a process that continues to this day, linking the ecosystems of the Americas with those of the rest of the world.

The term *Columbian exchange* was coined by the historian Alfred W. Crosby in his 1972 book, *The Columbian Exchange: Biological and Cultural Consequences of 1492*, which advanced Crosby's claim that "the most important changes brought on by the Columbian voyages were biological in nature."

Some species, such as domesticated plants and animals, were intentionally introduced with dramatic consequences. For example, sugar, which was domesticated in Asia, transformed the ecosystems of the West Indies and Brazil and motivated the forced migration of millions of enslaved Africans to labor on the plantations. Farther north, and a little later, the introduction of cotton, also domesticated in Asia, would have similar impacts. European farmers brought their cereal crops with them as they emigrated to the Americas: wheat, barley, oats, and rye. They also brought vegetables and fruit such as onions, cabbages, peaches, and pears. Africans carried domesticated varieties of African rice, as well as the knowledge to cultivate it in a new environment. Later, Asian varieties of rice would also be grown in the Americas with African labor and expertise. In addition, sorghum, millet, and yams, all eastern hemisphere domesticates, were transferred to the Americas. As human populations increased in the Americas over the next several centuries, the cultivation of these crops encouraged the transformation of the landscape through deforestation, draining of wetlands, and reduction of biotic diversity.

The plants that were carried eastward—from the Americas to Europe, Africa, and Asia—had equally significant effects. Maize, domesticated in Central America, was growing in Africa by the early 1500s. Manioc and peanuts would also prove to be important food crops in Africa. Potatoes replaced a variety of cereal grains and vegetables in the fields of Europe after they were introduced from the Americas. Like maize, potatoes offered a high caloric return and therefore could support a larger population on the same acreage planted to European crops; potatoes and maize helped to fuel a population surge that would ultimately lead to Europe's industrial revolution. Vegetables and fruit that made the voyage from the Americas included tomatoes, squash, pumpkin, avocado, and pineapple.

Native Americans had domesticated relatively few animals (dogs, llamas, fowl, and guinea pigs) in comparison to Asians, Europeans, and Africans. However, the introduction of new domesticates such as horses, cattle, pigs, sheep, and goats reshaped American cultures and landscapes. Domesticated animals had been important sources of food and labor in the eastern hemisphere, and would serve similar purposes in the western hemisphere. Horses played significant roles in the conquest of the Americas by Spanish conquistadors, but when they arrived on the North American Great Plains and the South American pampas, horses revolutionized the traditional subsistence patterns and cultural forms of indigenous groups. Likewise, the introduction of sheep impacted native groups such as the Navajo. Introduced animals affected the American landscape even more dramatically than introduced crops, at least in the first centuries after introduction. The native ecosystems of Hispaniola, for example, were severely damaged by cattle, horses, and pigs brought to the island by Europeans.

MAJOR DEMOGRAPHIC SHIFT

The Columbian exchange also comprised the largest demographic shifts in world history. European slavers forced the migration of some 10 million Africans to the Americas. The vast majority of these slaves were captured in West Africa, between the Senegal River just south of the Sahara Desert and Angola on the central African west coast. On average, 10 to 20 percent of the slaves that boarded ships in Africa died before they reached the Americas. By 1650 Africans made up over half of the settlers in the Americas, and up to the time of the American Revolution, six of every seven people who journeyed across the Atlantic were Africans. Approximately 80 percent of the Africans were carried to the Caribbean islands and Brazil.

The unintentional introductions to the western hemisphere were in some cases a nuisance and in others a devastating force. Weeds invaded native ecosystems, often abetted by the ecological disturbances created by livestock. Small mammals, most notably rats, accompanied the earliest European immigrants. However, the truly devastating introductions were too small to see: the microbes that caused diseases in humans. It is difficult to accurately determine the population declines of Native Americans after 1492 due to disease. Recent estimates suggest precontact populations between 43 million and 100 million. One estimate places the population in the Americas in 1492 at 54 million with about 50 million of these south of the present-day United States. This population was reduced by an estimated 76 percent between 1492 and 1650. Other scholars have estimated significantly higher mortality rates. Much of this population loss was due to infectious diseases such as influenza, measles, smallpox, bubonic plague, chicken pox, diphtheria, cholera, whooping cough, and scarlet fever. The worst of the epidemics occurred in the first century after contact. The first large-scale epidemic, primarily smallpox, broke out in the Americas in 1519 on the island of Santo Domingo, where it decimated the population of the Arawaks, the first natives that Columbus had encountered three decades earlier. From Santo Domingo the epidemic made its way to Mexico, where it paved the way for the conquest of the Aztecs by Cortez. Several factors explain the susceptibility of Native Americans to the diseases of the eastern hemisphere. Eastern hemisphere diseases were left behind as the earliest Americans crossed the Bering land bridge and moved southward and eastward through the Americas. Equally important, because indigenous Americans domesticated relatively few animals, the Americas did not develop the many infectious human diseases that originated in animal populations. These two factors left Native Americans defenseless, leading to what demographers refer to as "virgin soil epidemics."

SEE ALSO: Biodiversity; Cattle; Colonialism; Cotton; Deforestation; Ecosystems; Epidemic; Influenza; Invasive Species; Livestock; Maize; Potatoes; Rice; Smallpox; Sugar; Tomatoes; Weeds; Wheat.

BIBLIOGRAPHY. Judith A. Carney, "African Rice in the Columbian Exchange," *Journal of African History* (v.42, 2001); Alfred W. Crosby, *Germs, Seeds, and Animals: Studies in Ecological History* (M.E. Sharpe, 1994); Alfred W. Crosby Jr., *The Columbian Exchange: Biological and Cultural Consequences of 1492* (Greenwood Press, 1972); Gary B. Nash, *Red, White and Black: The Peoples of Early North America* (Prentice Hall, 1999); Kirkpatrick Sale, *The Conquest of Paradise: Christopher Columbus and the Columbian Legacy* (Alfred A. Knopf,

1990); B.L. Turner II and Karl W. Butzer, "The Columbian Encounter and Land-Use Change," *Environment* (v.34 1992).

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Command and Control Regulation

COMMAND AND CONTROL regulations of the environment use standards set by a regulator. The standards are set in order to regulate the environment or ecology in such a way that its natural integrity is maintained at an acceptable level. The standards are mandated at some level and are enforced in law. The focus of the mandated standard is to outlaw excessive amounts of pollution. The mandated standard makes what might be otherwise an allowable overage of pollution an illegal act. The goal is to establish a legal principle to which the potential polluter must adhere and which the government can enforce. The results will be an efficient level of pollution control.

Command and control regulations are a form of public policy that uses laws, measurements, rules, standards, and sanctions to enforce compliance with the policy of a clean environment. The command and control regulations require polluters to meet specific emission reduction targets or face fines. They may also have to install expensive equipment, which will be used to reduce their offending pollution.

Standards may be ambient, emission, or technology. Ambient standards regulate the amount of pollution present in the ambient environment. For example, oil seeps naturally from the ground into water sources, a cause of natural pollution. To measure what is naturally in the environment and compare them to human activities enables an ambient standard to be established.

The standards are set by making numerous daily observations over several seasons. If the observations reveal that a human polluting source is a contributing factor, then the goal will be to locate its source in order to eliminate it legally. The Clean Air Act set federal standards for ambient air quality for a region as well as localities, because pollution is can spread over wide areas. Ambient standards can be used to mandate regional compliance through a regional compliance plan.

Emission standards regulate the level of emissions that the government will allow in order to prevent pollution. Emission standards may regulate the number of particles of SO_2 emissions permitted per hour by a coal-fired electricity plant, or the levels of biochemical oxygen demand that can be allowed in wastewater.

Ambient standards and emission standards may not always be in a harmonious relationship. This is because emissions may exceed limits normally allowed because weather conditions create runoff or storm damage that interferes with the normal level of emissions. Electrical demand may have to be elevated during severe winter weather, which may mean a temporary increase in polluting emissions.

Technology standards are mandated to allow polluters freedom to choose the technology to eliminate pollution. Technology standards permit the use of the "best practicable technology" for an industry or for a industrial practice.

Some critics of environmental regulation believe that command and control regulation of the environment has failed. For them, it has fallen into disrepute because it is obsolete and did not fulfill its purpose due to inefficiency. Another criticism is that it interferes with the fundamental rights of people to the free and fair enjoyment of their property. In addition, it is not clear that human behaviors have been modified in any significant or fundamental way through command and control regulations.

Some critics advocate a system of incentives. Instead of the dictatorial command and control system, market-oriented critics promote economic means for reducing pollution. In meeting ambient standards, some have proposed using a system of credits that can be purchased. Pollution is allowed and not eliminated, while economic benefits go to those able to gain them while externalizing the pollution costs to others. In response, supporters of command and control regulations point to the enormous progress in cleaning up the environment. The American government and others around the world have made significant investments in time and money. These have created a system in which pollution has been reduced and has allowed many streams, rivers, and other natural environments to return to a closer proximity to their original natural state.

SEE ALSO: Clean Air Act; Coal; Drilling (Oil and Gas); Ecology; Electricity; Human Nature; Marine Pollution; Pollution, Air; Pollution, Water; Wastewater.

BIBIOGRAPHY. Cyrille de Klemm and Clare Shine, *Biological Diversity Conservation and the Law: Legal Mechanism for Conserving Species and Ecosystems* (IUCN, 1993); William H. Lesser, *Sustainable Use of Genetic Resources under the Convention on Biological Diversity: Exploring Access and Benefit Sharing Issues* (CAB International, 1998); John Nagle and J.B. Ruhl, *Nagel's the Law of Biodiversity and Ecosystem Management* (Foundation Press, 2002); Lyle Glowka and Clare Shine, *Guide to Undertaking Biodiversity Legal and Institutional Profiles* (Island Press, 1998).

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Commerce Clause

ACCORDING TO ARTICLE 1, Section 8, Clause 3, the Commerce Clause of the U.S. Constitution, "The Congress shall have power… To regulate commerce with foreign nations, and among the several states, and with the Indian tribes." There are essentially three different interpretations of this clause. First, there are those who claim that the clause gives Congress and the federal government the unique right to regulate all commerce. Another interpretation suggests that the clause also gives states the power to regulate commerce, a power that is only preempted in cases where state regulations contradict or preempt federal power. The third interpretation of this clause suggests that states and the federal government have different, sovereign zones of regulation. The federal government cannot violate the state zone or vice versa. The current interpretation of the Supreme Court evolved from a complicated combination of these different views argued in several cases. This interpretation basically limits the ability of states to regulate commerce in particular ways even as states and the U.S. Congress can regulate commerce in different zones concurrently.

For several key environmental laws, the Commerce Clause has been interpreted to extend federal authority over what might otherwise be separate state jurisdictions. Most prominently, the 1972 Clean Water Act is understood to be constitutionally sound insofar as the federal authority extends to waterways and wetlands via the clause. Recent petitions have been made to curtail the successes of the Clean Water Act by asserting that federal authority only extends to literally "navigable" waters (those suitable for use by commercial vessels) and only those wetlands and streams directly adjacent to waterways.

This clause has had a major impact on the ability of the federal government to enforce in-state environmental policy, leaving the states with the power to regulate beyond minimum federal standards. In some cases, however, the Supreme Court's interpretation of the Commerce Clause has limited the ability of individual states to enforce environmental policy if this policy has an adverse consequence for interstate commerce. In *Philadelphia vs. New Jersey* (1976), the Supreme Court ruled against a New Jersey law prohibiting the importation of garbage into the state. The Court saw this as a discriminatory ban against commerce from another state. In *Hughes vs. Oklahoma*, 1979, the Court also struck down an Oklahoma law intended to preserve and protect fish by prohibiting the export of minnows across the state. The Court rejected the idea that states can own wildlife, making it not officially an article of commerce. In *Maine v. Taylor*, 1986, however, the Court ruled that Maine had the right to prevent the import of certain baitfish to prevent the introduction of parasites because no alternative to discrimination against other state commerce existed. Thus, in most cases, the demands of commerce were preserved over the environmental policies. As the law presently stands, states have the power to regulate and preserve their environmental resources; but they cannot do so at the expense of interstate commerce, unless there is no other alternative.

SEE ALSO: Clean Water Act; Commodity; Markets.

BIBLIOGRAPHY. Paul Benson, *The Supreme Court and the Commerce Clause, 1937–1970* (New York, 1970);

Robert Meltz, *Constitutional Bounds on Congress' Ability to Protect the Environment* (New York, 2003); Joseph Zimmerman, *Interstate Economic Relations* (State University of New York Press, 2004).

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Commodification

COMMODIFICATION IS A widely if often somewhat loosely used term, usually with some sort of critical or pejorative connotation. But what does the term actually mean, what processes does it refer to, and what might rigorous perspectives on commodification have to offer to the study of environmental politics and environmental change?

At the most basic level, a commodity may be defined as that which is produced for sale. This is less an evaluation of the actual material character of production and more a recognition of the sociological significance of intent, with production for use being distinguished fundamentally from production driven by desire for exchange, and for profit. This distinction—one made by Aristotle, Marx, and Polanyi, among others—recognizes that there is something quite different about producing (e.g., fishing) for subsistence needs as opposed to producing for exchange and the generation of surplus. There is also something different about consumption mediated by market relations, particularly when production and consumption networks spread across vast expanses of space, as is characteristic of the contemporary global economy. If we accept that production primarily for sale is the defining feature of a commodity, then commodification refers to the uneven, dynamic, and *always* incomplete tendency toward circulating certain types of "things" as commodities, but it also refers more generally to the proliferation of more and more commodities, as production for use displaces production for exchange.

That said, production for exchange is not unique to capitalism. But the sheer proliferation of commodities, and the extent to which seemingly everything and anything can be produced as a commodity for exchange, is a defining feature of capitalist political economy, and particularly, of its expansionary tendencies. This expansion has been fruitfully discussed as having two interlinked facets, the first "deepening," the other "stretching." Deepening refers to the tendency of more and more "things" to be commodified— produced primarily for exchange. Stretching refers to the expansion of commodity markets, and thus the expanding scope of exchange dominated production, displacing production for use. Examples of deepening might include farmers increasingly buying commercial, synthetic fertilizers as opposed to using on-farm organic wastes, while stretching would include the ongoing international expansion of commercial markets for such fertilizers via the Green Revolution and liberalized trading regimes. And indeed, these selfsame tendencies toward the commodification of on-farm inputs have been theorized as a key facet of the development of capitalist agriculture more generally. Important links connect stretching and deepening with the commodification of labor power. This is because production for exchange, particularly on an expanding scale, gives rise to the purchase of labor power as a commodity (or at least based on the pretence that it is a commodity like any other) via payment of wages. Price-based competition fueled by expanding, wage-labor based production can push out petty commodity producers, and production based on other systems of social organization, such as mixed production for subsistence and barter exchange on a limited scale. This dynamic of competition has the effect of both deepening and stretching commodification. In addition, however, commodification of labor power is central because the increasing dependence of workers on wages used goes hand-in-glove with the production of more and more "things" as commodities for sale (food, clothing, shelter, etc.).

COMMODIFICATION AND ENVIRONMENT

There are important connections between commodification and environmental studies. For one, commodification is no stranger to resource and environmentally intensive production, so that the provision of biophysical resources as commodities (e.g., coal, oil, timber) underpins the material and energetic basis of capitalist economic production, often attended by serious and geographically uneven environmental impacts. Oil, for instance, is arguably the world's most important single commodity and is among the world's most heavily traded commodities, and oil companies were among the first modern, transnational firms.

But this points to a fundamental tension between commodification and the biophysical world. On what basis is it possible to say that production is primarily, if not exclusively, for sale (exchange) when all production, including the reproduction of labor power, depends on ecological production of various kinds? This is one of the reasons that nature as a category has been termed a fictitious commodity—it only *appears* to be produced by capitalist firms and allocated by markets. Nature is sustained and reproduced by ecological circuits not wholly subsumable to social coordination. Moreover, biophysical nature is also subject to contending social demands that compete with market pressures. As Polanyi noted, the allocation of land (nature) cannot be wholly subordinated to the market because this would result in society tearing itself apart.

Despite this, neoliberal efforts to deepen and stretch capitalist markets via the privatization and commodification of more and more discrete environmental resources and services make commodification an immediate concern in environmental studie. Examples include privatization and sale of fishing rights, private for profit water utility service provisioning, and waste disposal services. Significantly, this can include not only the commodification of material nature, but also commodification of representations and images of nature (such aspastoral images used to sell ski vacations). In fact, entire "political ecological imaginaries" circulate along with material commodities as a kind of surrogate for direct knowledge of production conditions, in the context of spatially stretched relations between producers and consumers. This semiotic commodification shapes and fuels desire for commodities in markets, and acts as a crucial link between producers and consumers. But it is also a potential source of leverage in progressive struggles to achieve social and environmental justice in commodity production by means of labels and branding. Whether robust social and environmental justice can actually survive commodification, with all that entails, is an open question indeed.

Commodification, via the expansion of production for exchange as opposed to production for use, arguably deepens an instrumental, utilitarian disposition toward biophysical nature that many identify as a cultural origin of modern environmental problems. Moreover, precisely because of the fictitious character of nature as commodity, there are particular problems and contradictions associated with making discrete elements of the biophysical world ciculate as such. How, for instance, is continuous ecological variation discursively rendered into the sort of acceptable, discrete gradations that market differentiation requires, such as discrete grades of wheat or lumber? What "work" is required to equilibrate and sunder discrete biophysical entities and processes to allow them to be exchanged as commodities? And since prior ecological (not to mention social) production sustains all formally capitalist, economic commodity production, commodification is necessarily and always uneven and incomplete, begging the question as to how commodification proceeds and how it articulates with wider networks of socio-ecological production and regulation.

SEE ALSO: Capitalism; Commodity; Commodity Chains.

BIBLIOGRAPHY. K. Bakker, *An Uncooperative Commodity: Privatizing Water in England and Wales* (Oxford University Press, 2003); N. Castree, "Commodifying What Nature?" *Progress in Human Geography* (27(3): 273-97, 2003); W. Cronon, *Nature's Metropolis: Chicago and the Great West*, (1st, New York: W. W. Norton, 1991). D. Goodman, "Reading Fair Trade: Political Ecological Imaginary and the Moral Economy of Fair Trade Foods," *Political Geography* (23: 891–915, 2004); D. Goodman, B. Sorj and J. Wilkinson, *From Farming to Biotechnology: A Theory of Agro-Industrial Development* (Oxford: Basil Blackwell, 1987); J. Guthman, *Agrarian Dreams: The Paradox of Organic Farming in California* (University of California Press, 2004); P. Lysandrou, "Globalization as Commodification," *Cambridge Journal of Economics* (29(5): 769–97, 2005); B. Mansfield, "Rules of Privatization: Contradictions in Neoliberal Regulation of North Pacific Fisheries," *Annals of the Association of American Geographers* (94(3): 565–84, 2004); J. McCarthy and S. Prudham, "Neoliberal Nature and the Nature of Neoliberalism," *Geoforum* (35(3): 275–83, 2004); T. Mutersbaugh, "Serve and Certify: Paradoxes of Service

Work in Organic Coffee Certification," *Environment and Planning D: Society and Space* (22: 533–52, 2004); K. Polanyi, *The Great Transformation: The Political and Economic Origins of Our Time* (Beacon Press, 1944); M. Robertson, "No Net Loss: Wetland Restoration and the Incomplete Capitalization of Nature," *Antipode* (32(4): 463-93, 2000); A. Sayer, "(De)Commodification, Consumer Culture, and Moral Economy," *Environment and Planning D: Society and Space* (21: 341–57, 2003); D. Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (Simon & Schuster, 2001).

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Commodity

THE COMMODITY IS intimately located at the interface of economy, society, and the environment. Referred to as "the DNA of capitalism" and the heart of contemporary market economies, the commodity appears as such a simple and obvious thing. We buy things to fill a perceived or required need. When one gets down to it, though, commodities are fascinatingly complex and multifaceted. They are vessels for a multitudinous array of social, political, economic, geographical, and environmental relationships. Think of just some of what went into bringing you that cup of coffee that started your day: the intensive labor of a small farm family in Mexico (or Ethiopia, Vietnam, Indonesia) or that of a plantation worker in Brazil (or Guatemala, Kenya, Columbia); the pesticides used; the processing/pulping plant with concrete drying slabs and bean-grading equipment; the containerized coffee sacks driven, shipped, and driven again to a massive roasting facility; and the store clerk who placed the carefully grown, harvested, sorted, roasted, and shipped coffee beans wrapped in a vacuum-sealed one-pound foil bag on the supermarket shelf.

And, yet, when we hold up a cup of coffee, a frozen chicken, new shoes, an mp3 player, a banana, or indeed any commodity—we are unable to "see" those relations behind these objects. This is what Karl Marx called the *fetishism* of commodities. An incredibly complex concept at the best of times, commodity fetishism can be understood as the ability of the commodity to hide the relations—social or otherwise—of its production. Commodities appear as if they are independent and naturalized forms apart from the people and environments that produced them. This leads to confusion and a concealing of these relations between people and ecologies, which are replaced and reconstituted as reified relations with commodities. As the geographer Michael Watts puts it, this obfuscation "…is central to the alienation [of both producers and consumers] rooted in a world in which everything is for sale, and everything is a thing." Further, looking back at the cup of coffee, the concern is for how this obfuscation works to veil the exploitation of small-scale, marginalized farmers and plantation workers as well as the ecological destruction caused by, among other things, chemical-intensive coffee production. Considered this way, drinking our morning java is an act of connection that brings us into relationships with literally hundreds of thousand of people; global economic, political, and trading institutions; and local, regional, and—to an extent—global ecological systems.

The concern is for how commodity obfuscation may veil the exploitation of small-scale plantation workers.

Commodities contain and express three forms of value. First, they have a *use value* in that they satisfy a human want and can be "used" for something. Coffee's historic use value has been to not only wake us up in the morning but make us more productive as laborers. Second, commodities have an *exchange value,* meaning they have the ability to be exchanged for other commodities. A bag of coffee might be exchanged for a hammer, four banana bunches, or a ready-to-eat chicken. Rather than this bartering of commodities, these days economies are organized into thoroughly monetized commodity systems. Watts describes this *commodity circulation* as the "process by which a commodity is exchanged for money, which in turn permits the purchase of another, different commodity." And, importantly, value is not imputed into commodities through price, but through the amount of labor expended to produce them.

The third form of value is loosely known as *sign value* and involves the *semiotics* of commodities: the social construction of value through branding; aesthetics; and an association with quality, status, and/or taste. This often translates into greater monetary price for particular branded commodities such as a Starbuck's latte or a bag of fairly-traded, shade-grown, organic coffee. Yet, this might not always be the case: Relatively low-cost McDonald's food sold outside the United States is a consumable proxy for "American culture" or "modernity."

Commodification is the process whereby something becomes a commodity. There are two essential *moments of commodification*: the material manipulation and transformation of "nature" into a priceable and sellable form; and the semiotic production of commodities through the use of meaningful symbols, logos, brands, language, and images that surround us in contemporary society. Still, commodification is often incomplete or partial. Many peasants produce much of their own food or other consumable goods, yet also sell commodities like livestock or cultural products to enable the purchase of cooking utensils or their children's schooling.

Additionally, there are what Karl Polanyi calls *fictitious commodities*. These "special" commodities—labor, land/nature, and money—are treated as commodities and enter markets but are not intentionally produced in commodity-like form. Thus, labor can be sold as units of money per hour, but people are not produced as commodities as such. The exception—and a nefarious one at that—is of course slavery.

Commoditization is the process of the spread of commodification to all parts of society and life. Jürgen Habermas called this the "colonization of the lifeworld" through the deepening and broadening of the commodity form. Commoditization is a defining feature of post-modern society as literally everything is now for sale, from genetic material, bodies (i.e., babies and women) and body parts, clean air, knowledge and ideas, to whole ecosystems.

Commodificiation and commoditization are complicit in and influenced by processes of globalization. We can see this most vigorously in the spread of American products in the iconic forms of Coke, the Big Mac, and Mickey Mouse. Some argue this contributes to the *homogenization* of global culture through the marginalization of local difference. George Ritzer characterizes this as the "globalization of nothing" in the vacuous commoditization and consumption of signs through global brands. Others, like the anthropologist Daniel Miller, argue that cultures make these products "theirs," localizing global brands culturally and economically. His work speaks to how, in a local context, Coke has come to express *differentiation* as the "sweet black drink" from Trinidad.

Commodities have *biographies*. They are "born," create and follow chains and circuits across places and people, are marketed, consumed, used, and discarded. Commodity biographies tell stories—from the rich and vibrant to the plain and mundane—of the trials, tribulations, and travels of goods in market economies. Commodities also have varied and moveable *social lives* as they slip in and out of various meanings, forms, uses, and trajectories over time and space. The most obvious example might be the cans and bottles set on the curb to be recycled by the local municipality, sold to a manufacturer, and transformed into a new product. Yet, those commodities (and their changing values) become part of "second-hand commodity cultures" such as goods sold at a charity shop or a garage sale, or items "re-gifted" to friends and family. Many go through an established circuit: they are first created as a product, invested with a value; then used as a "useful" object; then used up or not used at all, becoming "valueless" (a

Radical Concepts

There are other, more "radical" ways to address the nexus of overconsumption, commodification, and the environment. These confrontations often involve the active resistance to globalized commodification and privatization, or at least a slowing down and directional shifting of their processes. Several phenomena are important here: the movement for indigenous and local people's rights in both the global north and south around the concept of community-controlled (and often noncommodified, noncommodifiable) resources and landscapes; a "re-embedding" of commodity production and consumption in natural processes and local communities in the markets for organic, fair trade, and artisanal foods; the growth of Local Exchange Trading Systems (LETS), where communities develop their own local currencies for goods and services to promote community economic development and social networks; and the "subvert" movement led by Adbusters which turns commodity semiotics against itself by humorously "culturejamming" the meanings and messages of advertisements into those of hard-hitting "truths" about a product.

jacket that doesn't fit any more); and finally, given to a charity shop where they are "re-valued" and sold as second-hand goods. The success of eBay is a billion-dollar testament to the circulating social life of commodities and the re-valuation of goods.

In modern societies, unregulated commodification and commoditization are a large part of the environmental problem. We can see this most clearly in crude extraction industries, such as agriculture, forestry, and mining, but also in commodity manufacturing. Access to extractive and other resources fuels conflicts and warfare the world over. Further, it is the complex interweaving of both the aforementioned commodity moments and the creation of desire which puts considerable pressure on environmental resources. For example, marketing of grossly oversized SUVs for the urban "jungle" fosters demand for gas-guzzling behemoths, promotes overconsumption, further resource extraction, and a dose of pollution.

Deeper commodification has been posited as the solution to environmental problems. This is exemplified through "cap and trade" pollution control, whereby both pollution (and by proxy, clean air) are turned into purchasable commodities; the commodification of nature in the outright purchase of landscapes and rainforest reserves by environmental groups (e.g., the Nature Conservancy and Conservation International); and the commodification of ecosystem services in carbon trading program with the purchase of "carbon sinks" (such as forests and grasslands) in the global south by carbon dioxide-emitting corporations located in industrialized countries.

SEE ALSO: Capitalism; Commodification; Commodity Chains; Marx, Karl; Markets.

BIBILIOGRAPHY. Arjun Appadurai, *The Social Life of Things* (Cambridge University Press, 1986); Ian Cook, "Follow The Thing: Papaya," *Antipode* (v.36, 2004); Nicky Gregson and Louise Crewe, *Second-Hand Cultures* (Berg, 2003); Alex Hughes and Suzanne Reimer, *Geographies of Commodity Chains* (Routledge, 2004); *Journal of Rural Studies,* "Special Issue on Embeddedness, Quality, and Alternative Food Practices" (v.19, 2003); Daniel Miller, "Coca-Cola: A Black Sweet Drink From Trinidad," in *The Cultural Politics of Food* (Blackwell, 2005); Mark Pendergrast, *Uncommon Grounds: The History of Coffee and How It Transformed Our World* (Basic Books, 2000); Karl Polanyi, *The Great Transformation* (Beacon Press, 1944); George Ritzer, *The Globalization of Nothing* (Pine Forge, 2004); Michael Watts, "Commodities," in *Introducing Human Geographies* (Arnold, 1999).

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Commodity Chains

A COMMODITY CHAIN is the connected path across which raw materials travel to become processed into finished goods, and eventually consumed. For example, coffee may move along a commodity chain from the site in Columbia, where it is grown by a peasant producer, through a buyer in Argentina, to a processing plant in Jacksonville, Florida, to a big box store in Des Moines, Iowa, where a consumer buys it and drinks it in Cedar Rapids. At each point along the chain, the coffee is physically transformed and value is added to the product. With each successive sale, an increasing profit is made; processors generally earn more than growers, retailers more than processors.

Commodity chains encapsulate systems of social and spatial relationships connecting production and consumption. They are comprised of linear "links" representing discrete, but interrelated, activities involved in the design, production, and marketing of a product. Commodity chains emphasize relationships between commodity processes, societal practices and the institutions and environments in which commodities and their meanings are produced and circulate. Two intellectual traditions have dominated: global commodity chains perspectives and systems of provision approaches.

GLOBAL COMMODITY CHAINS

The global commodity chain literature draws on the world systems theory. Much of the early global commodity chain literature analyzed agricultural and industrial commodities, depicting how commodities were produced in peripheral regions of the world for consumption by a core of countries. This literature has highlighted the organization of chains—and the power of institutional agents such as manufacturers, buyers, and distributors—to influence and maintain flows of materials, peoples and knowledge.

An important aspect of the global commodity chain literature has been the concept of governance, with chains characterized as buyer- or producer-driven, depending on the type of firm that coordinates and/or controls relations along the chain. The growth of producer- (or supplier-) driven chains is linked to the emergence of a Fordist regime of capital accumulation post World War II, facilitated by the provision of export processing zones and the import substitution policies of both developed and developing nations. Producer chains are typified by vertically integrated transnational corporations that are capital- and/or technology-intensive (such as automobiles, aircraft, and computer firms). In contrast—in buyer-driven chains—retailers, marketing and branded manufacturers govern supply, and/or production of commodities, often through decentralized production networks. Buyer-driven chains have been associated with labor-intensive and consumer goods industries such as apparel, footwear, toys, and consumer electronics. Their rapid growth since the 1960s is a part of a general transformation from "manufacturer shift" to "consumer pull" assisted by a shift in the industrial strategies of developing countries from import substitution to export-oriented growth, and encouraged by neoliberal government policies and International Monetary Fund and World Bank policies. Buyer-driven chains have attracted much controversy because industrial production has frequently occurred in areas of low-cost labor, with minimal environmental standards or working conditions, and poorly unionized workers. In buyer chains, control of flows of information, skills, products, logistics, marketing, and design and branding remains in the core countries.

While the global commodity chain literature has emphasized the political economy of production and consumption links, research on food and agricultural commodity systems, the French *Filière* tradition, and "systems of provision" examines the transformations (and trajectories) of the commodities themselves and the systems, social relations, and sites that shape their flows. These approaches accommodate material and symbolic constructions of commodities, highlighting how chains for different commodities are constituted and expressed very differently, a consequence of the composition of the "systems" of production, circulation distribution, and consumption in which they are located.

The distinction between the global commodity chain and systems of provision approaches has become increasingly blurred. Both are useful for understanding how commodities connect people and places at a range of scales and for examining the political, social, and environmental expressions of chain formation in contemporary and historical contexts. Many social and environmental justice movements and organizations draw on the chain metaphor to emphasize connections between producers and consumers, and their practices to evoke consumer activism and to change government policy, and/or corporate practices. A politics of connection is also evident in the establishment of fair-trade commodity chains, and in the sale of commodities which make "ethical" or environmentally sustainable forms of production explicit.

Examinations of chains have been used to establish positions on academic and popular debates about globalization, sustainability, free trade, and the power of transnational corporations. There has also been controversy over the environmental expression of commodity chains. For example, in agro-food commodity chains, European consumers can contribute to land degradation in the form of over-cropping in Africa, and consumer preference for fast food and can be linked to air and water pollution through intensive agriculture. Following a commodity chain beyond purchase also discloses environmental consequences—the disposal of inorganic waste, for example, poses a significant environmental challenge.

The increasing complexity of a globalizing world has challenged the commodity chain as a model for understanding connections between production, consumption and place. Commodity chains have also been criticized for positioning consumption as a consequence of production, yet they remain a powerful metaphor for academic and populist understandings of production and consumption linkages, and the social and environmental contexts in which these occur.

SEE ALSO: Capitalism; Cash crops; Commodity; Markets.

BIBLIOGRAPHY. Ben Fine, *The World of Consumption: The Material and Cultural Revisited* (Routledge, 2002); William Friedland, "Commodity Systems Analysis: An Approach to the Sociology of Agriculture," H. Schwazweller, ed., *Research in Rural Sociology of Agriculture* (JAI Press, 1984); Gary Gereffi, "Beyond the Producer—Driven/Buyer-Driven Dichotomy," *IDS Bulletin* (v.32, 2001); Gary Gereffi and Michael Korzeniewicz, eds., *Commodity Chains and Global Capitalism* (Greenwood Press, 1994); D. Goodman, "Ontology Matters: The Relational Materiality of Nature and Agro-Food Studies," *Sociologia Ruralis* (v.41, 2001); D. Goodman and E.M. Dupuis, "Knowing Food and Growing Food: Beyond the Production–Consumption Debate in the Sociology of Agriculture," *Sociologia Ruralis* (v.42, 2002); E.R. Hartwick, "Towards a Geographical Politics of Consumption," *Environment and Planning A* (v.32, 2000); Alex Hughes and Suzanne Reimer, eds., *Geographies of Commodity Chain,* (Routledge, 2004); R. Johns, L. Vural, and L. Class, "Geography, and the Consumerist Turn: UNITE and the Stop Sweatshops Campaign," *Environment and Planning A* (v.32, 2000); Naomi Klein, *No Space, No Choice, No Jobs, No Logo: Taking Aim at the Brand Bullies* (Picador, 2000); Deborah Leslie and Suzanne Reimer, "Spatializing Commodity Chains," *Progress in Human Geography* (v.23, 1999); P. Raikes, M.F Jensen, and S. Ponte, "Global Commodity Chain Analysis and the French *Filière* Approach: Comparison and Critique," *Economy and Society* (v.29, 2000); R. Silvey, "Sweatshops and the Corporatization of the University," *Gender, Place and Culture* (v.9, 2002).

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Common Law

COMMON LAW IS the judge-made law developed in England after the Norman Conquest. The judges rode in circuits to different locations where court would be held. After about 1080, they began to decide cases between the people—none of whom were English, but were rather Celtic remnants, Saxons, Angles, Danes, Norsemen, Britons, and others who would eventually meld together to become English.

Between 1100 and 1300, the traveling judges developed the law common to all of England. In London, where they would return after they had finished riding their circuits to hear cases, they had their permanent residences and would meet in inns. From these meetings were established permanent legal institutions that have continued until the present as the Inns of Court.

The decisions of the judges that developed the common law and its principles were made well before the establishment of English Parliament as a legislature, which would make statutory laws. The key feature of the English and eventually Anglo-Saxon common law system is that it is judge-made law. Over what is usually a long series of cases, the judges develop the law on many issues.

The common law, as it developed in England, was stable because the common law developed the principle of "like cases should be tried alike"; it therefore followed precedents set in previous cases, which is called the rule of *stare decisis* (Latin for "let the decision stand"). The common law was not very flexible—in order to bring a case for damages, actual harm had to occur. However, a tort suit for recovery from a harmful action is meaningless if the harm is irreparable. If an orchard of 50-year-old walnut trees was cut down, there is no remedy to replace them. In order to prevent irreparable harms and injustices that could occur under the common law, another form of judge-made law also arose, called *equity law*.

The common law was exported to English colonies, including the United States. After the American Revolutionary War, common law and equity law were incorporated into the American legal system as a part of the Constitution of the United States.

In the United States, England, and other English-speaking countries where the common law was received, great areas of life are still regulated by the common law. In contrast, on the European Continent and in many other countries, the civil law system has been adopted. This system uses a code of general rules that have been formulated by jurists and other specialists in the law. The Civil Code of France, which began as the Code Napoleon, is an example. It has its roots in the ancient Roman Law and its legal institutions. The legislatures of the countries that adopt civil law codes assign to judges the responsibility to apply the rules of the code to the facts of a case. A similar function is also found in common law countries, when judges apply statutory law. However, in the United States, the existence of judicial review as a legal doctrine means that all statutory and administrative rules and regulations are ultimately reviewed by judges in cases as if these were also facts in a case, rather than the controlling legal rules.

There has been a radical change in the American legal scene since the advent of the Environmental Movement and a series of environmental crises after the 1960s. Historically, the common law protected the environment in a variety of ways. One of these was through bringing a suit to abate a nuisance. Nuisance actions can include not only an injunction to prevent (equity) the nuisance, they can also include the use of damages for restitution.

Another form of common law action was the use of trespass law. The ownership of property creates rights; the common law holds property in high regard. To invade it by some form of trespass, including the passing of airborne, waterborne, or land pollution, means that a defendant's actions can be held liable for damages to the quality of the environment.

Riparian rights are another area of law that was protected by the common law. Water in a stream or lake beside a piece of property was under the common law, not the property of a landowner. Riparian rights allowed water users to sue if the quality of the water was damaged.

ENVIRONMENTAL REGULATORY STATE

In the United States, an environmental regulatory state has developed. Rather than the interested parties and the judges creating cases, which economists believe is a more efficient way to regulate problems, enormous regulatory bodies have been created by Congress and all the 50 state legislatures. The assumption was that the common law system was inadequate to deal with environmental problems.

One particular case, the Love Canal case, has become important in the history of environmental regulation. The chemical company, Occidental Petroleum, was forced by eminent domain actions by the local school board to sell land where it had stored chemical wastes. It was not really the chemical company that created the environmental disaster that followed; it was by a governmental agency that acted unwisely. The terrible birth defects and health problems that followed occurred despite the very stern warning of Occidental Petroleum Company. However, Love Canal became a rallying cry for statutory and administrative regulations.

Many lawyers and political observers believe that the adoption of a bureaucratic regulatory mechanism for environmental supervisions will in the long run produce more problems than if the common law system had been allowed to take its course. The political realities are that legislation is subject to politically shifting tides of opinion where it is not in a system of judge made rules that are insulated from political fashions.

Civil law systems emphasizes social stability, but from a governmental perspective. The common law instead focuses on the rights of individuals. When the rights of individuals are in conflict with asserted claims of societal rights, there may be a serious loss of personal liberty.

SEE ALSO: Movements, Environmental; Private Property; Property Rights.

BIBLIOGRAPHY. Joshua Getzler, *History of Water Rights at Common Law* (Oxford, 2004); John Lowry and Rod Edmunds, eds., *Environmental Protection and the Common Law* (Hart Publishing Limited, 2000); Noga Morag-Levine, *Chasing the Wind: Regulating Air Pollution in the Common Law State* (Princeton University Press, 2003); Roger E. Meiners and Andrew P. Morriss, eds., *Common Law and the Environment: Rethinking the Statutory Basis for Modern Environmental Law* (Rowman & Littlefield Publishers, 2000); Bruce Yandle, *Common Sense and Common Law for the Environment: Creating Wealth in Hummingbird Economies* (Rowman & Littlefield Publishers, 1997); Wil Waluchow, *Common Law Theory of Judicial Review: The Living Tree* (Cambridge University Press, 2006).

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Common Property Theory

COMMON PROPERTY THEORY addresses the use and abuse of resources often held in common, such as pastures, forests, fisheries, groundwater, and even the global atmosphere. Common property theory has evolved from a concern with the Tragedy of the Commons, through a series of detailed studies documenting successful traditional systems for managing common property resources, and into a sophisticated body of theory addressing the conditions under which people are able to forge sets of rules and practices that coordinate the use and conservation of common resources.

According to the Tragedy of the Commons approach, a resource owned in common will almost certainly be abused. In a common property pasture, for example, individuals gain all the benefit from putting more sheep on the pasture; all the milk, meat, and wool belongs to the individual. However, each sheep added to the pasture subtracts from the total grass available. These actions of individual shepherds would inevitably lead to overstocking and grass depletion.

TRAGEDY OF THE COMMONS

The concept of "free-riding" is central to the Tragedy of the Commons formulation. "Free-riders" are resource users who shirk the work and responsibilities of contributing to resource management. For example, free-riders can eschew such work of investing in an irrigation system, but still enjoy the benefits of water delivery. When a person cannot be excluded from benefits that others provide, there is little motivation to contribute to joint efforts. If everybody decides to free-ride, however, there are no benefits from sound resource management. The free-riding problem makes voluntary contributions to a public good (such as common property maintenance) illogical; solutions require outside coercion. According to this early formulation of common property theory, only privatization or state control could resolve this dilemma. Either the resource must be allocated to individual owners who will suffer their own consequences if they overstock, or else the state must impose rules to restrain the effects of individual rationality.

One way to summarize the Tragedy of the Commons view is the adage that "everybody's property is nobody's property." For many, this formulation remains the Commons problem, in spite of a great deal of work documenting successful common property management regimes. Such ideas continue to have great cultural resonance in Western thinking. On the one hand, private property evokes the "invisible hand" of the market that guides individually selfish actions toward the greatest social good. On the other, lack of private property leads to brutish chaos and disorder.

Current common property theorists identify several conceptual errors in the Tragedy of the Commons formulation. Common property is not everybody's property. Instead, common property is one of several different ways to organize ownership of common pool resources—a class of resources for which it is difficult to exclude people and for which use involves the ability of subtraction. A fishery is a clear example of a common pool resource; it is difficult to keep fishers out, and when a fisher makes a catch, it is no longer available for other fishers.

There are four basic property regimes for such resources. Under open access, there is no exclusion and no rules governing individual use. Under private property, the resource is parceled out to individuals. Under state property, the state retains ownership and regulates the resources. Under communal property, which is often referred to as "common property," an identifiable community of resource users is able to exclude other users and subject the resource to customs and rules. It is a misunderstanding to conflate "the commons" or "common property" with open access. Tragedy of the Commons only portrays a very small subset of common pool resource ownership arrangements.

Common property theory addresses the use and abuse of resources often held in common, such as forests.

COMMON PROPERTY IN THE PAST

Over the years, the Tragedy of the Commons perspective has spawned a heated counter-response, especially from anthropologists, geographers, and other researchers familiar with the numerous small-scale, often non-Western societies that have successfully developed social practices to manage common pool resources. Ethnographies provide details on the diverse societies in the past and present that have independently come up with communal arrangements to manage common-pool resources. Many of these communal property systems have persisted for long periods, because they build on knowledge of the resource and cultural norms that have evolved and been tested over time. From medieval common grazing lands to wild beaver populations in subarctic Canada, different societies have frequently been able to work out rules for the orderly use of common pool resources of interest to them.

The rules for orderly use in different societies are often stunningly complex and intricately embedded in cultural systems. Researchers note, for example, that rural tenure systems in developing countries are typically quite different from the notion of exclusive private property in land, which has evolved over several centuries in the West. In contemporary rural societies, for example, there may be coincident rights to fruits from a tree, the firewood it produces, and the land it grows on. Rights holders are similarly complex. They include villages, kinship groups, households, men, women, government-sanctioned cooperatives, and national forest departments. Taboos, religion, and local views of morality often underline tenure systems. Local structures of authority—such as chiefs, temples, and village councils—play important roles in maintaining these rights and arbitrating disputes. A moral economy is often involved in maintaining these common systems.

Unfortunately, these complex resource-management systems are often susceptible to breaking down following clumsy interventions from the state, commercialization, land degradation, population pressures, encroachment, and the expropriation of common resources by outsiders or a few members of the community. In forests, for example, an anticommons attitude often resulted in nationalization or privatization via concessions. These policies sweep away established local systems of resource control, converting communal management regimes into open-access situations where the state has nominal authority, but no real power. The "real tragedy of the commons," according to some common property theorists, is the destruction of common pool resource management systems and subsequent environmental degradation following the intrusion of modernizing states and modern economic relationships.

Currently, debates about common property go beyond the Tragedy appraoches. Analysts now develop theories of common pool resource management that attempt to explain whether, and under what circumstances, common pool resource users can individually organize and achieve sound management of their fishery, forest, global atmosphere, or other common pool resource.

One group of common property theorists does not challenge the basic notion of a dilemma between individual and collective rationality; rather, it identifies the difference between open access and a common property regime, where internally-enforced rules, or social institutions, harness individual rationality to the collective good.

This school argues that free-riding is not always the dominant rational strategy. With adequate institutions, understood as rules that coordinate social relationships, cooperation becomes a rational strategy. For contemporary commons researchers, the question is under what circumstances are communal management arrangements appropriate, and can the state, the market and civil organizations together promote efficient, fair, and conservative use of common pool resource management?

Institutional Choice is one of the most influential and theoretically powerful attempts to address this question. The approach holds that people have the ability to craft the institutions (understood mainly as rules) that govern their use of a resource held in common. Institutional Choice addresses two basic issues. The search for design principles identifies and catalogues the features and rules shared by successful commons management systems. Institutional Choice also assesses the conditions under which groups of people are likely to develop successful common pool management systems. Institutional Choice rests on a notion of rational individuals making cost–benefit analyses of whether or not to invest in processes of institutional change.

SEVEN KEY DESIGN PRINCIPLES

Through fieldwork and a careful comparison of a large number of case studies of different types of long-enduring communal management regimes, common property theorists have identified about seven key design principles.

First, successful common pool management systems have *clearly defined boundaries* of the resource and its users. Second, there is a *proportional equivalence* between benefits and costs, such that rights of usage are balanced with obligations to invest labor, materials, and/or money into the management system.

Third, there are *collective-choice arrangements,* in which most resource users are included in the group and able to modify the rules. Fourth, there are *monitors*, sometimes the resource users themselves, who actively audit both physical conditions and user behavior, and who are at least partially accountable to the users.

Fifth, there are enforcement mechanisms with *graduated sanctions*. Violators of resource use rules are punished in accord with the seriousness and context of the offense. Sixth, *conflict-resolution mechanisms* are available so resource users and their officials can resolve conflicts amongst themselves. Seventh, the state grants resource users some *minimal recognition of rights to organize*. The state does not challenge locally devised institutions, and it recognizes users' long-term tenure rights to the resource. For resources that are part of larger systems—such as mountain pastures and large-scale irrigation systems—commons management systems are often "nested enterprises" with resource use, monitoring, enforcement, and conflict resolution organized in multiple layers of "nested organizations."

The Institutional Choice approach to common property theory also assesses the conditions under which groups of people are likely to develop successful, common-pool management regimes. According to this approach, rational actors choose to invest in rule changes based on an analysis of benefits and costs. A framework for analyzing institutional change summarizes these variables in a number of factors favoring collective action. First, users of a commonly held resource agree that lack of change will harm them; they know they have a resource-use problem. Second, the resource users care about the continuation of benefits from the common property resource. Third, they face relatively low information, transformation, and enforcement costs. Fourth, they share norms of reciprocity and trust. This includes a capacity to communicate and make binding agreements, the ability to arrange for monitoring and enforcement provisions, shared norms of guilt, concepts of self-worth, social censure, and patterns of reciprocity. Fifth, the group of resource users is well-defined.

Other things being equal, it may be more difficult to organize with a large, dispersed, and ethnically heterogeneous group than with a smaller, ethnically homogenous group living in a single settlement. While heterogeneity was originally viewed to inhibit collective organization, subsequent refinements to theory recognized that internal difference might foster cooperation via trade benefits. Other analysts stressed the importance of communication, preferably face-to-face, as a catalyst for collective decisions on rules of common-pool resource management.

CRITICS OF INSTITUTIONAL CHOICE

Several criticisms of Institutional Choice have arisen. Because Institutional Choice emphasizes the role of local communities in resource management, and often obscures the role of states, influential market structures, and other powerful actors operating at multiple scales, some point out that common property management regimes evolve or erode amongst resource-use influences and power relations embedded in local, regional, national, and international scales. For some common property theorists, these are much more important than the local-scale situational factors fostering collective action or the types of rules associated with successful commons management. Common property theorists call for increased attention to the relationship between common property management regimes and outside structures, such as market structure, the multiple implications of commodification, state programs, and even international trade agreements and regulations.

A cultural critique rejects the idea that rational choice can successfully explain the commons. For these common property theorists, institutions of common pool resource management, the community, the individual person, and culture are all interpenetrated items composing a realm of meaning and identity. Commons users are not only embedded in specific historical sets of political and economic structures, but also in cultural systems of meanings, symbols, and values. For this approach, the commons is culture, so rational choice only makes sense within a specific cultural context, and is often constrained by deeply rooted moral economies.

Common property theory is also challenged by the global scale of common pool resource management issues. Questions remain, for example, about the extent to which the design principles and situational variables central to common pool management regimes at the local scale will transfer to the realm of international cooperation and other large-scale, common pool resources.

Finally, common property theorists also struggle to factor in the inherent uncertainty and instability of environmental systems. It is difficult to separate environmental flux from the role of social institutions and human activities when analyzing common pool resource management successes and failures.

Despite these continuing disagreements and uncertainties, common property theorists agree that common pool resources are not always destined for a tragedy of over exploitation. They agree that the commons can be successfully managed by a wide variety of ownership arrangements.

SEE ALSO: Hardin, Garrett; Institutions; Prisoner's Dilemma; Tragedy of the Commons.

BIBLIOGRAPHY. David Feeny, Fikret Berkes, Bonnie J. McCay, and James Acheson, "The Tragedy of the Commons: Twenty-Two Years Later," *Human Ecology* (v.18, 1990); National Research Council, *The Drama of the Commons*, E. Ostrom, T. Dietz, N. Dolsak, P. Stern, S. Stonich, and E. Weber, eds., *Committee on the Human Dimensions of Global Change* (National Academy Press, 2002); E. Ostrom, *Governing the Commons. The Evolution of Institutions for Collective Action* (Cambridge University Press, 1990).

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Commoner, Barry (1917–)

BARRY COMMONER IS renowned as one of the early founders of the environmental movement. He was educated at Columbia and Harvard Universities. He became a cellular biologist and was working at Washington University in the 1950s when his attention was drawn to the effects of nuclear fallout resulting from the testing of nuclear devices in the Nevada desert. His investigations led him to challenge government insistence that there were no health implications of the tests, and also challenge of data being classified. He helped establish the St. Louis Committee for Nuclear Information in the bid to pierce this secrecy. His careful observations were able to demonstrate the negative effect of fallout on children, and his work was instrumental in the creation of the Limited Test Ban Treaty of 1963, which was signed by the United States, Soviet Union, and the UK, and outlawed testing of nuclear devices underwater, in outer space and, most importantly, within the atmosphere.

Commoner argues in *Making Peace with the Planet* that managing the pollutants and by-products that result from the modern industrial and consumer-based society is not practical given the environmental damage it causes. Instead, it is necessary to reorganize the whole of society on lines that are more environmentally sustainable. This caused him to help establish the Citizen's Party (1979–84), which proposed a manifesto of quite radical environmental initiatives born out of frustration with the policies of existing parties. At the 1980 presidential election, Commoner ran with La Donna Harris and received nearly 250,000 votes. Subsequently, Commoner has been involved with education and the furthering of science as well as promoting his ideas for the reorganization of the industrial systems of the developed world. He has become associated with the thesis that environmental degradation results from industrial development rather than from population pressure, as argued for by Julian Simon. Consequently, he does not argue that the number of people should be controlled or that management of industrial functions, if properly effected, can be sustainable.

In 2006, he taught at Queens College in New York City, where he moved after his unsuccessful presidential bid. He has been recognized by various eminent authorities and by his home city of St. Louis. His work has extended across a range of scientific investigations, in addition to the well-known environmental issues for which he has come to be much celebrated. This has also included research into ozone layer depletion and the practicalities of redistributing wealth and income on a global basis.

SEE ALSO: Nuclear Weapons; Simon, Julian; Sustainability; Sustainable Development.

BIBLIOGRAPHY. Barry Commoner, *Making Peace with the Planet* (New Press, 1992); Barry Commoner, *The Closing Circle: Nature, Man, and Technology* (Random House, 1971); Barry Commoner, "The Relationship between Industrial and Ecological Systems," *The Journal of Cleaner Production* (v.5/1–2, 1997).

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Communications, Interspecies

INTERSPECIES COMMUNICATIONS IS a phenomenon and an area of study. The systematic study of communications within and between species is an emerging discipline that seeks to find ways to develop human communications with other species and to identify and understand communications between different species. Communications, the sending of messages that have intelligent or rational meanings that can be comprehended, takes places when feelings or thoughts are shared between one life form and another. Intraspecies communications occurs between members of the same species. Interspecies communications occurs between members of different species. From the most ancient times, people have observed species communicating among themselves. Fish, reptiles, birds, and mammals communicate in forms of intraspecies communications.

Beginning in prehistoric times, humans began to domesticate wild dogs, donkeys, hawks, hunting cats, camels, and cows. Simple observation of domesticated animals demonstrates that humans communicate with a large range of different species. Humans have trained dogs, birds, horses, camels, and donkeys as working livestock. When humans use trained dogs to guard and herd sheep, the dog uses signals to move sheep in a desired direction. Much of this communication is reflexive or instinctual. Dogs, horses, and elephants have also been trained for war, which seems to excite the aggressive nature in these animals and also communicate fear or aggressiveness. Since the end of World War II, extended studies have been made of dolphins and some of the great apes. These studies have attempted to teach animals language that can be understood by humans. The U.S. Navy has trained dolphins to locate explosive sea mines and scout for enemy vessels, especially submarines.

RATIONAL COMMUNICATION

Recent studies with dolphins and primates such as Bonobos and chimpanzees have sought to demonstrate that they can learn words and communicate rationally with humans. Since the 1960s, a number of ape-language projects were established to study the possibility of developing communications between apes and humans. One ape sign language center was the Yerkes Regional Primate Research Center of Emory University in Atlanta, Georgia. Bonobos (*Pan paniscus*), the most rare of the great ape species, are found in the Republic of Congo. They are very matriarchal and about the size of chimpanzees. Kanzi, a Bonobo studied at Emory University, learned to communicate with humans using a keyboard with 120 symbols. He was such a quick learner that he apprehended the meaning of words and symbols without any instructions, or with little training. His active vocabulary increased to over 200 words and to 500 words for his receptive vocabulary. Psychological studies of the ways children acquire language skills, developing rapidly in the 1970s, were helpful in teaching Kanzi. In return, Kanzi was a contributor to an emerging theory that children could be taught to sign as communication long before they learn to speak.

Some researchers have engaged in studies of communications with whales using music. Others have sought to develop communications with cetaceans using echolocation clicks, songs, and whistles. Communication by humans with other species that is an exchange of rational thoughts requires humans to function on the behavioral time of the species. Children often tell adults that they can communicate with animals, but have been told that it's "just their imagination." Research efforts have noted that some imagination is required for humans to be empathetic with an animal communications subject, especially when the communication is nonverbal and nonbehavioral telepathic. The Samantha Khury Institute of Interspecies Communications in Sweden specializes in this from of communication.

Interspecies communications studies of the variety of ways that animals communicate between themselves have been conducted in increasing number in recent decades. Researchers all over the world have advanced understanding of the vocabulary and syntax of animal species languages. The rapid development of computer devices that can be used for interspecies communications holds great promise for future breakthroughs of communications by humans with other species. These devices could possibly enable not only speech recognition, but also smell, behavioral, or animal sentience to be transformed in a hand-held black-box by a system of artificial intelligence that delivers intelligible communications.

SEE ALSO: Animals; Dolphins; Species.

BIBLIOGRAPHY. Dawn Hayman, *If Only They Could Talk* (Simon & Schuster, 2005); Roger Fouts, Stephen Tukel Mills, and Jane Goodall, *Next of Kin: My Conversations with Chimpanzees* (Sagebrush Education Resources, 1998); Sue Savage-Rumbaugh and Roger Lewin, *Kanzi: The Ape on the Brink of the Human Mind* (John Wiley & Sons, 1994); Penelope Smith, *Animal Talk: Interspecies Telepathic Communication* (Beyond Words Publishing, 1999).

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Communism

AS AN ECONOMIC concept, Communism represents the establishment of communes, where large numbers of people work for the collective good. For many people during the 19th century, an agricultural cooperative was seen as a good idea in theory. However, many of these cooperatives failed. Robert Owen's establishment of New Harmony in Indiana in 1825 was one of the best-known of these cooperative ventures, but it failed. There was then the influence of Charles Fourier, who promoted the concept of communes. Both Brook Farm and Fruitlands, run by the Transcendentalists during the 1840s, failed within a few years of their formation. A large number of similar cooperatives in Latin America during the middle of the 19th century also failed.

The *Communist Manifesto* of 1848 by Karl Marx advocated the idea that Communism would be the last stage of Socialism, at which time goods would be so abundant that they could be distributed on the basis of need rather than endeavor. It was in support of this idea that the Bolshevik wing of the Russian Social-Democratic Workers's Party, which came to power during the Russian Revolution of 1917, changed its name to the All-Russian Communist Party in 1918. Soon afterwards many of its allied parties in other countries also changed their name to Communist Party, although a few continued to operate under other names, but stated that their doctrines were "Communist."

SOVIET UNION: THE UKRAINE

Communism in practice was very different to Communism as a theoretical construct. In the Soviet Union, the first task for the new government was to try to repair the damage during World War I and the Russian Civil War. Economically the country was in poor shape, and the industrial base, which was weak at the start of the Russian Revolution in 1917, was in tatters by the end of the wars. This led to what became known as War Communism, which lasted from June 1918 until March 1921, and the introduction of policies such as the expropriation of private business and also the nationalization of all industries, along with the forced requisition of surplus grain and other foods from peasant farmers. These measures damaged both agricultural and industrial production, reducing the incentives for people to grow surplus grain, and it also encouraged secret hoarding by many peasants. The result was that by 1921, industrial production had fallen to 20 percent of the level in 1913, with wages falling by one-third.

The resulting public discontent led to demonstrations and strikes, which were part of the cause of the Kronshtadt Rebellion of March 1921. This led to the Communists delaying their plans to introduce a socialist economic system by decree, and the introduction of their New Economic Policy. The Communists, therefore, had to embark on a massive campaign of industrialization. Vast factory complexes were built, the mining sector was expanded, and the plan was to build an economy based on coal, iron ore, and steel.

The workers who had supported the Communists coming to power in the Soviet Union also had to be housed after the Russian Civil War. The devastation that had taken place in the countryside had resulted in an influx of many people into the cities. To deal with the housing shortage quickly, many drab apartment buildings were erected on the outskirts of many of the main cities throughout the Soviet Union. This was combined with an upgrading of public transport to bring these people from satellite suburbs into work at factories and in cities. There was also the building of resorts along the Black Sea and other warmer regions.

In 1932 and 1933, millions of Ukrainian peasants starved when vast grain reserves were requisitioned by the government to feed the people in the cities. In spite of a drought and reduced harvest yields, the government under Stalin advocated farm collectivization for economic reasons, or as many suggest, to stifle any resistance to collectivization and eliminate nationalist sentiments.

The German invasion of the Soviet Union in June 1941 destroyed vast tracts of western Russia, and then in the guerilla wars that followed. Once again, the Soviet Union had to devote much of its resources to providing housing for the people rendered homeless after the war, with many drab office blocks and apartment buildings being erected in many of these cities such as Minsk, Smolensk, and Kiev. After World War II, the Soviet Union embarked on a nuclear power and nuclear weapons program. Two underground nuclear test sites were established—at Novaya Zemlya Island in the Arctic Circle, and at Semipalatinsk in Kazakhstan.

SOVIET UNION: ASIA AND MONGOLIA

With the introduction of Communism into Central Asia, large cities were built either for administrative or military reasons, as well as close to sites of mining or industrial ventures. Soviet urban planners laid out enormous city complexes such as Alma-Ata (founded in 1854 as the small garrison town of Verny). The Soviet Union also used Kazakhstan and other parts of central Asia for military installations and parts of their space program. Many towns and cities, such as Chkalovsk in Tajikistan, were closed to foreigners. The development of new farmland was introduced with the Virgin Lands program. Massive infrastructure projects saw the construction of large dams and power plants such as those on the Dneiper River. Nuclear power also initially seemed to provide much cheap electricity, but the Chernobyl accident in 1986 created massive awareness of widespread pollution, not just in the nuclear field, but also industrial pollution and the prevalence of chemical waste, especially in some parts of central Asia.

Communism in Mongolia also led to many changes in the country. Initially after the death of Lenin in 1924, Stalin was content to allow Mongolia some level of independence—the proclamation of the Mongolian People's Republic took place in 1924, making Mongolia the first Communist nation outside the Soviet Union.The moves introduced by Sükhbaatar, the leader of the Mongolian People's Party, were initially moderate; but in 1920 Choibalsan became the minister of foreign affairs, and started to dominate the economic life of the country. Land was seized from landlords and handed over to peasants or turned into cooperatives. It has been estimated that 27,000 people (including 17,000 monks)—up to 3 percent of the population at the time—were killed. Gradually the moves became more extreme, with harsh punishments for any form of dissent. As with the Soviet Union, large numbers of office blocks and drab apartment buildings were erected in Ulan Bator and in newly created cities throughout the country. Although infrastructure was good during much of the Communist period, it was costly, and as soon as Communism ended, massive social problems arose with much of the population unprepared to adapt to free market policies.

CHINA, NORTH KOREA, VIETNAM, CUBA

The Communist victory in China in 1949 resulted in the whole of China being put under central planning for the first time. Initially, the changes were minor and administrative in many areas, with so much of the population at peace in the country since the warlord period of the 1920s, the civil war, the war with Japan and the final stage of the civil war from 1945 until 1949. China's industry was badly damaged in the fighting, as well as substantial amount of the country's infrastructure—roads, railways, hospitals, and schools. This meant that the new government had to divert many resources to these projects, as well as to sending soldiers to Korea from 1950 to 1954, and giving support to other friendly governments such as North Vietnam.

After land reform, the breakup of the big estates, and destruction of the landlord class, the next program embarked by the Chinese Communist leader Mao Zedong was to see through his plans for the industrialization of the country. The Great Leap Forward campaign of 1958–60, urging for the creation of a large steel industry, failed because it relied too heavily on small producers rather than major factory projects. This policy was gradually reversed, but the economic advancement of the country was dramatically affected with the Great Proletarian Cultural Revolution that started in 1966. It put ideology ahead of economic progress and led to major economic, cultural, and social problems, which were to plague China for many years. With the rise of Deng Xiao-ping, the Communist Party's role remained unchallenged, but a capitalist economy was introduced.

Although there were environmental advances made in China during this period, there was little protection of wildlife. However, the panda bear became heavily identified with the country, and panda bears were given to zoos around the world as a gesture of goodwill and friendship.

Other Communist countries around the world experienced varying levels of success with their economic policies. In North Korea, collectivization started soon after the Communists came to power in 1945. Korea had long been isolated from the rest of the world, and after the Korean War of 1950–54, the Communist leader Kim Il Sung isolated his country even further by introducing his Communist concept of Juche, by which the North Korean economy was able to become wholly independent. Their industrial wealth was largely responsible for this, but North Korea has always suffered from its lack of agricultural land. When the harvests failed in the late 1990s, mass starvation followed.

North Vietnam and Cuba, also Communist countries, tried to engage with the rest of the world after Ho Chi Minh and Fidel Castro, respectively, came to power. However, they quickly became identified too strongly with Communist China and the Soviet Union; Vietnam eventually broke with the Chinese and allied with the Soviet Union.

Eastern Europe

Much of eastern Europe—Albania, Bulgaria, East Germany, Hungary, Poland, Romania, and Yugoslavia—had similar experiences of Communism as the Soviet Union, with the first Communist rulers having to embark on massive urban development projects to house those made homeless during World War II. They faced an unprecedented move from the countryside to the cities and towns, and the necessity of providing employment. Much of this came from a boost to the agricultural sector and, at the same time, a large industrialization program around projects such as the Gdansk shipyards in Poland. There were also continuous problems with eastern Europe—the Hungarian Revolt of 1956, the rift with Enver Hoxha's Albania, the ending of the Prague Spring of 1968, the split with Tito's Yugoslavia, problems with Nikolai Ceausescu in Romania, and finally the emergence of the Solidarity Trade Union Movement in Poland. Whatever the political disagreements, with the exception of the split with Albania, economic policies in many of these countries remained stable. This resulted in an improvement in the standard of living of many people, although at the same time vast waste of economic resources. Environmentally, large tracts of eastern Europe were polluted.

DISASTEROUS CONSEQUENCES

The most extreme form of Communism was in Cambodia, where the Khmer Rouge under Pol Pot launched their hardline Maoist policies of collectivization within hours of coming to power. They evacuated the cities and towns, and tried to recreate an agricultural society. It was a disaster, with up to a million people killed by the regime or dead from disease, malnutrition, or overwork. It ended in December 1978 when Communist Vietnam invaded and established its client regime, the People's Republic of Kampuchea, with a civil war fought from 1979–91. There have also been Communist governments in Africa: Angola, Mozambique and Guinea-Bissau. All three had been former Portuguese possessions, with the first two enduring long wars against pro-Western guerilla movements backed by South Africa and the United States.

The environmental policies of Communist countries have varied considerably, with many facing severe shortages of resources because of wars. Underdevelopment and restrictions on movement, as well as on private land development, have helped some natural resources survive. However, many other areas have become badly polluted because of economic mismanagement and the lack of concern of some officials for the natural environment. While wildlife diversity and national parks were created in some countries, flora, fauna, and the environment have suffered badly in other areas.

SEE ALSO: Albania; Angola; Bulgaria; Cambodia; Central Planning; Chernobyl Accident; China; Collective Agriculture; Cuba; Drought; Guinea-Bissau; Hungary; Industrialization; Kazakhstan; Marx, Karl; Mongolia; Mozambique; National Parks; North Korea; Poland; Romania; Socialism; South Africa; Soviet Union; Transcendentalism; Ukraine; Vietnam; Wildlife.

BIBLIOGRAPHY. C.R. Bawden, *The Modern History of Mongolia* (Weidenfeld & Nicolson, 1968); Mark Elvin and Lieu Ts'ui-jung, eds., *Sediments of Time: Environment and Society in Chinese History* (Cambridge University Press, 1998); Jean Esmein, *The Chinese Cultural Revolution* (Andre Deutsch, 1975); Robert Maxwell, ed., *Information U.S.S.R.* (Pergamon Press, 1962); J.P. Nettl, *The Soviet Achievement* (Thames and Hudson, 1967); A.J.K. Sanders, *The People's Republic of Mongolia* (Oxford University Press, 1968).

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Community Forestry

COMMUNITY FORESTRY IS an approach to forest conservation and management in which forest inhabitants participate in management activities and ideally enjoy the economic and livelihood benefits. Community forestry contrasts with exclusionary models of forestry, including logging concessions to large firms and national parks that prohibit most human uses.

Community forestry appeared in the context of three broad social trends. First, there was the late 20th-century context of political change, including the widespread replacement of authoritarian regimes with democracies throughout the world and the rise of neoliberal development policies that encouraged states to decentralize, deregulate, privatize, and generally withdraw from many traditional management activities. Second, the analysis of conservation and forestry projects repeatedly identified social conflicts between managers and forest residents that often jeopardized conservation goals. Third, there were increasingly influential social movements of indigenous people and other traditional forest inhabitants demanding greater autonomy and self-determination. Within this context, states have increasingly recognized the legitimacy of forest residents' land claims, and in some cases, implement forest regulatory structures that permit forest inhabitants to participate in forest management. In other cases, states maintain forest ownership but grant concessions to communities, or create joint management arrangements between forest departments and local groups. In addition, many communities still occupy and manage forests without official state sanction, but they risk suddenly finding their forests scheduled for logging or exclusionary preservation.

Community forestry also varies greatly in the rights of communities to benefit from forests. In many countries, timber is one of the few forest values recognized by existing markets, but it is rare for states to recognize full community rights to its commercial use. Where economic benefits are denied, community forestry is little more than a way for states to dump environmental management responsibilities on communities while granting the rights to economic benefits to forest departments, or other privileged, noncommunity actors.

MULTIPLE APPROACHES

There are multiple approaches to community forestry in different countries. Mexico exemplifies an approach in which the state recognizes village members as collective owners of specific areas of forest where they have the main responsibility for forest management. Villagers often establish forest management enterprises that engage in logging and forest management. Except for normal taxes, the state makes no claim to community revenues from the sale of forest products. In Guatemala, most forests remain state property; but in some cases, the state grants concessions to communities as a strategy to protect forests from illegal logging or clearing for agriculture. The Guatemalan community concessions do not concede ownership rights, but they do include the rights to harvest timber, take nontimber forest products, and even to continue farming on previously cleared agricultural lands surrounding villages. India's most widespread approach to community forestry is called Joint Forest Management.

This approach does not transfer ownership of forests; instead, beneficiaries are organized into village committees and given recognition of rights to collect minor forest products. They are also entitled to a portion of the proceeds from the sale of forest products, including trees. The proportion of the harvest that goes to the community varies from 100 percent in a few states to only 20 percent in others.

In the United States, 56 percent of forests are private, 38 percent are on government lands, and 6 percent are owned by indigenous peoples. Logging in these forests is increasingly embroiled in paralyzing conflict about endangered species, unsustainable timber yields, and industrial restructuring. Community-based collaborative partnerships are increasingly important in U.S. natural resource management, as groups of people work together to define and address common resource management issues that affect specific places but cut across government regulatory agencies. A few U.S. national forests have entered into isolated collaborative efforts with local communities. Stressing the idea that healthy forest ecosystems depend on healthy human communities, regional movements of community forest activists advocate wider legal and political openings for increased local stewardship over forests, despite opposition from some environmental organizations.

Community forestry remains controversial. Some conservationists prefer preservationist approaches, usually with a stronger role for the state in forest management and protection. Others criticize the romantic way in which community forestry policies sometimes overlook social difference, social conflicts, and injustice within communities. Despite these criticisms, it is often successful in improving both rural development and forest conservation outcomes.

SEE ALSO: Common Property; Institutions.

BIBLIOGRAPHY. M. Baker and J. Kusel, *Community Forestry in the United States: Learning from the Past, Crafting the Future* (Island Press, 2003); M. Poffenberger and B. McGean, eds., *Village Voices, Forest Choices: Joint Forest Management in India* (Oxford University Press, 1996).

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Community Gardens

URBAN COMMUNITY GARDENS are cool green oases in city environments that are often overwhelming in their density and complexity. Beyond their role as refuge, however, community gardens have provided the basis for a number of novel sociocultural experiments. Neighborhood residents grow vegetables to supplement their grocery budgets, giving them greater control over their own food and nutrition. Children have an opportunity to learn about gardening, plants and insects, and the ecology of their own neighborhoods. Artists stage music, theater, and other performances in gardens for audiences who otherwise might not have access to cultural resources. With the advent of development and the struggle to defend green space, the community gardens have also become the locus of grassroots political organizing.

HISTORY OF COMMUNITY GARDENS

Urban agriculture has a lengthy history in the United States. The Work Projects Administration (1935–43) sponsored relief gardens in vacant lots and city parks during the Depression, and many urbanites grew Victory Gardens on city land during World War II. Historical accounts of community gardening, however, usually begin with the 1970s. American cities like New York, Detroit, and Boston were experiencing severe fiscal crises, city services were unavailable or very low quality in many neighborhoods, and properties were abandoned or burned down by absentee landlords. The vacant lots, plagued by illegal dumping, vermin, and crime, were a disaster for property values and neighborhoods' quality of life.

The community gardens were born out of citizen direct action in response to this urban devastation. Gardeners cut locks on fences, hauled away tons of trash and rubble, and on occasion drove away drug dealers by force. In place of these unwanted land uses, gardeners created a wide variety of public green spaces. Many of the community gardens reflected the ethnic character of their neighborhoods and gardeners. For example, Puerto Rican gardeners throughout New York recreated the Puerto Rican countryside with *casita* gardens.

Poster for the U.S. Department of Agriculture promoting World War II victory gardens and vegetable growing.

In many cases, land for community gardens was provided as a sort of city service, akin to the Victory Gardens of the World War II era or the allotment gardens in the United Kingdom. For example, New York City's Operation Green Thumb helped gardeners secure free temporary leases to their lots. In such cases, the leasing process was often a bureaucratic challenge, requiring the gardens to establish a board of directors and regular meetings. Many of the garden groups lacked the experience or resources to pursue this route, so many of them persisted in a semi-legal status, facilitated by benign neglect from authorities.

On the other hand, many gardeners were essentially squatters, occupying city-owned or vacant lots without any sort of official sanction. As urban real estate values climbed through the 1980s, gardens increasingly came under pressure from development. Community garden activists responded in a variety of fashions, from fund drives to direct action. The New York garden conflicts became famously bitter; Mayor Guiliani told garden supporters, "This is a free-market system. Welcome to the era after communism." Meanwhile, garden supporters compared the mayor to Hitler. Many of these conflicts over community gardens remain unresolved, even when a number of specific settlements have been reached and the political context of community gardening continues to evolve.

SEE ALSO: Urban Ecology; Urban Gardening and Agriculture.

BIBLIOGRAPHY. Richard Goodman, *Report on Community Gardening* (National Gardening Association, 2000); Barbara Huff, *Greening the City Streets: The Story of Community Gardens* (Clarion Books, 1990); Patricia Hynes, *A Patch of Eden: America's Inner City Gardeners* (Chelsea Green Publishing, 1996); Malve von Hassell, *The Struggle for Eden: Community Gardens in New York City* (Bergin & Garvey, 2002).

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Community-Based Conservation

COMMUNITY-BASED CONSERVATION IS commonly seen as having two central objectives: to enhance conservation of wildlife, biodiversity, and/or the environment; and to provide economic, social, cultural, and political benefits to local people. These objectives are connected; when communities benefit from conservation, they will be more likely to support it. Community-based conservation is also a process achieved by a variety of mechanisms, including devolution of control over resources from states to communities, development of community institutions to manage those resources, meaningful participation of communities in decision making about conservation, and legalization of property rights. Central to the community-based conservation concept is the assumption that people living closest to and depending on a resource will be most affected by its depletion, and thus have high stakes in its sustainable management.

The predecessors of community-based conservation include the concept of buffer zones, introduced by UNESCO in 1979, and Integrated Conservation and Development Projects, popularized in the late 1980s and early 90s. Both have been criticized for their failure to adequately involve local people in planning. In theory, community-based conservation is different than its predecessors, because it places the community's involvement at the center of conservation, rather than the mechanism (such as a park or project) for achieving it. Thus, participation is critical to the community-based conservation concept, and takes place ideally at all stages, from planning to implementation, management, and monitoring.

RESPONSE TO "FENCES AND FINES"

Community-based conservation and its predecessors arose in response to critiques of the traditional parks and protected areas, or "fences and fines" approach to conservation. This approach relies on excluding people from protected areas, eliminating consumption of resources within those areas, minimizing the impacts of preferred forms of use (leisure, recreation, and scientific research), and enforcing rules by the state. Critiques of this traditional approach address pragmatic, philosophical, and justice concerns. Pragmatically, the amount of land that can ultimately be protected and the costs and effectiveness of protection efforts have been questioned. Without local support, the biological goals of conservation can be undermined through encroachment and illegal harvesting activities, and efforts to enforce exclusion can consume disproportionate amounts of conservation funds. Philosophically, parks and protected areas historically were linked to North American romanticism and European utilitarianism, both of which emphasize the separateness of humans from nature. This vision of separateness has routinely conflicted with local visions of human–environment relations in many developing countries and can undermine local cultural and social norms, and traditional knowledge. From a justice standpoint, parks and protected areas impact most on local human populations living near them by restricting access to resources and associated livelihood activities. Thus, parks can exacerbate inequities between rural people living next to them and those who gain through visiting parks or receiving wider environmental benefits of protection. Thus, community-based conservation operates on a principle that local residents with legitimate claims to land or resources must be allowed to participate in their management and conservation.

The rise of community-based conservation also reflects more general trends, including the global spread of democracy, interest in social justice, and indigenous rights movements as well as the overall emphasis on sustainable development. With conservation and development defined as "opposite sides of the same coin," conservation organizations began to acknowledge the development needs of local people, and community-based conservation was envisioned as the way to meet these needs. The concept was so widely promoted in the 1990s that it became almost impossible to talk about conservation without referencing the community's involvement. Community-based conservation was in danger of becoming little more than a conservation catchphrase, appealing as it did to a wide array of conservation and development policymakers and practitioners.

Community-based conservation has experienced mixed success in practice, encountering several major obstacles. First, its implementers have failed to operationalize community participation in project identification, design, and management. Participation is, rather, often seen as a means to get people to support predetermined conservation programs. Second, community-based conservation projects have often been undertaken without an adequate understanding of local social and economic contexts and by environmental nongovernment organizations with limited experience in community development. A common recommendation for community-based wildlife conservation projects, for example, is the uncritical promotion of ecotourism, an activity that often relies on the continued existence of parks and protected areas. Third, *community* is a problematic term, too often treated as self-evident or generic. Communities are assumed to be homogenous entities, acting collectively to achieve common environmental goals. Little consideration is given to individuals within communities and the motives they might have to work against conservation programs. Fourth, the preoccupation with community has often meant that the ways in which communities are embedded in (and constrained by) larger economic and political systems have been overlooked. Finally, community-based conservation projects have focused too much on economic incentives and have often failed to enable genuine empowerment and social justice.

Proponents argue that critiques of community-based conservation arise from failure to properly implement it, rather than from any fundamental flaw with the concept itself. In contrast, a "resurgent protectionist" argument that calls for a return to people-free parks and protected areas is increasingly evident. Driven by some prominent conservation biologists, the argument cites the failure of community-based conservation to adequately protect biodiversity. What is not clear is how such a return will be done without also returning to original critiques of the protectionist paradigm. While community-based conservation may be flawed, it arose in response to real problems with parks and protected areas and it should not be deserted lightly.

SEE ALSO: Buffer Areas; Indigenous Peoples; Justice; Property Rights.

BIBLIOGRAPHY. Arun Agrawal and Clark Gibson, eds., *Communities and the Environment: Ethnicity, Gender, and the State in Community-Based Conservation* (Rutgers University Press, 2001); David Hulme and Marshall Murphree, eds., *African Wildlife and Livelihoods: The Promise and Performance of Community Conservation* (James Currey, 2001); David Western and Michael Wright, eds., *Natural Connections: Perspectives in Community-Based Conservation* (Island Press, 1994).

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Commuting

COMMUTING IS THE movement of people and vehicles between the place of work and the place of residence. Two peak traffic hours, at 7-8:00 a.m. and 5-6:00 p.m., correspond to the critical times of traveling to work and school in the early morning, and going back home in the evening.

The U.S. Census Bureau estimated the average travel time to work was 24.3 minutes in 2003. There are not significant differences between big cities—New York, NY, is 38.3 minutes; Chicago, IL, is 33.2; Los Angeles, CA, is 29.0; Miami, FL, is 29.0—but variation is remarkable compared to the cities in the last positions—Wichita, KS, is 16.3 minutes; Corpus Christi, TX, is 16.1. American workers of 16 years and over spend more than 100 hours commuting to work each year. However, averages hide important differences between automobile commuters and bus and train commuters, because mass transit requires extra time for transfers or the search for stops in poorly serviced areas.

Various commuting types depend on the directions of movement. *In-commuting* is a process of movement from suburbs to the central city in the early hours—completed with a reverse commuting in the late evening. *Lateral commuting* occurs where there are mixed land uses—particularly within residential areas or suburbs—where job opportunities emerge with service demands. Because residential areas are mostly located outside the city center, *in-commuting* prevails. This category of commuting, however, corresponds to an urban structure where the city core holds a central business district which excludes residential areas, and that is not the case of old cities with historical districts or high urban density areas.

This massive movement has a direct negative effect on mobility, engendering congestion and compromising urban sustainability. Once carrying capacity of roadways is exceeded, average speed diminishes and traffic congestion leads to supplementary public demands for increasing capacity with improved infrastructures. New capacity eases movement and favors further urban sprawl, increasing the total number of trips and the length of the movements, so new congestion emerges. The effects on the environment are higher levels of air and noise pollution, a reduction of green lands for building roads, and a greater dependence on fossil fuels. Strategies such as carpooling help to reduce the emissions per person, but usually require dedicated HOV (high occupancy vehicle) lanes, usually shared with buses.

Commuting has two basic accessibility requirements: a wide, complex, and interconnected road network for automobiles and buses, complete with an effective and multiple transit system—including light and heavy train, metro, bus, or ferryboat. However, mass transit has certain dysfunctions. Infrequent services are in low density areas, while others are overcrowded; or cities are almost totally car-dependent because the public transportation system has been scaled down.

Commuter buses and trains offer services with higher frequency at specific hours, fixed routes, and frequent stops and changeovers, and they serve metropolitan areas as an extension of the core city. *Intermodality* facilitates passengers' access in an integrated manner to multiple systems, responding to the complex urban structure or to local environment. Also, park and ride terminals—located in main train stations—allow commuters to leave their private vehicle and transfer to public transportation.

Both commuting time and trip length have slightly increased as congestion becomes more intense. The adaptive response is housing and job suburbanization and the relocation to less congested areas in searching for affordable housing. Concurrently, companies change their facilities, offices and factories from city center to the periphery—approaching the workers—and shopping malls move to reach consumers. This response strengthens lateral commuting and reduces inward and outward commuting. In the same way, more compact, dense, vertical cities with mixed land uses contribute to reduce travel times and facilitate walking or cycle commuting, notably reducing congestion. This happens in some European and Asian cities, where almost 30 percent of commuting falls in this category.

Once carrying capacity of roadways is exceeded, average speed diminishes and traffic congestion results.

Commuting garners not only environmental, economic, or urban planning costs, but also social costs. Families have to pay for high transportation costs, which are progressively increased with rising gasoline prices. This, in turn, induces changes in transportation patterns, favoring a greater use of public transportation. People usually overestimate the benefits of the transaction—better house, salary or school, lower rent—and tend to underestimate the losses—social connections, free time, and stress—resulting in dissatisfaction. Some low and moderate income households can only find affordable housing far from their jobs, or dual-income households fail to live near both jobs, leading to the growing phenomenon of extreme commuting. The percentage of extreme commuters, those who travel 90 or more minutes and even up to 3 hours one way, has increased from 1.6 percent in 1990 to 2.8 percent in 2000.

SEE ALSO: Automobiles; Carpooling; Urban Sprawl.

BIBLIOGRAPHY. Jeffrey R. Kenworthy, Felix B. Laube, *An International Sourcebook of Automobile Dependence in Cities, 1960-1990* (University Press of Colorado, 2000); Jos Van Ommeren, *Commuting and Relocation of Jobs and Residences* (Ashgate, 2000); Alan E. Pisarski, *Commuting in America II: The Second National Report on Commuting Patterns and Trends* (Eno Transportation Foundation, 1996); Qing Shen, "Spatial and Social Dimensions of Commuting," *Journal of the American Planning Association* (v.66, 2000); Wayne Simpson, *Urban Structure and the Labor Market. Worker Mobility, Commuting, and Underemployment in Cities* (Oxford University Press, 1992).

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Complexity Theory

"COMPLEXITY" IS A multifaceted term. Scientists, managers, and the public may mean quite different things by the term, since they each have distinct personal experiences that influence ideas and processes. Complexity science and related theories derive from natural science disciplines such as physics and chemistry. There is a widely recognized fact that the practice of managing human-environment interactions is complex. Complexity science and theories have become increasingly influential in environmental management in the last decade or so, following in the footsteps of broader systems and ecosystem concepts that became influential in the 1960s and 1970s.

The earlier incorporation of systems and ecosystem approaches into environmental planning and management brought home the connected and hierarchical nature of human–environment systems: connections between ecosystems, economies and societies, and between levels of ecological or government systems, for example. It also underscored basic thermodynamic implications: every activity uses or transforms energy and matter and produces waste, which in turn must go somewhere, being transformed again and again but never actually going away.

COMPLEX AND DYNAMIC INTERACTION

As environmental research continued, most famously into forest-insect pest dynamics, fisheries management and weather and climate forecasting, it became clear that ecosystems and human–environment systems were much more complex and dynamic than assumed. This made them difficult or impossible to predict, and even harder to manage for specific, maximum, sustainable yields and similar optimum goals. Change is increasingly recognized as normal and common, and predictability as rare—whether we are looking at animal populations, weather changes, or the desired and undesired effects of new products or management approaches.

What is meant by complexity? To begin with, complexity may encompass many parts, but that in itself is complicated. And if there are many parts involved, then statistics and probability come into play and yield a form of predictability. Complexity in an environmental management context means more than a few (but not astronomically large) numbers of parts—what Gerald Weinberg called *middle number systems*. Complexity also entails extensive connectedness of a system.

These are connections between social, economic, and ecological structures and processes; between individuals and organizations; and across scales from the local to the global. Complexity approaches recognize that systems are not static or unchanging, or even necessarily stable. In fact, they may change in major, qualitative, and sudden ways, and exhibit patterns of change over time that are themselves very complicated or even complex; this is not the simple straight lines or even gradual oscillations on a traditional x-y graph that we base our thinking. Patterns of change may seem completely random, or "chaotic," never repeating or showing any noticeable pattern at all.

The key natural science complexity theories that underlie these insights include chaos theory, self-organization, fractals, and others such as catastrophe theory that go back to the 1960s. All of these derive from looking at the structure and behavior of physical and chemical systems in space and time, and later from applications to biological, ecological, economic, and social systems with varied degrees of success and rigor.

The roots of chaos theory go back to the 19th-century physics and dynamics work of Henri Poincaré, which was first credited to Edward Lorenz's work in forecasting weather and atmospheric dynamics. He found that small errors in describing an atmospheric system's initial state rapidly amplified to large errors in a prediction of its future state. This has been called *sensitive dependence on initial conditions*. It is a result of nonlinear dynamics in the system, positive feedbacks, and other interactions that greatly amplify small differences as the system evolves in time. Self-organization ideas derive from work in complex chemical reactions that self-catalyze, and exhibit spatial and temporal patterns; or from the dynamics of lasers. Such systems dissipate energy and resources in maintaining their internal dynamics (like living organisms) through complex internal structure and connections. They go through periods of stability followed by instability in which their internal condition fluctuates, but ultimately "self-organizes" through internal nonlinear dynamics and amplification into a particular future state—which may well be a sudden, major transformation. Fractals are a form of complexity found in spatial, physical objectives—most famously in coastlines that get longer the finer the measuring stick you use, and which, like snowflakes, show similar patterns as different scales of resolution. The various complexity theories are connected at fairly deep, mathematical, and theoretical levels. For example, complex systems may exhibit complex, but not random patterns in time. These are called *attractors,* and mathematically, some are fractal in structure.

All of these theories are difficult to apply to human-environment systems in a quantitative way—it's a challenge even in purely biophysical contexts such as ecological or atmospheric systems. So they have primarily had influence by analogy and metaphor, as inspirations for newer, more systems-oriented frameworks for analyzing and describing human–environment systems. They have been a strong influence in ecosystem approaches and ecosystem management. Adaptive management, which seeks to adapt to uncertainty by treating management as an experiment and designing and implementing management to ensure ongoing learning, was an early response.

C. S. Holling and his colleagues have extended adaptive management into panarchy theory, which sees adaptive cycles of stability, disturbance, release, and reorganization in many human–environment systems. Fikret Berkes and colleagues write about resilience and social-ecological systems and their connectedness, changeability, and integral social, cultural, and institutional elements. Others have developed an Adaptive Methodology for Ecosystem System Sustainability and Health (AMESH) that draws deeply on complex systems ideas as well as the linked ideas of post-normal science.

Overall, the implications of complexity for human–environment systems include greater prominence for disturbance and change; greater recognition of how human intervention can alter natural processes that can have unintended consequences; greater recognition of the potential for sudden change in natural and human systems; and greater efforts to adapt to uncertainty through approaches such as adaptive management, adaptive governance, or precautionary management. An understanding of system dynamics is improved through nuanced notions of stability, including resilience and resistance, as well as more knowledge of the potentially complex, yet nonrandom patterns of system behavior. Researchers and managers are also increasingly driven to new approaches in science and human–environment systems intervention, driven by the complexities and uncertainties of the systems. While the implications of complexity for environmental planning and management are just beginning to be filtered, there are strong hints of the new understanding to be gained and the new approaches that are needed. These will extend traditional, single discipline-based prediction, master planning, and control to multi- and trans-disciplinary, participatory, and action-oriented development of many smaller, and adaptable plans that seek to influence—rather than control—complex human-environment systems.

SEE ALSO: Adaptive Management; Chaos Theory; Complexity Theory; Ecosystem.

BIBLIOGRAPHY. Fikret Berkes, J. Colding, and C. Folke, eds., *Navigating Social-Ecological Systems: Building Resilience for Complexity and Change* (Cambridge University Press, 2003); John Gribbin, *Deep Simplicity: Bringing Order to Chaos and Complexity* (Random House, 2004); Lance H. Gunderson and C.S. Holling, eds., *Panarchy: Understanding Transformations in Human and Natural Systems* (Island Press, 2002); Michael C. Jackson, *Systems Thinking: Creative Holism for Managers* (John Wiley & Sons, 2003); Stuart A. Kauffman, *At Home in the Universe: The Search for the Laws of Self-Organization and Complexity* (Oxford University Press, 1995); Kai N. Lee, *Compass and Gyroscope: Integrating Science and Politics for the Environment* (Island Press, 1993); G. Nicolis and I. Prigogine, *Exploring Complexity: An Introduction* (W.H. Freeman & Company, 1989); David Waltner-Toews, *Ecosystem Sustainability and Health: A Practical Approach* (Cambridge University Press, 2004); Gerald M. Weinberg, *An Introduction to General Systems Thinking* (John Wiley & Sons, 1975).

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Composting

Composting is a natural process that farmers and gardeners have practiced since time immemorial.

COMPOSTING IS A natural process of decomposition of organic matter (once living materials—including plant remains, plant leaves, and fruit and vegetable peels) into a dark earthy substance that can be used as an enriching garden soil or as a natural fertilizer for plants. Composting is a controlled aerobic process carried out by successive microbial populations combining mesophilic and thermophilic activities, leading to production of carbon dioxide, water, minerals, and stabilized organic matter. Composting is a natural process that has always occurred in forests, when the leaves from trees and plants fall on the forest floor and mix with the earth through a process of decay and decomposition. The living roots reclaim the nutrients from these decomposed leaves and finish the process of natural recycling. Farmers and gardeners have practiced composting since time immemorial. "Night soil," vegetable matter, animal manure, and household garbage are placed in piles or in a pit and allowed to decompose until ready to be used as fertilizer.

COMPOSTING NATIONS

The main development of composting has been in India, China, southeast Asia, and east and south Africa, but in recent years there has also been much interest in mechanizing the process of composting in developed nations for treatment of waste. The potential benefits of using earthworms in composting has led to a "sub-variety" of composting, referred to as *vermin-composting*. This is especially recommended for composting for households. Compost plants can be classified into two broad categories—*windrow* and *in-vessel*. Windrow systems involve the use of long heaps of material (windrows) that can be either static, or periodically turned. In the static type, the aeration is accomplished without disturbing the windrow and can be of two types: passive aeration and forced-air aeration. Turned-windrow aeration involves the breaking down and rebuilding of a windrow. In-vessel composting is done inside reactors to accelerate the composting process through maintaining optimum conditions for microbial activity and to minimize or eliminate adverse impacts upon the ambient environment.

There are many important factors to consider when composting. Carbon and nitrogen are the two most important elements in the process. Carbon is an energy source for the microorganisms, and nitrogen is important for microbial population growth. The bacteria need this carbon and nitrogen from a balance of green (such as kitchen waste) and brown (such as leaves) sources. With favorable conditions, bacteria can multiply every five or six minutes. Oxygen and temperatures are important factors. They fluctuate because of the microbial activity, which consumes oxygen and generates heat. Aerating the compost will re-supply oxygen and carry away excess heat. This allows for what is known as *aerobic* composting. Another important consideration for decomposition is moisture. However, a balance must be maintained. If the pile is too wet, the oxygen supply will lessen; if there is too little water, it will result in *anaerobic,* or without oxygen, decomposition. This can cause odors and other by-products.

Composting presents both benefits and undesirable environmental impacts. Benefits of composting for soils and plants include improvements to soil structure by adding organic matter. In sandy soil, the compost will hold moisture and help prevent the soil from degrading. Compost particles bind with clay particulates that will improve soil structure in a heavy clay type soil by allowing surface water movement through the larger aggregates. Compost can help the soil retain water and resist surface erosion and crusting. The addition of compost to the soil can also improve soil aeration. Compost helps the soil by supplying it with necessary nutrients such as phosphorus, calcium, nitrogen, and trace elements. Some chemical fertilizers release nutrients and mineral elements at such a fast rate that it is not possible for plants to benefit from it. Use of compost provides a slower, more sustained release of nitrogen and phosphorus, which conserves them for plants throughout the growing season.

On the other hand, there are several potential environmental impacts. One of the main problems with composting is the offensive odor from anaerobic composting. The offensive smell does not become a health hazard up to a certain level (there is no standard for this intensity level), but the main sufferers are the residents near the composting sites. Air emissions are also generated during waste collection and transport, as well as carbon dioxide from the process of composting.

When the composting turns anaerobic, methane gas is also produced. Microbes are also transported out of the pile by dust. Runoff is a problem mainly during rainy seasons. Waste in compost can attract rodents and flies. It is also a breeding ground for mosquitoes, which spread some illnesses. Finally, when compost is applied to soil, it decomposes and sometimes releases some unwanted and potentially hazardous elements like cadmium, chromium, lead, mercury, nickel, and zinc.

SEE ALSO: Fertilizer; Soil Erosion; Soil Science; Soils.

BIBLIOGRAPHY. F.L. Diaz, et al., *Solid Waste Management for Economically Developing Countries* (ISWA, 1996); Clare Foster, *Compost* (Cassell, 2002); V.I. Grover, "Solid Waste Management, A Case Study of Delhi," Doctoral Thesis; T.L. Richard, "MSW Composting Fact Sheet 2: Biological Processing," *Cornell Composting Resources* (Cornell Waste Management Institute, 1993).

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Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

THE COMPREHENSIVE Environmental Response, Compensation, and Liability Act (CERCLA) was enacted in 1980 in the wake of growing public concern over the health risks associated with abandoned hazardous waste sites. Years ago, there was less understanding of the potential environmental, health, and safety threats posed by hazardous wastes that had been buried, abandoned, or disposed of in landfills. In the 1970s, the national media brought public attention to the plight of several residential communities impacted by abandoned wastes sites and there were calls for government action to address the problem.

LOVE CANAL AND OTHER HAZARDS

The most famous abandoned waste site was known as Love Canal. In the 1940s, the Hooker Chemical Company had disposed of more than 20 tons of hazardous waste in a former canal located near Buffalo, New York. Later, the land was sold to the city, and homes and schools were built over the former disposal site. In the 1970s, residents of the area began experiencing severe health problems that were attributed to this past waste disposal. Studies conducted by the New York Department of health confirmed the health dangers posed by the chemicals, and residents attempted to gain compensation for their losses.

At another site in Kentucky, over 4,000 leaking drums were found to be contaminating soil, groundwater, and surface water and impacting the health of nearby residences. This site became known as the Valley of the Drums.

Love Canal and the Valley of the Drums highlighted the problem of abandoned hazardous waste sites, but they were merely indicative of a larger and more pervasive problem. A survey of contaminated sites conducted in 1979 by the Environmental Protection Agency (EPA) identified 250 hazardous waste sites considered to pose "significant threats of damages" to human health. Many of these sites were characterized as *orphan* sites, meaning that the party responsible for cleaning up the contamination could not be identified.

CERCLA was enacted to identify the worst sites, finance the cleanup of existing contaminated property, and deter generators from improperly disposing of hazardous wastes in the future. It provided for the remediation of soil and groundwater at contaminated sites, and held owners or operators of a property financially responsible for cleanup, regardless of whether the contamination occurred prior to CERCLA's enactment or even whether they contributed to the contamination.

SUPERFUND

Congress charged the EPA with establishing a National Priorities List (NPL) that identified the sites that posed the greatest threat to public health and for establishing the criteria for cleaning up and closing hazardous waste sites. The initial government cleanup was financed through the Superfund, a trust fund established through taxes on petroleum products and chemical feedstocks. The government could then seek reimbursement from "responsible parties" who owned the site or contributed to contamination at the site. Subsequently, CERCLA is often called Superfund.

CERCLA imposed liability for cleanup without regard to fault or negligence. Several parties could be found liable: current owners or operators, past owners or operators, those responsible for transportation or disposal of hazardous substances, and those who arranged for its transportation. Even lenders could be held liable for waste cleanup if it was determined that the lender had the "capacity to influence" the waste management practices of the operators. The liability provisions were intended to provide a strong incentive for generators, transporters, and others to manage waste in a responsible manner. In some cases, a purchaser is allowed to claim that it had no way of knowing that hazardous waste was on the property. In such cases, the purchaser can avoid liability by invoking what has come to be known as the "innocent landowner" defense.

Prior to 1980, Congress had attempted to address the problem of improperly disposed hazardous waste through the Resource Conservation and Recovery Act (RCRA) and indeed, many of CERCLA's opponents argued that no additional legislation was necessary. However, while they are both designed to protect human health and the environment from the dangers of hazardous waste, RCRA is primarily concerned with managing hazardous waste and cleaning up active hazardous waste sites, while CERCLA is primarily concerned with addressing inactive or abandoned sites.

CRITICISM AND CONTROVERY

CERCLA and its Superfund provisions have been controversial since their inception. The Government Accounting Office (GAO), the Rand Institute, and others have criticized Superfund for the slow pace and high cost of cleanups. A 2000 GAO study, for instance, found that it could cost between $25 and $140 million to clean up a single Superfund site, with the average cleanup taking 10 years. Superfund has been assailed by its detractors as being a "Superfailure" and a "hazardous waste of taxpayer money" for spending too much money on attorneys and not enough money on actual site clean-ups.

Advocates for Superfund contend that Superfund must be evaluated within the context of CERCLA's dual goals of cleaning up contaminated sites and serving as a deterrent to improper waste disposal. Supporters argue that Congress initially underestimated the scope and magnitude of the problem and did not take into account the length of time it would take to implement a cleanup from beginning to end. Furthermore, they argue that avoiding high cleanup costs is an incentive for generators, transporters, and disposal facilities to manage wastes properly.

Despite criticisms of inefficiency, Superfund was reauthorized in 1986 when Congress passed the Superfund Amendments and Reauthorization Act (SARA). SARA increased the Superfund trust fund to $8.5 billion, to be financed through chemical taxes, general revenue, and costs recovered from responsible parties. It also set strict cleanup goals, established provisions for cleaning up leaking underground storage tank sites, and added "right-to-know" provisions requiring industries to provide the public with information on chemicals stored on site and released to the environment.

Another criticism of CERCLA was that its strict liability provisions deterred new businesses from using or developing so-called *brownfields* sites, which are sites that have had a history of environmental contamination. Often these sites are located in urban areas, and critics argue that fear of being held liable for the cleanup of brownfields sites has caused businesses to seek out *greenfields*, or previously undeveloped sites, in the suburbs. In response, the EPA introduced its Brownfields program in 1995. The program provides loans and other incentives to the private sector for the purpose of cleaning up and redeveloping contaminated sites.

THE FUTURE OF CERCLA

The Superfund is now funded primarily through the Treasury Department rather than through taxes on chemicals. In November 2003 a special advisory council recommended that the CERCLA program focus on improving the efficiency and effectiveness of the program while also acknowledging the program's success in cleaning up 900 NPL sites since its inception. Although CERCLA and Superfund have been characterized by controversy since the legislation was first enacted, it appears that they will remain fixtures of U.S. environmental policy for years to come.

SEE ALSO: Brownfields Properties; Environmental Protection Agency (U.S.); Landfills; Love Canal; Resource Conservation and Recovery Act; Superfund Sites.

BIBLIOGRAPHY. John Acton, *Understanding Superfund: A Progress Report* (Rand Corp., Institute for Civil Justice, 1989); Eckardt Beck, *The Love Canal Tragedy* (EPA Journal, 1979); Comprehensive Environmental Response, Compensation, and Liability Act of 1980 42 U.S.C. §§ 9601 et seq. (PL 96-510); John Hird, *Superfund: The Political Economy of Environmental Risk* (Johns Hopkins University Press, 1994); Robert Percival, *Environmental Regulation: Law, Science, and Policy* (Aspen Law and Business, 2000); U.S. EPA, "About Superfund," www.epa.gov/superfund/about.htm (cited January 2006); U.S. GAO, *Superfund: Current Progress and Issues Needing Further Attention* (GAO, 1992).

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Conflict

THE DEFINITION OF the term *conflict* is not so straightforward. C*onflict* can be defind as an open clash between two opposing groups (or individuals) or as a hostile meeting of opposing military forces in the course of war. The term *conflict*, as has been used in political science, sociology, anthropology, and psychology, refers to tension, which may explode into full-fledged violence, hostility, and insecurity. Conflict among humans is nothing new; it has always existed from antiquity to the present in one form or another.

In the context of society and environment, it is believed that dwindling natural resources have fueled conflict between members of different groups throughout the world. Many see environmental disruption in its all manifestations—global warming, soil depletion, desertification, water and air pollution, etc.—as a possible cause of future conflict. The most often quoted theorist on the relationship between population and resources is Thomas Malthus who first wrote his *Essay on the Principle of Population* in 1798. Malthus argued that in nature, plants and animals produce far more offspring than can survive, and that man, too, is capable of overproducing if left unchecked. His conclusion was that unless family size for the poor was regulated, man would experience misery, vice (conflict), and famine, which would put population growth in check. His propositions that poverty and famine were natural outcomes of population growth and food supply have been heavily criticized in the scholarly community. Nevertheless, his ideas continue to be influential as far as the link between population, resources, and conflict is concerned. Ideas of influential scholars such as Charles Darwin, Karl Marx, and modern day neo-Malthusians such as Paul R. Ehrlich, author of *The Population Bomb*, have their foundation in the Malthus principle of population growth.

POLITICAL CHANGE AND VIOLENCE

In recent decades there has been a spurt of models advanced by neo-Malthusian scholars, in which they attempt to link population and economics to a third variable, political change, and political violence, and to show how the variables interact. The

1994 work of Robert Kaplan, the 1994 and 1999 works of Thomas Homer-Dixon, and the 2002 work of Michael Dobkowski and Isidor Wallimann are recent examples that attempt to link population variables to conflict for resources. In these works, the argument is that natural resources help fuel conflict, either by attracting predatory groups seeking to control them or by financing wars that were initially caused by other factors. The ongoing conflicts in Sierra Leone, Angola, Democratic Republic of the Congo, Sudan, and Rwanda are explained in these terms. Conflicts have also flared in areas where the benefits of mining and logging projects accrue to a small group of elites, while the social and environmental burdens are borne by local communities. Excellent examples of such conflict include oil in Columbia and the Niger Delta in Nigeria, and timber and natural gas in Indonesia.

VIOLENCE AND DESTRUCTION

When conflict escalates into violence, many lives are lost and the environment and natural resources also suffer in various ways. As Michael Renner points out in his 2002 article, "The Anatomy of Resource Wars," governments, rebels, and warlords have made billions of dollars by selling conflict commodities and have used the money to arm themselves and line their own pockets. The cost of these conflicts in human toll has been unprecedented with more than five million people killed during the 1990s, and as many as 20 million driven from their homes. There has also been considerable environmental destruction in conflict hot spots. Mozambique and Angola are two examples of the worst affected countries in the world due to conflict during the period 1970–2000. The effects of this conflict are still being felt long after the guns have gone silent. Angola and Mozambique are the most landmine-afflicted countries in Africa, with land mines laid over decades by the Portuguese, South African, Cuban, Angolan, and Mozambican government forces, and the rebel groups of UNITA in Angola and RENAMO in Mozambique. In both countries, millions died and millions were displaced as refugees in surrounding countries during the course of the conflict.

Angola and Mozambique are also excellent examples of how land mines were deployed to degrade the environment, making them an environmental and health problem. Most of the land mines in Angola were laid on paths used by civilians to go to fields, schools, markets, and medical centers. The second major area of landmine injuries is along roadsides where land mines target people who leave the road to take a shortcut or to rest. Built-up areas have not been spared, and the spate of landmine casualties has resulted in the desertion of villages. Land mines were also planted on riverbanks, especially around bridges and along or on railroad tracks, to disable trains and target people who use the tracks or embankments as footpaths. To kill elephants for ivory, poachers—many of them belonging to the fighting factions—often laid antitank mines on elephant paths. The whole business of laying mines in Angola and Mozambique has affected not only the fighting factions, but also the civilians, particularly children and women. Land mines affect a large portion of the population, with 80,000 amputees in Angola alone and an ever-expanding number of victims under the age of 15.

Warfare exacts a toll on natural ecosystems and resources as well as on human populations. Environmental damage associated with conflict, including disruption of agriculture and infrastructure, is a cost of war that may hinder a nation's ability to recover after hostilities have ceased, as illustrated amply by the cases of Angola and Mozambique. Since the end of World War II in the 1940s, there have been numerous conflicts throughout the world, particularly in the developing world. There is general agreement that there is a great need to understand why violence occurs and how future conflicts could be prevented. It should be understood that the root causes of conflicts are complex and cannot be reduced to Malthusian principles alone; there is the interplay between political, economic, and historical factors, which ultimately result in civil war and the failure of states as illustrated in the conflicts in Somalia, Sierra Leone, Cote D'Ivoire, Rwanda, Democratic Republic of the Congo, and elsewhere in the world.

It is important to note that the debate about the extent to which abundant or scarce natural resources contribute to fueling conflict is ongoing and quite intense. It is a fact that throughout history, countries have fought over resources. In various parts of the world, conflicts have erupted over fishing rights, oil, diamonds, and access to water and other resources. In the case of water, many major rivers cross international boundaries, making water a precious commodity in semi-arid environments such as the Sudan and Egypt through which the Nile River passes. Overuse of the Nile waters in source areas such as Ethiopia, Uganda, and the Sudan, may jeopardize Egypt's water needs, which might result in interstate warfare. Generally, the common denominator of resource conflicts has been the presence of greedy elites monopolizing the resources or one ethnic group or nationality taking more than its fair share of a commodity that transcends international boundaries. Experts agree that equitable access to natural resources essential for life, stable political institutions, and peaceful international agreements are crucial for a secure future.

SEE ALSO: Angola; Malthus, Thomas; Malthusianism; Mozambique; Nile River; Resources; Wars.

BIBLIOGRAPHY. Daniel Chirot and Martin E. P. Seligman, *Ethnopolitical Warfare: Causes, Consequences, and Possible Solutions* (American Psychological Association, 2001); Michael N. Dobkowski and Isidor Wallimann, *On the Edge of Scarcity: Environment, Resources, Population, Sustainability, and Conflict* (Syracuse University Press, 2002); Kurt Finsterbusch and George McKenna, *Taking Sides: Clashing Views on Controversial Social Issues* (Dushkin Publishing Group, 1994); Thomas F. Homer-Dixon, "Environmental Scarcities and Violent Conflict," *International Security* (v.19, 1994); Thomas F. Homer-Dixon, *Environment, Scarcity, and Violence* (Princeton University Press, 1999); Robert D. Kaplan, "The Coming Anarchy," *Atlantic Monthly* (v. 273, 1994); Joseph R. Oppong and Ezekiel Kalipeni, "The Geography of Land Mines and Implications for Health and Disease in Africa: A Political Ecology Approach," *Africa Today* (v.52/1, 2005); John O. Oucho, *Undercurrents of Ethnic Conflicts in Kenya* (Brill, 2002); Michael Renner, "The Anatomy of Resource Wars," *Worldwatch Paper 162* (Worldwatch Institute, 2002); Allan Schnaiberg and Kenneth Alan Gould, *Environment and Society: The Enduring Conflict* (St. Martin's Press, 1994); Arthur H. Westing, *Cultural Norms, War, and the Environment* (Oxford University Press, 1988).

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Congo

AFTER ACHIEVING INDEPENDENCE in 1960, the French region of Middle Congo became the Republic of the Congo. In 1990, the country discarded 25 years of Marxism in favor of democracy. Seven years later, a Marxist-led rebellion overturned the democratic government, setting off a period of civil unrest that ended only in 2003 when a tenuous peace was declared. International groups have continued to pressure the government over human rights violations. Once a major exporter of oil, Congolese reserves have declined. Other natural resources include timber, potash, lead, zinc, uranium, copper, phosphates, gold, magnesium, natural gas, and hydropower.

With a per capita income of only $700, the Congo is the eighth poorest country in the world. Around 37 percent of the people are severely undernourished. Less than one percent of the land is arable, and agriculture provides for only 6.7 percent of the Gross Domestic Product (GDP). While industry accounts for 62.4 percent GDP, Congolese industries vary from village handicrafts to sophisticated oil companies. The government sector is overstaffed, draining revenue away from essential services. Since the 1980s, petroleum reserves have steadily declined, and oil earnings have been used to pay off huge government loans. The government turned to the World Bank and the International Monetary Fund for help and applied for debt relief under the Heavily Indebted Poor Countries initiative. In March 2006, the World Bank approved a $2.9 billion debt relief package contingent on the eradication of corruption in state-run oil companies.

In addition to a 169-kilometer stretch bordering the South Atlantic Ocean, the Congo is bordered by Angola, Cameroon, the Central African Republic, the Democratic Republic of the Congo, and Gabon. The terrain of the Congo is generally flat with a coastal plain and a central plateau that give way to southern and northern basins. The highest point in the country is only 903 meters at Mount Berongou. The climate is tropical. The rainy season from March to June is followed by a five-month dry season. Temperatures and humidity are consistently high and are known to be particularly enervating in the section that strides the Equator. Flooding is common during the rainy season.

Like many of the poorest African nations, the Congo produces a social and physical environment conducive to disease. The population of 3,700,000 suffers from an HIV/AIDS rate of 4.9 percent. Some 90,000 Congolese have contracted HIV/AIDS, which has killed 9,700 people since 2003. The people of the Congo also have a very high risk of contracting food and waterborne diseases, because only 46 percent overall and 17 percent of rural residents have sustained access to safe drinking water, and only 9 percent overall and 2 percent of rural residents have access to improved sanitation. Common diseases include those borne by food and water such as bacterial diarrhea, hepatitis A, and typhoid fever and malaria, a vectorborne disease. High incidences of disease have led to low life expectancy (52.8 years) and growth rates (2.6 percent) and high infant mortality (85.29 deaths per 1,000 live births) and death rates (12.93 percent per 1,000 population).

On the average, Congolese women give birth to 6.07 children. The United Nations Development Program (UNDP) Human Development Reports rank the Congo 142 of 232 countries on overall quality of life issues. Approximately 70 percent of Congolese live in either Brazzaville or Poine-Noire or along the rail line that connects the two cities. In these areas, the Congo is experiencing air pollution from vehicle emissions. Between 1980 and 2002, carbon dioxide emissions tripled. Water is polluted from the dumping of raw sewage. Deforestation has occurred as trees are cut or burned for agricultural use and as an energy sources. The government has protected 6.5 percent of land area covering around 1.5 million hectares. Of 450 mammal species identified in the Congo, 40 are endangered, as are 28 of 345 bird species. In 2006, scientists at Yale University ranked the Congo 112 of 132 countries on environmental performance, roughly in line with the comparable income and geographic groups. The overall score was reduced by the poor showing in environmental health.

In 1991, the Congo passed the Law of the Environment, creating the Ministry of Environment and instituting the National Environmental Action Plan. Major projects targeted rural development and conservation of natural resources. The government established protected areas that included the closed forest of Nouabale-Ndoki, the community reserve at Lake Tele, a sanctuary of savannah and gallery forest at Lefini-South, and the reinforced mixed gallery forest of the Condouati Reserve.

The Republic of the Congo participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Ozone Layer Protection, Tropical Timber 83, Tropical Timber 94, and Wetlands. The Law of the Sea agreement has been signed but was never ratified.

SEE ALSO: Amazon River Basin; Congo; Rain Forests.

BIBLIOGRAPHY. CIA, "Congo, Republic of the," *World Factbook,* www.cia.gov; Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (New Brunswick: Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (Santa Barbara: ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (Jefferson, North Carolina: McFarland, 1993); UNDP, "Human Development Report: Congo, Republic of" www.hdr.undp.org; World Bank.

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Congo River and Basin

THE CONGO RIVER is the second largest river in Africa (after the Nile) with a length of 2,718 miles. It has greatest flow of any river in the continent and second only to the Amazon worldwide. The river drains more than 1.3 million square miles, making its watershed, the Congo Basin, once again second only to that of the Amazon. Due to the fact that part of the Congo River flows above the Equator and the rest below it, it has a year-round flow and no dry season. In its final descent from Malebo Pool in the Democratic Republic of Congo into the Atlantic Ocean, the river falls more than 1,000 feet in merely 200 miles. Because of its perennial flow and topography, Congo River alone accounts for about one-sixth of the world's hydroelectric potential. Recently, the South African state-owned power enterprise, Eskon, has announced plans to build the largest power-generating dam in the world on the Congo. Once completed, it would produce twice as much energy as the Three Gorges Dam in China. A major transportation route, the Congo River houses several towns and cities along its banks. These include the capital of Democratic Republic of Congo, Kinshasa, and Brazzaville, the capital of the Republic of Congo.

Several, mostly small chieftaincies have historically existed along the Congo, their livelihood predicated upon fishing. In 1485, a Portuguese explorer first came across the mouth of the Congo River, and thereafter several expeditions tried to approach its source. Each of these attempts, however, was futile because of the strong flow of the Congo and the presence of more than 30 imposing cataracts in the first 200 miles. It was only in 1885 that the British-American explorer Henry Morgan Stanley managed to navigate the entire length of the Congo. He did it, however, from the opposite direction. Stanley's group started in Zanzibar on the eastern coast of Africa and decided to follow the route of the Congo River, first believing that it was the Nile. A few years later, Stanley was contracted by King Leopold II of Belgium to further explore the river and set up trading and military stations along it. This sowed the seeds for full-blown colonialism in Congo; carried out at first personally by Leopold, and after his death in 1909 by the Belgian state.

Political dynamics have been central to the environmental history of the Congo River and basin. The river is perfectly navigable after Malebo Pool, and portage railways were built by forced labor in the 1890s to bypass the cataracts. This set the base for massive exploitation of resources such as ivory, rubber, copper, and gold in the interior of Congo during the colonial period. Large-scale deforestation for timber and rubber plantations was routine during the Belgian colonial occupation of the Congo in the first half of the 20th century. The legacy of plunder has been continued by postcolonial rulers of Congo. Mobuto Sese Seko, the president of Congo for 32 years, amassed great personal riches from the Congo's vast resources. After a coup that ended Mobuto's tyrannical rule in 1997, however, Congo spiraled into civil war that cost millions of lives.

The Congo River flows through the second largest rainforest in the world. It has received some attention with regards to the political ecology of climate change, but not nearly as much as the Amazon basin. Both state-led and unregulated logging and incessant mining in the region—often to finance warring militias—pose a threat to the forests and to biodiversity in the region. If unchecked, this will not only deplete a significant carbon sink, it will prove to be devastating for millions of people whose livelihoods depend on the rainforest.

SEE ALSO: Amazon River Basin; Congo; Nile River (and White Nile); Rain Forests.

BIBILIOGRAPHY. J. Conrad, *Heart of Darkness* (Dover, 1990); A. Hochschild, *King Leopold's Ghost: A Story of Greed, Terror, and Heroism in Colonial Africa* (Houghton Mifflin, 1999); R. Harms, *River of Wealth, River of Sorrow: The Central Zaire Basin in the Era of the Slave and Ivory Trade 1500–1891* (Yale University Press, 1981); E.M. Iloweka, "The Deforestation of Rural Areas in the Lower Congo Province," *Environmental Monitoring and Assessment* (v.99/1-3, 2004); G. Stewart, *Rumba on the River: A History of the Popular Music of the Two Congos* (Verso, 2000); D. Wilkie, et al., "Roads, Development and Conservation in the Congo Basin," *Conservation Biology,* (v.14/6, 2000).

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Congo, Democratic Republic

AFTER OBTAINING INDEPENDENCE in 1960, the Belgian Congo experienced a period of political and social instability that set the stage for the frequently brutal 32-year tenure of Colonel Joseph Mobutu, who changed the name of the country to Zaire. An influx of refugees from Rwanda and Burundi helped to topple Mobutu in 1997 and led to the establishment of the country as the Democratic Republic of the Congo (DROC) under Laurent Kabila. The ensuing battle for power led to interference from Rwanda, Uganda, Zimbabwe, Angola, Namibia, Chad, and the Sudan before peace was

Brazza

Pierre-Paul-François-Camille Savorgnan de Brazza, who was born near Rome in 1852, was an Italian who became a French citizen in 1874. After a short time in the French Navy, he became involved in exploring the Congo, establishing what became the French (Middle) Congo (present-day Republic of the Congo), and also founding the capital, Brazzaville.

The French-American explorer, Paul du Chaillu, had started the French colonial interest in Gabon during the 1850s, and the land on the left bank of the River Congo was taken over by the Belgians with the help of the Welsh-American journalist and adventurer Henry Morton Stanley. Brazza, finding himself in Equatorial Africa from October 1875 until November 1878, decided to try to secure the right bank of the Congo for the French.

Brazza explored the Ogooué (Ogowe) River and basin from the Atlantic coast of Gabon to the interior, managing to find his way to the source of the river, and also finding a tributary of the Congo River, the Alima River. As a result the French asked him to navigate the Ogooué River again in 1880. On this occasion, near Stanley Pool (modern-day Malebo), he signed treaties with the local tribal chiefs to establish a French protectorate over the region. In 1891 this became the French Congo.

After spending some time in Gabon, Brazza returned to France in June 1882 and was able to see the French government ratify the treaty. In 1884 he returned to the Congo, founding the city of Brazzaville, and then was governor of the colony from 1886 until 1897. He was then recalled to France, and French companies started vying for concessions in the Congo. Brazza was sent in 1905 to investigate accusations that funds were being misappropriated, and died at Dakar, Senegal, on his return voyage to France.

declared in July 1991. By that time, 2.33 million Congolese has been displaced internally and another 412,000 had fled the country. Estimates place the total death count at 3.3 million people, with most dying from starvation and disease. Despite ongoing conflict in some areas, Joseph Kabila managed to effectuate a semblance of national unity after his father was assassinated in 2001.

With a per capita income of only $800, the DROC is the eleventh poorest country in the world. Over seventy percent of the population is severely undernourished. The ongoing political strife and government corruption have produced a weak infrastructure that has made in impossible for the government to realize full economic potential from the wealth of natural resources that include cobalt, copper, niobium, tantalum, petroleum, industrial and gem diamonds, gold, silver, zinc, manganese, tin, uranium, coal, hydropower, and timber.

Less than three percent of the land area of DROC is arable, but agriculture accounts for more than half the Gross Domestic Product (GDP). Industry, on the other hand, produces only 11 percent of GDP. DROC has a distinct geography. In addition to straddling the equator, the country possesses a narrow strip of land that controls access to the lower Congo River and provides a 37-mile coast along the South Atlantic Ocean. Dense tropical rain forest spans the central river basin and the eastern highlands, covering almost one million square miles and comprising 47 percent of total African tropical forests. DROC shares land borders with Angola, Burundi, the Central African Republic, the Republic of the Congo, Rwanda, the Sudan, Tanzania, Uganda, and Zambia. The low-lying plateau with its thick rainforest gives way to mountains in the east. Elevations range from sea level in the extreme west to 5,100 meters at Pic Marguerite on Mount Stanley in the northeast.

The tropical climate is generally hot and humid in the equatorial river basin. The southern highlands experience cool, dry weather, unlike the eastern highlands, where it is cooler and wetter. South of the Equator, the wet season (November to March) is followed by a six-month dry season. Elsewhere, a short dry season (December to February) is preceded by the wet season (April to October). Periodic droughts occur in the south. During the wet season, the Congo River is prone to flooding. The Great Rift Valley of the east is home to a number of active volcanoes.

The population of 62,600,000 is constantly threatened by poverty and disease. DROC has an HIV/AIDS rate of 4.2 percent. It is estimated that since 2003, the disease has killed 100,000 people, and 1.1 million others are living with it. Less than half the total population has sustained access to safe drinking water (29 percent in rural areas). Only 23 percent of rural residents have access to improved sanitation as compared to 29 percent of urban residents. Consequently, the Congolese have a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever as well as schistosomiasis, a disease caused by contact with infected water. Ricks of vectorborne diseases that include malaria, the plague, and African sleeping sickness (trypanosomiasis) are high in some areas.

DISEASE AND LAND DEGRDATION

Because of high incidence of disease, the Congolese experience low life expectancy (51.46 years) and growth rates (3.07 percent) and high infant mortality (88.62 deaths per 1,000 live births) and death rates (13.27 per 1,000 population). Congolese women give birth to an average of 6.7 children. Low literacy rates (76.2 percent for males and 55.1 percent for females), a school attendance rate of only 30 percent for all levels, and a highly rural population (68.2) combine with ethnic and religious differences to make the dissemination of health and environmental information difficult. DROC has a major problem with poaching that threatens to destroy the wildlife population. Extensive deforestation has occurred as refugees have cut down trees to use for cooking and fuel. Tree loss and flooding have accelerated the processes of soil erosion and degradation. Irresponsible mining activities employed in the process of extracting diamonds and gold have resulted in extensive environmental damage in DROC, including the practice of allowing miners to take over national parks. Apes have become extinct because they are hunted for bush meat.

In 2006, scientists at Yale University ranked DROC 119 of 132 countries on environmental performance, in line with the relevant income group but below the relevant geographic group. The lowest scores were received in the categories of environmental health and biodiversity and habitat. Five percent of the land area of DROC is protected. Some 11,000 species of plants, 450 mammals, 1,150 birds, 300 reptiles, and 200 amphibians have been identified in the rain forest. Of 200 endemic mammal species, 15 are endangered, as are three of 130 endemic bird species.

The Minister of Environment, who is charged with enforcing and monitoring environmental laws, has begun working with local communities to better protect the fragile environment. In April 2006, the government ceded control of the Tayna Nature Reserve and the Kisimba-Ikobo Nature Reserve so that endangered Grauer gorillas, eastern chimpanzees, forest elephants, and okapi would be protected. The government plans to increase the number of protected areas to 15 percent. DROC is one of the countries included in the Congo Basin Forest Partnership established by the United States and South Africa in partnership with 27 public and private groups to alleviate poverty and promote sustainable development and conservation of natural resources and wildlife in the area.

DROC participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Tropical Timber 83, Tropical Timber 94, and Wetlands. The agreement on Environmental Modification has been signed but not ratified.

BIBLIOGRAPHY. CIA, "Congo, Democratic Republic of the," *World Factbook* www.cia.gov; Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (New Brunswick: Rutgers University Press, 2005); Environment News Service, "DROC Entrusts Two Reserves to Communities, www.ens-newswire.com (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (Santa Barbara: ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (Jefferson, North Carolina: McFarland, 1993); UNDP, "Human Development

Report: Congo, Democratic Republic" www.hdr.undp.org (cited May 2006); World Bank, "Congo, Democratic Republic" www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index" www.yale.edu (cited May 2006).

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Coniferous Forest

CONIFEROUS FOREST IS dominated by conifers—evergreen, cone-bearing, needle-leaved trees such as spruce (*Picea*), fir (*Abies*), hemlock (*Tsuga*), or pine (*Pinus*). Larch (*Larix*), a deciduous conifer that drops its leaves in winter, may be common in some coniferous forests, especially in more northern latitudes. Conifers are the signature tree species of coniferous forests, but some broad-leaved deciduous tree species, such as birch (*Betula*) and aspen (*Populus*), are minor components of coniferous forests.

Coniferous forests are largely confined to the Northern Hemisphere and consist of several types. The world's largest expanse of coniferous forest is the boreal forest or taiga, covering over 18 million square kilometers. Taiga occurs as a broad circumpolar belt located between 50 degree and 70 degree north latitude, including parts of North America, Europe, and Asia. Montane coniferous forest occurs at higher elevations and covers over 3 million square kilometers in temperate North America, Europe, and Asia. Wet coastal coniferous forest—temperate rain forest—occurs in a narrow strip of northwestern North America from Alaska to northern California and in Japan. Local coniferous forest types such as the pitch pine (*Pinus rigida*) coastal plain forests are also recognized in the northeastern United States, among others. Many coniferous forests in warmer climates are successional, such as the extensive pine forests of the southeastern United States. In the absence of human or natural disturbance—especially fire—successional coniferous forests are replaced in time by deciduous forests.

Climate plays a key role in determining the distribution, composition, and productivity of coniferous forests. The taiga climate is the most extreme, with a growing season of 50–100 days, and winter temperatures that often drop below –30 degrees C. The annual precipitation is low, ranging from 40–50 centimeters, and falling mainly in summer when temperatures range from 12 degrees C to 15 degrees C. The climate of the montane coniferous forest is generally milder and wetter than that of the taiga, but topography, elevation, and aspect create a diversity of climatic conditions. In the European Alps, annual precipitation varies between 80–260 centimeters, winter temperatures range between 0 degrees C and 5 degrees C, and summer temperatures average 10 degrees C to 18 degrees C.

In the North American Rockies, annual precipitation varies from 40–120 centimeters, with winter and summer temperatures ranging from –5 degrees C to –10 degrees C and 15 degrees C to 20 degrees C, respectively, depending on latitude. North America's wet coastal coniferous forests have the mildest climate with a frost-free period that can exceed 240 days and winter temperatures that rarely surpass –5 degrees C. Annual precipitation ranges from 40–200 centimeters and is often embellished by sea fog. North America's wet coastal coniferous forest is the most productive on the continent, harboring species like coast redwood (*Sequoia sempervirens*) that may grow 100 meters tall and reach 2,000 years in age.

Humans have exploited coniferous forests for food, timber, fuel, and fiber for millennia. Today, many coniferous forests are intensely managed for timber and pulpwood, like the pine forests of the southeastern United States. Other coniferous forests, like the taiga of Russia and Canada—which contain 50 percent of the world's old-growth forests—are under increasing human pressure for harvest and oil development. The peat soils of the taiga are an important global carbon sink and heavy development may influence global warming rates.

SEE ALSO: Boreal Forests; Cloud Forests; Forests.

BIBLIOGRAPHY. O.W. Archibold, *Ecology of World Vegetation* (Chapman & Hall, 1995); Michael G. Barbour, Jack H. Burk, Wanna D. Pitts, Frank S. Gilliam, and Mark W. Schwartz, *Terrestrial Plant Ecology* (Benjamin/Cummings, 1999); Jessica Gurevitch, Samuel M. Scheiner and Gordon A Fox, *The Ecology of Plants* (Sinauer Associates, 2006); Robert Leo Smith and Thomas M. Smith, *Ecology and Field Biology* (Benjamin/Cummings, 2001).

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Conservation

CONSERVATION IS THE protection of certain features from modification and use. The evolution of conservation ideas, coupled with the creation of particular models of natural resource management, are rooted in key historical events, ethics, political philosophies, and understandings about the relationships between humans and the environment. These ideas also differ culturally, as many countries have pursued their own conservation strategies that fit with local understandings of the environment. Interest in conservation in the United States expanded at the end of the 19th century as the result of economic, demographic and environmental factors. Prior to this time, industrial and urban expansion on the continent superseded a national concern for conserving the American landscape. Environmental historian Roderick Nash argues that Americans were primarily afraid of the wilderness landscape and were intent on modifying it for their comfort and use.

The early settlers cast the environment in superstitious tones that presented it as a threat to their existence, consisting of evil elements and spirits. These ideas were supported by the need for raw materials to support the Industrial Revolution, which made the clearing of the environment part of the national mission. These pressures began to be challenged as people became increasingly aware of the value of the American landscape. Historian Frederick Jackson Turner published an influential essay in 1893, which asserted that the American frontier, the iconic representation of American character and lifestyle, had disappeared. The U.S. census at that time marked the official end of the frontier with the closure of the American West. The westward expansion that accompanied Manifest Destiny and the Homestead Act had effectively transformed the region while laying the foundation for a growing conservation ethic.

Conservation principles and ideas have been heavily influenced by a number of American writers in the 19th century. Primarily located in the urban Northeast, a number of authors helped instill a sense of beauty for the natural world. One such group was the Transcendentalists, who broke from the principles of the Enlightenment in asserting that truths could be discovered not through science, but in vision and emotion. Transcendentalists argued that wilderness was critical to experience and that the natural world represented and reflected spiritual truth and moral law. Key among them was Henry David Thoreau, who in his classic book *Walden* detailed his time spent in nature near his Concord, Massachusetts home. In a classic lecture before the Concord Lyceum, Thoreau argued that the preservation of the world could be found through experiencing nature.

AN EMERGING STEWARDSHIP

The Transcendentalists were not the only group arguing for a changing relationship between humans and the environment. In his book *Man and Nature*, George Perkins Marsh asserted that the destruction of the natural world represented a threat to the survival of human civilization. In suggesting that ancient civilizations declined because of their abuse of the environment, Marsh helped develop an emerging stewardship for the natural world. Another influential writer and activist was John Muir, who spent much of his adult life in the wilds of the Sierra Nevada Mountains of California. Muir became a nationally recognized figure, and worked in concert and in opposition with key actors to help establish Yosemite National Park and other protected areas. One of Muir's key legacies is his advocacy for preservationism as a guiding conservation philosophy. Preservationists argue that the natural world should be left to its own devices. This belief contrasted with utilitarianism, which asserts that the utilization of the environment is acceptable and necessary. One key utilitarian advocate, Gifford Pinchot, became the first chief of the Forest Service and argued that conservation was best realized through the use of natural resources and development. In one of the central rifts of the early conservation movement, Muir and Pinchot fought over the damming of the Tuolumne River in the Hetch Hetchy Valley of Yosemite National Park. The decision to build the dam within the national park represented an early victory for utilitarian conservation.

CONSERVATION MODELS

One of the central conservation models has been the national park, which has its origins in the United States in the 19th century. Writers and activists were successful in pushing forward the idea of a national park to protect natural landscapes and wildlife from intrusion. Also important were various industries, including tourism and railroad, that were looking for opportunities to expand into the American West. Several expeditions were funded by financiers to help develop interest in the western landscape. The Washburn–Doane Expedition of 1870 is regularly cited as a catalyst for the creation of Yellowstone National Park, but the expedition's influence was only part of a convergence of factors for the creation of Yellowstone National Park in 1872, which was the first protected area of its kind. Yellowstone was a bit of an oddity; it did not prompt the immediate expansion of the national park system and was intended to benefit the expanding tourism industry into the Western United States. The Yellowstone bill specifically identified the geysers, hot springs, and other geological features to be the most critical for protection. Wildlife species were not given the same consideration, and early park management was intent upon removing various predators that were believed to threaten the bison and other wildlife the tourists wanted to see. It would not be until the 20th century that wildlife and fire management strategies would be changed within the national park system.

An expanding urban population in the Northeast fueled an increasing desire to experience nature. This resulted in a growing tendency to associate wilderness with the frontier and pioneer past. Wilderness was believed to be responsible for many unique and desirable national characteristics and acquired importance as a source of virility, toughness, and savagery. Natural landscapes were increasingly invested with aesthetic and ethical values, and as such, they become valuable for contemplation and recreation. National figures such as Theodore Roosevelt, Gifford Pinchot, and John Muir helped push for expanded conservation in the United States through the Forest Service and Antiquities Act. The National Park Service (NPS) was established in 1916 in an effort to connect the various national parks under one department. The NPS began working to expand the number of national parks while meeting the needs of a growing number of tourists.

DRAMATIC EXPANSION

Conservation expanded dramatically in the United States in the latter half of the 20th century. The environmental and health effects of continued industrialization and development prompted the passage of various pieces of legislation. In the classic book *Silent Spring*, Rachel Carson warned of the health impacts of chemicals upon ecological systems. Her dire warnings prompted the banning of DDT as a pesticide following World War II and helped the recovery of bird species, like the bald eagle, whose population numbers were in decline. In *A Sand County Almanac*, Aldo Leopold used ecological principles to argue that a land ethic was needed to change the relationship between humans and the environment. Various pieces of environmental legislation were signed into law that helped make the environment more central to national policy. The Clean Water Act, Safe Drinking Water Act, Clean Air Act, and Endangered Species Act (ESA) were all critical pieces of legislation. The ESA established a list of endangered species that are managed by the U.S. Fish and Wildlife Service. The 1964 Wilderness Act established a national network of wilderness areas managed by the Forest Service, National Park Service, Bureau of Land Management, and Fish and Wildlife Service. There are now many different conservation types in the United States, including national parks, state parks, national monuments, wildlife refuges, sanctuaries, national and state forests, and tribal lands. Their management is entrusted to local, state, and federal agencies.

SUSTAINABLE DEVELOPMENT

Conservation principles have expanded globally through sustainable development, which attempts to merge economic development with environmental sustainability. The origins of sustainable development can be traced to the 1970s as the result of a number of events and conferences. The United Nations (U.N.) Conference on the Human Environment held in 1972 in Stockholm, Sweden, was the first major summit on environment and development. Attendees from 113 nations agreed to a number of principles, including the idea that economic growth and environmental sustainability could coexist. The Stockholm Conference was followed by the World Conservation Strategy (WCS) of 1980, which attempted to integrate development goals with conservation planning. The WCS helped merge conservation of the environment with mainstream development processes. A major event in the establishment of sustainable development was the World Commission on Environment and Development (WCED) *Our Common Future* Report of 1987, which defined sustainable development as "[meeting] the needs of the present without compromising the ability of future generations to meet their own needs." Among its many goals was the conservation of the natural resource base and the merging of environment and economics in decision making. Sustainable development has played a key role in the expansion of conservation throughout the developing world. Conservation areas were linked with sustainable development principles and premised as key areas of protection for threatened flora and fauna species. Their creation was considered all the more important, considering the rates of deforestation and habitat destruction occurring around the world.

The concept of the national park did not exist solely within the United States and Europe. Throughout Africa, colonists created conservation areas to provide natural experiences in wild Africa. The interplay between human and nonhuman species in these constructed geographical spaces was designed to allow wildlife to be observed unfettered by human interference. In the post-colonial era, African countries found that national parks,

Social Movements

Conservation in the 20th century of the United States increasingly involved protests and social movements. Various environmental organizations, including Earth First!, Sierra Club, Greenpeace, Nature Conservancy, and the World Wildlife Fund increased in influence. The year 1970 marked the first Earth Day, a national gathering to focus on environmental concerns. Since then, Earth Day has become an annual international gathering. Other events reflected an increase in public concern for environmental issues. The debate over water management and large dam construction, begun between John Muir and Gifford Pinchot, would become central to the American conservation movement in the 20th century. The successful construction of the Hoover Dam kicked off a wave of dam building in the western United States. Utilitarian and preservationist perspectives clashed again as various actors cited the Glen Canyon Dam, which was completed in 1966, as either a technical miracle or an ecological disaster. Attempts by the Bureau of Reclamation to establish additional dams on the Colorado River, including one in the Grand Canyon, were heavily resisted by environmental groups and the public. Activists like David Brower of the Sierra Club helped push preservationist views in suggesting that large infrastructure projects had their limits.

Concerns for specific environmental issues, including biodiversity, desertification, deforestation, and human population growth, increased in intensity in the 1970s. This was particularly the result of several alarmist studies. Paul Ehrlich and others argued that global population was expanding beyond the capacity of the natural world to sustain it. In *The Population Bomb,* Ehrlich argued that human population growth would result in the deaths of hundreds of millions of people. This text was mirrored by other studies, including the Club of Rome report in 1972, which used computer modeling to assert that major changes in geopolitical relations would be needed to stem an environmental catastrophe and population collapse. The energy crisis that accompanied the embargo from the Organization of the Petroleum Exporting Countries (OPEC) was an additional reminder that critical resources were not limitless.

and other types of conservation areas, presented a significant source of revenue. Tourism became a contributing factor to conservation and these areas presented a source of economic growth for national governments.

These trends have expanded the presence of national parks and protected areas around the world. Between 1900–49, less than 600 protected areas were established worldwide. Between 1950–90, however, this figure grew to nearly 3,000, of which 1,300 were established just in the 1970s with the majority located in the developing world. The World Conservation Union (IUCN) has categorized protected areas into eight separate management domains: scientific reserve/strict nature reserve; national park; national monument/national landmark; managed nature reserve/wildlife sanctuary; protected landscape; resource reserve; natural biotic area/anthropological reserve; and multiple-use management area/managed resource. At the end of the 20th century, more than 25,000 protected areas existed worldwide and approximately 5 percent of the land surface of the planet had been set aside as protected areas with a variety of management goals and structures. More recently, the 2003 U.N. List of Protected Areas identified more than 100,000 protected areas that constituted roughly 11.5 percent of the land surface of the planet.

The drive to protect biodiversity and habitat often comes at the expense of human populations that live adjacent to national parks and protected areas. Concerns for the impacts of national park planning upon local populations have expanded interest in community conservation strategies that attempt to integrate local livelihood needs and concerns with the broader conservation mandate. Community

A German Shorthaired Pointer explores the Great Dismal Swamp National Wildlife Refuge in Suffolk Virginia, which is protected by a Conservation Easement. There are now many different types of conservation areas in the United States.

conservation is a broad category that includes community-based conservation, community wildlife management, collaborative management, community-based natural resource management, and integrated conservation and development programs (ICDPs). There are examples of these approaches all over the world, such as the extractive reserves in Brazil and the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) program in Zimbabwe. CAMPFIRE was created in 1989 to allow private property holders to claim ownership of the wildlife on their land with the goal of providing incentives to protect environmental resources. CAMPFIRE was designed by the government's Department of National Parks and Wildlife Management (DNPWM) to decentralize management authority and decision-making of common property resources (CPRs) to the local communities that incur the costs of management. Since its beginnings, the CAMPFIRE approach has been applied to the management of other CPRs, including grazing, forest resources, and fisheries. Other community conservation initiatives, like extractive reserves in the Brazilian Amazon, have increased in popularity as a means of reconciling the competing demands of human development and conservation.

Another strategy for combining conservation with development is ecotourism. Tourists continue to visit international destinations for their diverse ecological features. Often labeled ecotourism, this trend represents a promising opportunity to generate revenue for conservation while providing incentives for developing countries to protect their environments from development. The International Ecotourism Society defines ecotourism as "responsible travel to natural areas that conserves the environment and improves the well-being of local people." This involves the following principles: minimized impact, development of environmental and cultural awareness, generation of financial benefits for conservation, and the support of human rights and democratic movements. A number of countries, including Costa Rica, Belize, and South Africa, have been aggressive in promoting their national parks and assorted conservation areas to generate financial revenue through ecotourism.

Various environmental challenges confront conservation ethics and the global community. Biological diversity is threatened with the continued deforestation of various habitats around the world. Global warming remains one of the most significant challenges that will require shifts in energy consumption, infrastructure, and planning. Underpinning these issues are continued debates about the appropriate relationships between humans and the environment. It remains hotly debated as to whether conservation should be guided by a preservationist or a utilitarian perspective.

SEE ALSO: Preservation; Muir, John; Pinchot, Gifford; National Parks.

BIBLIOGRAPHY. Edward Abbey, *Desert Solitaire: A Season in the Wilderness* (Ballatine Books, 1971); Rachel Carson, *Silent Spring* (Penguin, 1999); Krishna B. Ghimire, "Parks and People: Livelihood Issues in National Parks Management in Thailand and Madagascar," *Development and Change* (v.25, 1994); Martha Honey, *Ecotourism and Sustainable Development: Who Owns Paradise?* (Island Press, 1999); Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (Oxford University Press, 1968); George Perkins Marsh, *Man and Nature* (University of Washington, 2003); Roderick Nash, *Wilderness and the American Mind* (Yale University Press, 1967); Roderick P. Neumann, *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa* (University of California Press, 1998); R. Sayre, J. Mansour, X. Li, T. Boucher, S. Sheppard, K. Redford, "The Parks in Peril Network: An Ecogeographic Perspective," In: Brandon, K., Redford, K.H., Sanderson, S.E. (Eds.), *Parks in Peril: People, Politics, and Protected Areas* (Island Press, 1998); Henry David Thoreau, *Walden* (Bramhall House, 1970).

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Conservation Biology

CONSERVATION BIOLOGY IS a scientific field that studies the processes and patterns that maintain or alter biological diversity, and engages with applied research and policy in order to further biodiversity conservation. In order to achieve its positive and normative goals, conservation biology draws upon several subfields of ecology as well as the social sciences and philosophy to understand the human and ethical dimensions of ecological change and inform appropriate policy responses. Ecological subfields that contribute to basic and applied research in conservation biology include genetics, population and community ecology, as well as ecosystem and landscape ecology. Several social science disciplines—including economics, geography, anthropology, political science and sociology—have contributed theoretical and methodological tools.

The long history of human-induced transformations of the earth dates back at least to the dawn of plant domestication approximately 10,000 years ago; the conversion of natural ecosystems having accelerated in the past three centuries. Recent human-induced transformations of the environment, however, are widely perceived to be unprecedented in scope, rate and magnitude, and a significant driving force of global environmental change. Human population growth, along with political-institutional, socioeconomic, technological, and cultural factors are the primary anthropogenic drivers of ecological change, and have led to biodiversity loss and species extinctions in several locales. Global-scale declines in biological diversity during recent history gained widespread scientific recognition by the 1970s; this led to the emergence of a multi-disciplinary conservation biology in the 1980s. Conservation biology as a field is a targeted response to this biodiversity loss, and blends traditional disciplinary research with applied scientific fields such as forestry and natural resource management. Michael Soulé, the co-founder of the Society for Conservation Biology, referred to the immediacy of conservation needs when he referred to conservation biology as a *crisis discipline*, one that forces conservation scientists to balance scientific knowledge with policy advice, often despite prevailing uncertainty.

The field's philosophical roots reach back several centuries. Biological diversity and nature in general has been valued based on its intrinsic worth as well as for utilitarian purposes, such as sustained flow of goods and services for the benefits of human societies. In the United States, one philosophical approach to conservation focused on a spiritual–aesthetic appreciation for nature and its intrinsic value, and may be traced to the ecocentric Romantic–Transcendental ethic as reflected in the writing and legacy of such figures as Ralph Waldo Emerson, Henry David Thoreau, and John Muir in the mid-1800s. The utilitarian perspective, espoused on the other hand by John Stuart Mill, Gifford Pinchot, and others, was rooted in an anthropocentric view of nature's worth, and espoused the conservation of natural resources to ensure "the greatest good of the greatest number for the longest time." Aldo Leopold's Evolutionary–Ecological Land Ethic combined the tradition of the utilitarian resource conservationists with developments in the scientific disciplines of ecology and evolution, conceptualizing nature as a system of interacting parts, and laying the foundation for present-day conservation biology.

Meffe and Caroll (1994) propose three "guiding principles" for conservation biology: a focus on evolutionary change to better understand the dynamics of biodiversity through a historical perspective; a focus on the changing, stochastic, uncertain and non-equilibrium nature of ecosystems, which has increasingly replaced previous closed-system, equilibrium conceptualizations of most ecosystems; and a focus on human agency, in both its positive and negative aspects, for a better understanding and pragmatic approach to biodiversity conservation. These principles remain relevant for various scientific and applied/policy concerns within the discipline, including the design of nature reserves, restoration ecology and the management of endangered species.

SPECIES DIVERSITY

Species diversity has been the target of most conservation efforts for the longest time, and of significant biodiversity legislation, such as the Convention on International Trade in Endangered Species (CITES) and the U.S. Endangered Species Act (ESA). The identification of global "hotspots" of biodiversity, mostly located in tropical systems, also focuses on areas with very high levels of species diversity and endemism, as well as the threat of habitat loss. Rare, long-lived, and keystone species may often be particularly vulnerable to extinction. However, deciding what constitutes a species is no simple task, and different conceptualizations of species (e.g., biological, cladistic, evolutionary, ecological, and others) pose scientific challenges to their definition and therefore conservation. Most legislation is based on the biological species concept. Species richness can be divided into three major components: the number of species present in a small homogenous habitat; changing species composition across a range of habitats (e.g., along an environmental gradient), and diversity across larger spatial scales, such as landscape gradients.

Although species afford a useful framework for conservation and provide publicly and legally identifiable entities that may be valued, tracked, and managed, a species-only approach to conservation fails to address several fundamental threats to ecosystems and habitats. Structural, compositional and functional aspects of biodiversity are now commonly conceptualized at a number of critical hierarchical scales, including genes, species, populations, communities, ecosystems, and landscapes, that include both spatial and temporal variability and change.

SUSTAINABLE DEVELOPMENT

Conservation biologists now combine basic and applied scientific research with resource monitoring, spatial analysis and decision support systems such as satellite image processing and geographic information systems to track changes in ecosystems and habitat. In addition, the field has increasingly opened up to the concept of sustainable development, acknowledging the interdependence of human development needs and environmental conservation. The United Nations Man and the Biosphere Program was among the first attempts to explicitly move from earlier preservationist approaches to a more pragmatic and socially aware conservationist approach by adopting the goal of ecologically sustainable economic development for Biosphere Reserve Conservation.

Participatory conservation–development is another relatively recent trend in conservation biology, wherein local communities are identified as critical stakeholders in the conservation process, and their participation is sought in research, planning, monitoring, and educational activities. In reality, however, the integration of conservation with development in protected areas can be difficult. Conservation/development policies in many protected reserves may fail to protect biodiversity, or have socially detrimental impacts such as wildlife–livestock conflicts, social displacement, armed conflicts, and strengthened authoritarian regimes. Effective conservation policy requires an approach that combines basic ecological/biodiversity research and effective monitoring/modeling tools with social science research and policy analysis that highlights the complex and dynamic interactions among communities; prevailing land tenure, property regimes, policy and market institutions, and local ecological systems.

SEE ALSO: Endangered Species; Extinction of Species; National Parks.

BIBLIOGRAPHY. G.K. Meffe and C.R. Carroll, *Principles of Conservation Biology* (Sinauer Associates, 1994); R. F. Noss, “Indicators for Monitoring Biodiversity: A Hierarchical Approach,” *Conservation Biology* (v.4, 1990); G. Pinchot, *Breaking New Ground* (Harcourt, Brace and Company, 1947); B.L. Turner, R.W. Clark, J.F. Kates, J.T. Mathews, and W.B. Meyer, eds., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere Over the Past 300 Years* (Cambridge University Press, 1990); P.M. Vitousek, “Beyond Global Warming: Ecology and Global Change,” *Ecology* (v.75, 1994).

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Conservation Easements

A CONSERVATION EASEMENT is a negotiated contract between a landowner and either a nonprofit organization or a government entity. In exchange for giving up some portion of a property’s development rights, the value of the property is lessened and the landowner receives an economic benefit. This benefit results usually in lower property taxes, often in a reduction of estate taxes, and if donated, may also qualify for an income tax benefit. Because conservation easements have been viewed as providing a flexible and nonregulatory mechanism for achieving conservation goals, they have increasingly become a major tool used by land trusts and governments to protect land.

As legal agreements, conservation easements derive from the "bundle of rights" property concept that allows a portion of rights to be separated from the whole and held by another entity. Unlike other easement types, which permit the holder to do something, conservation easements allow the holder to prevent particular uses or types of uses. As a result, the separated rights are "retired" and become encumbrances on the property deed that travel with the land and bind future property owners. Easements may be written for a specified period of time, but are typically written to last "in perpetuity." The specifics of each conservation easement and the piece of land to which it pertains are generally determined on a case-by-case basis through negotiations between the landowner and the organization. Land trusts tend to tailor conservation easements to individual landowner needs, while government agencies have tended to use a "one-size fits all" approach.

EMERGENCE OF EASEMENTS

In the United States, conservation easements emerged as a market- and incentives-based alternative to the use of regulatory tools, such as outright acquisition through the use of eminent domain or zoning-related land-use restrictions. First used in Boston, Massachusetts, in the 1880s as part of Frederick Law Olmsted's park design, they were also important to the creation of a number of scenic parkways. However, it is their use by nongovernmental organizations, such as land trusts, to meet diverse conservation goals that has been most celebrated. Over the past century, conservation easements have become one of the most widely used tools to protect land that is valued for its ecological significance, including the presence of wetlands, or as wildlife or endangered species habitat; aesthetic importance or scenic beauty; for agricultural or forestry production; beaches and other recreational features; or historical significance.

The use of conservation easements, both inside and outside the United States, is growing. Between the late 1950s, when this conservation tool first became more widely known, and 2003, there were approximately 17,800 conservation easements covering a total of approximately 7 million acres in the United States. Much of this activity occurred after 1998. Likewise, conservation easements have been used elsewhere, including in Canada, Costa Rica, and Mexico. They are also being advocated as a possible solution to conservation issues in South America and beyond.

There have been a number of concerns about the growing use of conservation easements, which have potentially important implications for their future use. First, it is unclear how well existing conservation easements contribute to emerging conservation goals, particularly the creation of integrated networks of protected areas that are seen as essential to biodiversity conservation and habitat protection. In particular, this concern about efficacy derives from the application of ecological principles to easement design. On one hand, this concern centers on the technical adequacy of the management requirements for individual properties and whether these sufficiently address issues of ecological change. On the other hand, conservation scientists question the extent to which the pattern of specific parcels is sufficient to conserve an area's biodiversity or natural resources. Taken together, these concerns signal the potential need for greater government involvement in ecological conservation. Second, conservation easements have been lauded as voluntary and nongovernmental conservation interventions, but several challenges to this view are emerging. Because they rely heavily on the economic incentives created by tax relief, they are in fact expenditures of public funds. In some cases, government agencies may even provide funds directly to private groups that negotiate conservation easements. In both cases, questions have been raised about the appropriateness of spending public funds on these activities. Third, questions about who benefits from conservation easements and issues of equity are being raised. U.S. tax rules have tended to limit the economic benefits associated with easements in ways that disproportionately benefit higher income landowners. This issue led to congressional hearings on the practice in 2005.

SEE ALSO: Biodiversity; Habitat Protection; Land Trusts; Land Use; Land Use Policy and Planning; Property Rights.

BIBLIOGRAPHY. Richard Brewer, *Conservancy: The Land Trust Movement in America* (University of New England Press, 2003); Janet Diehl, *The Conservation Easement Handbook* (Land Trust Alliance, 1988); Julie Ann Gustanski and Roderick H. Squires, *Protecting the Land: Conservation Easements Past, Present, and Future* (Island Press, 2000); Adina Merenlender, Lynn Huntsinger, Greg Guthey, and Sally Fairfax, "Land Trusts and Conservation Easements: Who Is Conserving What for Whom?" *Conservation Biology* (v.10, 2002); Leigh Raymond and Sally Fairfax, "The 'Shift to Privatization' in Land Conservation: A Cautionary Essay," *Natural Resources Journal* (v.42, 2000).

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Conservation Reserve Program

THE CONSERVATION RESERVE Program (CRP), run through the office of the U.S. Department of Agriculture's Farm Service Agency, was first established in the Farm Security Act of 1985. This voluntary program aims to promote sustained land and soil conservation efforts by private agricultural land holders by retiring highly erodible or environmentally sensitive farmland from active crop production for a period of 10–15 years. In exchange, landowners are provided annual rents. By retiring land from active crop cultivation, the program's objectives are to help stem the rate of soil loss and erosion, reduce nutrient runoff, leaching, and sedimentation into streams and rivers, improve water quality, and enhance wildlife habitat conditions by planting more appropriate grasses, trees or cover crops. As of 2005, nearly 424,000 farmers across the United States, along with approximately 35 million acres were participating in this program.

Landowners may sign up for CRP during specified time windows, and to be eligible for enrollment, must have owned or operated the land parcel for at least a year prior to signing up for the program. Additionally, the land must have been planted with an agricultural commodity at least four out of the previous six years. Federal aid through the program compensates landowners with annual rental payments for land under long-term conservation contracts. Rental payments are calculated based on local soil productivity and market conditions. Furthermore, a 50 percent cost-share program helps landowners who wish to plant approved cover such as grasses, trees or other alternatives on their land to improve soil, water, and habitat conditions. Several federal, state and local agencies, including the Natural Resources Conservation Service, the U.S. Department of Agriculture's Extension Service, and state forestry agencies provide technical support for the program, while the Farm Service Agency is responsible for overall administration.

More recently, the Conservation Reserve Enhancement Program (CREP), an offshoot of CRP implemented with the 1996 Federal Agriculture Improvement and Reform Act, has bolstered federal, state, and local stakeholder partnerships in targeting agriculture related conservation efforts. While similar to CRP in many ways, CREP differs in that it is limited to specific geographic areas with high-priority environmental concerns, requires measurable environmental outcomes and must involve cost-share between federal and state funds.

There has been some concern about the economic implications of CRP on local communities. Farmland retired from production will have an impact on the demand for agricultural and allied services, including those providing farm inputs and related agricultural processing services. Likewise, there is the possibility for declines in local agricultural labor markets as well. Initial studies suggest that CRP's economic impacts vary geographically; and while in many cases the economic impact might be minimal, smaller rural counties that serve as agricultural service hubs might face more acute conditions. All the same, advocates of CRP have argued that the long-term environmental benefits of this program would positively influence long-term economic security. The most recent Farm Security and Rural Investment Act of 2002, which extends funding for agricultural and rural development programs through 2007, reaffirmed CRP funding and its objectives.

BIBLIOGRAPHY. Farm Service Agency (FSA) website, www.fsa.usda.gov (cited July 2006); Conservation Reserve Enhancement Program (CREP) website, www.fsa.usda.gov (cited July 2006); P.D. Sullivan, L. Hellerstein, R. Hansen, S. Johansson, R. Koenig, W. Lubowski, D. McBride, M. McGranahan, S. Roberts, S. Vogel, and S. Bucholtz, "The Conservation Reserve Program: Economic Implications for Rural America," *Agricultural Economic Report No. AER834* (Economic Research Service, USDA, 2004).

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Consultative Group for International Agricultural Research (CGIAR)

THE CONSULTATIVE GROUP for International Agricultural Research (CGIAR) is a network of research laboratories and largely public-sector organizations that was formed in 1971, at a time when it was feared that massive famine was likely throughout the developing world. The CGIAR focused on the productivity of agriculture, and success in this area helped prevent at least some of the projected famines. The roots of the network were nurtured by the co-operation between the U.S. government, the Rockefeller Foundation, and the Mexican government in the 1940s to identify methods of increasing agricultural production. A team of scientists led by Norman Borlaug, who won the 1970 Nobel Peace Prize, managed to develop semi-dwarf varieties of wheat that tripled yields of this cereal and helped make Mexico self-sufficient in food production. The CGIAR was created to extend this successful research to other parts of Latin America, Nigeria, and the Philippines.

Research centers were established in Colombia, Nigeria, and the Philippines in the late 1960s. To create the CGIAR on a firm basis, a series of consultative meetings was scheduled with key future partners in the World Bank, British and American governments, the United Nations (U.N.), and the Rockefeller and Ford Foundations. World Bank President Robert McNamara pushed through an agreement in which his institution would take a leading role in promoting the Green Revolution. His success led to a significant increase in the scope and size of World Bank activities, with several thousands of scientists trained at its newly opening facilities and the new varieties of wheat being planted around many parts of the developing world. The CGIAR has subsequently gone on to achieve many successful improvements in global agriculture. The original objectives adopted by the CGIAR were to examine the needs of developing countries for specialized efforts in agriculture; harmonize international, regional, and national efforts to finance and undertake agricultural research; provide finance for high priority agricultural research activities; and to undertake continuing review of priorities. A Technical Advisory Committee was also established to provide an independent source of advice about technical and scientific issues to guide board members.

Fifteen separate research institutes are currently members of the network: the Africa Rice Center in Benin; the Centro Internacional de Agricultura Tropical in Colombia; the Center for International Forestry Research in Indonesia; the Centro Internacional de Mejoramiento de Maiz y Trigo in Mexico; the Centro Internacional de la Papa in Peru; the International Center for Agricultural Research in the Dry Areas in Syria; the International Crops Research Institute for the Semi-Arid Tropics in India; the International Food Policy Research Institute in the United States; the International Institute of Tropical Agriculture in Nigeria; the International Livestock Research Institute in Kenya; the International Plant Genetic Resources Institute in Italy; the International Rice Research Institute in the Philippines; the International Water Management Institute in Sri Lanka; the World Agroforestry Center in Kenya; and the WorldFish Center in Malaysia.

This network is governed by a series of institutions and councils led customarily by an executive from the World Bank. Disharmony has broken out from time to time concerning the proper future directions of the CGIAR and the research on which it focuses. The early successes achieved by the CGIAR in improving agricultural production in a range of different crops and animal livestock have meant that its scientists have been able to consider a broader range of research topics. However, it has been argued by some that the CGIAR's choice of such activities has been inappropriate in some cases in that they do not reflect the core competencies and competitive advantage that the network has to offer; further, more attention should be paid to private sector research and the growing importance of intellectual property rights (IPR) in the research process. These issues are reflective of a larger controversy about IPR that divides the developing world from the developed world. The latter, so it is claimed, is using IPR to obtain inequitably higher levels of control and influence over agricultural production in the former. By awarding IPR production to private sector products and then aggressively marketing them to developing world farmers, it is feared that the international community will be able to control those farmers and lock them into purchasing comparatively high-cost products from companies in developed countries.

SEE ALSO: Agriculture; Farming Systems; Green Revolution; World Bank.

BIBLIOGRAPHY. Eran Binenbaum, Philip G. Pardey, and Brian D. Wright, "Public-Private Research Relationships: The Consultative Group for International Agricultural Research," *American Journal of Agricultural Economics* (v.83/3, 2001); CGIAR, www.cgiar.org (cited November 2006); Uma J. Lele, *The CGIAR at 31: An Independent Meta-Evaluation of the Consultative Group for International Agricultural Research* (World Bank Publications, 2004).

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Consumers, Ecological

THE TERM *ECOLOGICAL CONSUMERS* refers to species that cannot produce their own food, and so get energy and nutrients by eating other organisms. Properly termed *heterotrophs*, they are distinguished from *autotrophs*, or producers, that produce their own food via photosynthesis (plants and cyanobacteria) and chemosynthesis (carried out by bacteria near deep ocean hydrothermal vents). Consumers occupy the highest levels of the trophic hierarchy, a system of classification in which species are grouped according to their position in food chains and webs. Other levels of the trophic hierarchy involve the conversion of energy (solar and heat), gases and inorganic gases into biotic carbohydrates and proteins (via producers), and back into the abiotic components (via decomposers, such as fungi), whereas consumers strictly cycle biotic compounds and energy.

Consumers are further subclassified according to the nature of predator–prey interactions. Primary consumers engage in herbivory (considered to be a form of predation). Secondary consumers prey directly upon primary consumers, and include carnivores and insectivores. Tertiary consumers include top carnivores and omnivores, and include all of those species that prey upon multiple trophic levels. For example, bears are tertiary consumers, as are humans, because they eat fruits (producers), herbivores (primary consumers) and secondary consumers (such as salmon). Consumers play an important ecological role in maintaining biodiversity in that they keep the populations of prey species in check, and cycle nutrients and energy through the ecosystem.

Between each trophic level, some energy is lost to heat. Due to these inefficiencies, the biomass of each successive trophic level decreases. A given mass of vegetation in an ecosystem will support a smaller mass of herbivores, which in turn support successively smaller mass of secondary and tertiary consumers. The reduced mass of consumers across each of the levels typically translates into decreased populations of respective species. A given landscape will typically support a higher number of primary consumers than secondary consumers, with tertiary consumers being fewest in number. A general rule of thumb cites a 90 percent loss of energy across each trophic level, but this figure varies greatly between differing species and systems when analyzed empirically.

Large populations of tertiary consumers thus need a larger productive base to support them. Similarly, human societies have differing levels of impact on the landscape based on consumption habits and affluence. For example, ecologists often compare the number of people a certain amount of land can support through grain production, if those people consume the grain directly or if the grain is first fed to cattle, and the cattle subsequently eaten by people. Due to the inefficiencies across multiple trophic linkages, the land supports a smaller human population through beef consumption than if people consumed the grain themselves; that society requires substantially more land and has a higher ecological impact.

Alternatively, pastoral nomadic societies survive in semi-arid grasslands precisely because of these same inefficiencies across multiple trophic levels. Despite being unable to directly digest grass, people are able to survive in these inhospitable climates by keeping livestock that digest the grass, then consuming the livestock's productivity. Similarly, range-fed beef is considered by many to be a more ecologically sound choice than grain-fed beef.

SEE ALSO: Biodiversity; Ecosystem; Livestock; Predator/Prey Relations; Solar Energy.

BIBLIOGRAPHY. Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Tom L. McKnight and Darrel Hess, *Physical Geography* (Pearson Prentice Hall, 2005).

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Consumers, Economic

THE ORIGIN OF understanding of consumers and consumption derives from the microeconomic frameworks first constructed in the 19th century. This economic viewpoint depends on the concepts of utility and rational thought. It is assumed that the consumer has a finite stock of money that can be spent on a variety of different commodities or products. Since it is possible for individual consumers accurately to place a specific amount of happiness (or utility) on the possession of a unit of each available product—and the value of that utility declines if the consumer already has bought some unit of that item—then the consumer will make rational decisions in order to maximize the amount of utility that can be obtained. This model remains influential, although it has undergone a number of refinements over the years.

First, the concept of rationality was challenged on the basis that it demanded high levels of information and that it was clear that this did not reflect reality. In fact, sellers generally know far more about the utility offered by goods than buyers do, and it is difficult to place an accurate value on gaining information. As a result, rationality has been replaced by the concept of *bounded rationality,* which implies that consumers will accept that seeking to obtain full information about products would be an inefficient process.

A second area of improvement to the understanding of consumers and their behavior was provided by Maslow's Hierarchy of Needs, which represented a slightly more sophisticated understanding of how consumers choose their products. According to Maslow, consumers will first of all look for the deepest psychological needs (safety, health, food) and, once these needs have been satisfied, the next level represents well-being such as family life, comfort, and purpose. Higher levels of need add self-realization or status. This model of consumer behavior has proved to be quite robust. Intensive research into the psychology and nature of consumers in various sets of circumstances has added to Maslow's Hierarchy of Needs, which has shown that people can behave differently in the presence of various sets of situational or environmental factors. This understanding has led to a huge increase in the sophistication and efficiency of the retail and service sectors.

The term *consumer* refers to a person who uses up or destroys some kind of resource. This was not previously considered problematic in an age in which the ability of humanity to dominate nature appeared to be both inevitable and a suitable solution to the growing level of demand within economies. However, as the pressure on the environment continues to increase and the strain becomes evident in terms of environmental degradation, global warming, and the limited levels of fresh water, the need to reform the understanding of the consumer has become more urgent. It is no longer possible to consider as acceptable the individual as a consumer who will participate in the Tragedy of the Commons. Instead, people and institutions are often reinvented as caretakers or husbands of resources, ensuring their sustainable use and development. This has led to conflict with commercial interests who profit by exploiting unsustainable resources and who believe that continued economic growth without constraints is a genuine possibility.

SEE ALSO: Common Property Theory; Consumers, Consumption; Ecological; Economics; Marx, Karl.

BIBLIOGRAPHY. James G. March and Herbert A. Simon, *Organizations* (Blackwell Publishers, 1993); Abraham Harold Maslow, *Motivation and Personality* (Harper Collins Publishers, 1987); Michael Silverstein and John Butman, *Treasure Hunt: Inside the Mind of the New Consumer* (Penguin Group, 2006).

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Consumption

CONSUMPTION CAN BE understood as the complex sphere of social relations and discourses that center on the sale, purchase, and use of commodities by individuals and households. Consumption, as more than an act of purchase, considers the range of practices and discourses through which people make and give meaning to goods and services, including choice and selection, rituals of use, resale, and disposal. While consumption implies the using up of things, it also involves the production of meaning, experiences, knowledges, or objects. Central to the notion of consumption is the commodity—a good, service, idea, or even person, which takes its form as an object of consumption and exchange. In capitalist societies, commodities exchanged through an economic system assume a use value (the capacity to satisfy a want or need) and an exchange value (the ability to command other commodities in exchange). However, because commodities both convey and create meaning, their consumption is equally about symbolic value. The meaning ascribed to commodities is also a significant part of the material culture of societies and their environments. Like commodities themselves, consumption practices and their meanings occupy different social and spatial "moments" as they are transformed over time and distances. This means that consumption, and its expression in different environments, can only be understood within specific contexts in which discourses and practices of politics, economics, citizenship, gender, race, age, and religion are involved.

Although societies are characterized by an abundance or paucity of commodities, consumption matters as part of individual wants, needs, and desires. Consumption has been an intrinsic part of social relations since humans first created, used and exchanged objects, but the emergence of "modern" consumption is said to have it's origins in 17th- and 18th-century Europe in societal changes that accompanied the Industrial Revolution. The development of new technologies, factory-produced commodities, the separation of production from consumption sites, and the emergence of new socialites and consumer practices around consumption evolved during this time.

However, it was during the 19th and earlier part of the 20th centuries that the sphere of consumption expanded rapidly, facilitated by the global extension of the capitalist mode of production, new technologies, burgeoning advertising and marketing industries, and wider availability of industrially produced commodities. In the 20th century, *commodification* (the process where more and more aspects of social life become subject to exchange in the marketplace) has been accompanied by social change directed toward consumerism. Consumerism entails the everyday lives of individuals becoming enmeshed in commodity acquisition.

CONTEMPORARY CHANGES

Over the second half of the 20th century, the sphere of consumption has become more complex, deepening and broadening to encompass new spaces, practices and relationships. More and more consumption is occurring in dematerialized spaces, via information and communications technologies, including the Internet. There are numerous consumption sites such as e-shopping, trading, and gaming. Internet auction site eBay, for example, set up in the United States in 1995, now provides a medium of consumption for tens of millions of registered users globally.

While themed shopping malls, fast-food restaurants, chain stores and commodified leisure activities are most often cited as evidence of the growing visibility of consumption in contemporary landscapes, they continue to evolve alongside other forms of consumption, many of which may be more mundane (outdoor/indoor markets, grocery stores, auctions, and secondhand commodity exchange) but none the less important. Consumers frequently service more of their own needs through consumption than previously (for example, automated tellers, via self-service retail outlets, and vending machines).

Consumption activities have also become subject to de-differentiation, where previously discrete consumer activities such as shopping and banking, medical services, travel, theme parks, and shopping malls now merge. The term *McDonaldization* has been coined to examine how this trend has become increasingly instrumental and rationalized due to predictability, control, efficiency, and quantification. Themes and visual activity in such spaces (such as video, live entertainment, and leisure activities) provide a means of re-enchanting such spaces and promoting both excitement and a point of difference for consumers.

EXTENSION INTO SOCIAL CONTEXTS

The significance of consumption in contemporary societies extends well beyond the individual consumer and their use of commodities. While consumption is commonly equated with "shopping" practices connected with identity, such a view is limited; as the sphere can involve a whole range of commodity practices involving goods and services connected with such things as daily needs, leisure, sport and recreation, tourism, housing, and education. The extension of the commodity form to more and more aspects of social life connects consumption with other social, political, and cultural formations. Marketers, advertisers, and designers of goods and services help reflect and create consumer taste, while simultaneously establishing particular modes, and norms of consuming. Spaces of consumption may also shape consumer identities and practices through surveillance and the regulation and representation of appropriate ways of consuming. Privately-owned shopping malls, for example, frequently masquerade as "public spaces," yet are often policed and controlled.

Consumption has a role in the constitution of a diverse range of social groups and institutions from the "family" to the "state." States, and other institutions in turn, also have a role in promoting or prohibiting forms of consumption (for example, encouraging patterns of consumption centered on particular constructions of gender, domesticity, and family), and in the making of consumer "citizens"—for example, patients and students constructed as consumers of medical and educational services respectively.

The increased significance of consumption discourses, practices and spaces in contemporary societies has been associated with the theorized emergence of a post-modern condition from the 1970s. As part of this condition, consumption is assumed to have a greater economic and political significance, having an important role in the formation of human desires. Commodities and their meanings provide individuals with a repertoire of identity choices. Consumption plays a role in the formation of lifestyle or consumer cultures, built around such things as fashion, food, leisure activities, and music; it also provides a social identity for movements built around ethical responses to consumption (such as Green consumerism, slow food movements, charitable organizations, and recycling groups).

However, a post-modern view of consumption as "identity shopping" centered on hedonistic, materialistic, and individualist consumerism is problematic. This concept tends to neglect the mundane and social reasons why people consume, ignoring that commodities also exist through noncommodified moments (as in gift-giving) and that some forms of consumption (such as the state providing housing, education, or health) do not center on the commercial purchase of goods.

There is considerable debate over the significance of consumption in identity formation and whether processes of consumption are actually new or simply an extension of much older relationships and practices. The rapid opening up of previously Communist-run European countries to commodification and new practices of consumption, for example, has not replicated the experiences of the new emerging capitalist economics in the 18th and 19th centuries.

Extension of capitalist relations of consumption and production in Russia, for example, have occurred unevenly—with access to many of the new forms of consumption and commodities concentrated in larger cities and accompanied initially by increases in inflation, crime, poverty, and social division. Rapid increases in car ownership have produced undesirable environmental effects, particularly in cities, exacerbating traffic congestion and contributing significantly to air pollution.

GLOBALIZATION AND CONSUMPTION

Contemporary change in consumption has been linked to processes of globalization, which result in increasing homogeneity and social and spatial convergence—for example, the serial repetition of consumer spaces such as shopping malls, theme parks, and fast food outlets, and global availability of brand-name commodities. Western ways of consuming and rising consumerism are assumed to erase social difference and diversity, subsuming local cultures, practices, and environments under processes variously described as *Americanization*, *Coca-colonization,* and *McDonaldization*. While globalization has exposed more people to a wider range of commodities and to different ways of consuming, the notion of global homogenization is partial, relying as it does on people and places as passive recipients of cultural change emanating from "outside" and failing to acknowledge the extent to which globalization is also a material practice, and one that also produces new kinds of difference in society and environment. Globalization may heighten inequalities in access to goods and services. It can also have a role in distancing people from the effects of their actions, spatially separating consumption and production processes, and removing their immediate social and environmental consequences from households and shifting the environmental costs of consuming to other institutions or places.

Consumption involves a whole range of commodity practices connected with such things as daily needs.

While globalization has meant many people have had greater exposure to a wider range of commodities and their meanings, the geography of consumption is uneven and contradictory. The Worldwatch Institute reports 60 percent of private consumption occurs in the 12 percent of the world population that lives in North America and western Europe, while the one-third living in south Asia and sub-Saharan Africa only accounts for 3.2 percent. Inequalities in access to resources, wealth, and ability to purchase cannot only be mapped between countries but within borders of nation-states as well. While consumption provides a medium for identity construction and choice, it can also operate as a source of social exclusion. In the United States, changes in desires and the expectation of a "good life," changing concepts of needs and wants, and a desire to "upscale" has been labelled *Affluenza*, yet the percentage of families going hungry or homeless continues to rise. Commentators argue rising consumer aspirations and purchases have both undesirable social effects (sweatshops, social polarization, debt, and poverty) and environmental consequences (landfills, resource depletion, pollution, and a decline in biodiversity from land development).

CONSUMPTION AND ENVIRONMENT

Though consumption is conceptualized as the selection, purchase and use of commodities by "final" consumers (individuals and households), debates about the environmental effects of consumption often include consumption by the public sector and the use of resource and material inputs by companies. The state may be a direct consumer of resources, but it may also naturalize particular forms and patterns of consumption (for example, through promulgating notions of consumer sovereignty, facilitating private home-ownership, or through differential taxing of goods and services). Similarly, firms consume resources, goods, and services as part of commodity production. The concept of an "ecological footprint" has been promoted as a means of measuring the consumptive capacity of populations. This involves calculating the amount of productive land and sea resources consumed by humans on different parts of the planet, and has been used to encourage reflection on consumption patterns as well as to speculate on future resource depletion.

SUSTAINABLE CONSUMPTION

While households and individuals are not the largest contributors to environmental degradation, consumer practices and preferences can be linked via commodity chains (particularly buyer-driven forms) to production processes and their environmental challenges. Individual and household consumption is nevertheless still significant, having steadily increased over the last two decades. Global expenditure by households on goods and services was more than $20 trillion in 2000, increasing fourfold since 1960. Harmful environmental affects result from the use of vehicles, food consumption, cleaning products, home heating and air conditions, and waste disposal practices. Increasing numbers of goods are used and discarded (including packaging), with the amount of municipal waste in Organization for Economic Cooperation and Development (OCED) countries expected to grow by 43 percent from 1995 to 2020. A consequence of the purchase of computer and electronic commodities, for example, is their discards often end up as stockpiles of toxic e-waste, a proportion of which is exported to countries with less stringent occupational and environmental regulations. While local people's economic livelihoods have become established around the reprocessing and sorting of computer, television, and mobile phone components, workers are frequently unprotected from the damaging effects of lead, cadmium, toner, mercury, barium, and beryllium common in high-tech waste; and these toxic elements may contaminate both ground and water supplies.

There is a diverse range of factors and institutions that both promote and constrain consumption practices. These include price, availability, policy and regulatory frameworks, media discourse, belief systems, processes of identity formation, lifestyle, purchasing patterns, gender, family and household structures, socio-economic status, education, technology, and infrastructure. Consumption is also influenced by moral dispositions, which can inform particular politics and agendas for change. Visible representations of "the hungry" in the media, for instance, may conjure polarized metaphors of under-consumption by the poor, or overconsumption by rich. Moral imaginings of consumption as greed and materialism, or more positive constructions of consumption in terms of caring, social justice, and ethical obligation, can both be used to promote politics of action designed to alleviate poverty and encourage sustainable resource use. While consumption is not intrinsically negative, it is important to recognize that individual consumption choices that may be morally good for some (such as purchasing a larger vehicle to transport more people at once, land clearance for self-provision of food) may be destructive for others (resulting in more pollutants, use of fossil fuels, deforestation, and greenhouse gas). Most of the negative consequences of consumption tend to occur at the regional or national level, so ascertaining how individual consumption choices leads to particular environmental consequences is not straightforward.

Altered moral dispositions about consumption influence how the negative environmental effects of consumption might be addressed. Viewing consumption solely as a matter of individual choice, for example, would suggest an appropriate action to reduce environmental effects would be to change the conditions in which people make consumption decisions via such measures as education, fuel taxes, or more public transportation. When consumption is understood as a social phenomenon, change might involve addressing particular social relations and norms such as the link between consumption of electronic commodities and marketing focused on disposability and fashion.

The recognition that sustainable consumption is a necessary component of sustainable development emerged from the United Nations Conference on Environment and Development and the publication of Agenda 21. Sustainable consumption does not necessarily mean the reduction of consumption, but involves changing patterns of consuming goods and services so as to minimize the use of natural resources, toxic material, and emissions of waste and pollutants. Individual governments have facilitated sustainable consumption through their legislation and policy, as well as international treaties such as the Kyoto Protocol and the Basal Convention on Hazardous Wastes. Nongovernmental organizations have also had a significant role in promoting more sustainable patterns of consumption, including the United Nations Environment Program and its Commission on Sustainable Development, and the Environment Directorate of the Organization for Economic Co-operation and Development. Yet institutional action and reform is only part of reducing environmental impacts of consumption. Questions about the sustainability of consumption cannot be separated from politics and economics, nor from how consumption is practiced, experienced, understood, and manifested by individuals in particular social and environmental contexts.

SEE ALSO: Commodity; Consumer (Economic); Use Value versus Exchange Value.

BIBLIOGRAPHY. Peter Corrigan, *The Sociology of Consumption* (Sage, 1997); John De Graaf, David Wann and Thomas H Naylor, *Affluenza: The All-Consuming Epidemic* (Berret-Koehler, 2005); Global Footprint Network, www.footprintnetwork.org (cited May 2006); Jon Goss, "Consumption," in P. Cloke, P. Crang and M. Goodwin (Eds.), *Introducing Human Geographies* (Arnold, 1999); Kirsty Hobson, "Consumption, Environmental Sustainability and Human Geography in Australia: A Missing Research Agenda?" *Australian Geographical Studies* (v41, 2003); Martyn J. Lee, *Consumer Culture Reborn: The Cultural Politics of Consumption* (Routledge, 1993), David E. Lorey, ed., *Global Environmental Challenges of the Twenty-First Century. Resources, Consumption and Sustainable Solutions* (SR books, 2003); Juliana Mansvelt, *Geographies of Consumption* (Sage, 2005); Steven Miles, *Consumerism as a Way of Life* (Sage, 1998); H. Norberg-Hodge, "We Are All Losers in the Global Casino: The March of the Monoculture," *The Ecologist* (v.29, 1999); OECD, *Towards Sustainable Household Consumption?* (OECD, 2002); Michael Redclift, *Wasted: Counting the Costs of Global Consumption* (Earthscan, 1996); G. Ritzer, *The McDonaldization of Society: An Investigation Into the Changing Character of Contemporary Social Life (*Pine Forge Press, 1993); Frank Trentmann, "Beyond Consumerism: New Historical Perspectives on Consumption," *Journal of Contemporary History* (v.39, 2004); Richard Wilk, "Consumption, Human Needs, and Global Environmental Change," *Global Environmental Change* (v.12,2002); WorldWatch Institute, *State of the World Trends and Facts: The State of Consumption Today,* www.worldwatch.org (cited May 2006).

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Continental Shelf

THE CONTINENTAL SHELF is the submerged outer edge of a continent. The shelf begins at the shoreline's low tide mark and slants gently beneath the ocean. At the outer edge of the shelf, a continental slope breaks downward to the great ocean depths. The maximum width and the depth of the shelf vary. The depth is generally less than 330 feet (100 meters) to 660 feet (200 meters) deep. The width varies from less than one mile (1.6 kilometers) to several hundred miles.

A continent's position relative to tectonic plate boundaries influences the width and depth of its shelf. A continent has a narrow shelf where it sits on the leading edge of a plate that collides with an oceanic plate. Jolting earthquakes and erupting volcanoes accompany the convergence. The crunch also causes downward movement (subduction) of the oceanic plate and creates a deep oceanic trench. The shelf is narrow because the collision causes the edge of the continent to rise and the continental slope to plunge sharply into the deep trench. River-borne sediments do not ordinarily accumulate in thick layers on the narrow shelf; they quickly slough off into oceanic trench. The trailing edge of the same continent is too distant to experience earthquakes and volcanic activity. As a result, its continental shelf slopes gently beneath the sea, where it accumulates thick layers of sediments carried to the ocean by eroding streams and glaciers.

The North American continent is a good example of a continent with both types of continental shelves. The west coast has a narrow continental shelf due to ongoing or relatively recent tectonic plate convergence. Conversely, North America's east coast is thousands of miles from the violent edges of conflicting tectonic plates, so its continental shelf sinks gently beneath the sea, and in some areas, it extends hundreds of miles offshore.

Sedimentary rocks of some continental shelves contain biogenous components (parts of dead plants and animals) that form hydrocarbon compounds, such as oil and natural gas. These fuels are the most valuable geological resources of the continental shelf. The offshore dredging of loose aggregates (gravel and sand) and the extracting of salt from evaporation ponds generate incomes locally. Additionally, coastal winds cause phosphorus and nitrogen-based nutrients to upwell from the shelf floor. As a result, some of the best commercial fisheries in the world occur in zones of coastal upwelling. Herring, sardines, and anchovies are the main commercial fish harvested from these areas. Oysters, clams, scallops, and mussels are the main shellfish varieties. Seaweed, which is an important food item in Asia and an additive in other foods, is the most important commercial plant harvested on continental shelves.

The management of resources of the continental shelf is vital to the security of national economies and to the global economy. Thus, most nations are signatories to the 1982 United Nations Convention of the Law of the Sea (or Law of the Sea Treaty). This treaty allows coastal nations to extend their control of the ocean's resources from their coastlines to 200 nautical miles (370 kilometers) and to as far as 350 nautical miles (649 kilometers), if the shelf extends beyond 200 nautical miles.

SEE ALSO: Law of the Sea; Oceanography; Oceans.

BIBLIOGRAPHY. Robert E. Gabler, James F. Peterson, and L. Michael Trapasso, *Essentials of Physical Geography* (Brooks/Cole, 2004); Harold V. Thurman and Allan P. Trujillo, *The Essentials of Oceanography* (Prentice Hall, 2004); John M. Van Dyke, Durwood Zaelke, and Grant Hewison, eds., *Freedom for the Seas in the 21st Century* (Island Press, 1993).

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Continents

CONTINENTS ARE THE large dry landmasses of the earth. They are areas of continental crust atop subterranean areas of the lithosphere. The continental crust is thicker, but less dense than the oceanic crust, and is floating on the molten mantle. While the continents hold deposits of heavy materials such as iron or gold, they are mostly felsic materials that are lighter rocks composed mostly of silicate minerals, sodium, potassium, and aluminum. Each continent is connected to the oceanic crust or the sea floor that adjoins it. Continental margins are the sides of the continents. They are composed of the continental shelf, the continental shelf break, the continental slope, and the continental rise. The bottoms of the continental margins exist in the ocean basins as zones that are directly adjacent to a continent. They include the belt of continental crust and lithosphere that is in contact with the oceanic crust and its associated lithosphere. This is an area that often has an active plate boundary. Continental shelves are areas covered by relatively shallow seawater. Barrier islands are areas of sand built up on the continental shelf such as the barrier islands off of the coasts of Georgia or Texas.

The continental shelves surrounding the continents usually reach a maximum depth of 600 feet (200 meters). They extend from a few miles to several hundred miles from shore. At the outer limits of the continental shelf, there is a drop off called the continental shelf break. The transition from the gently sloping continental shelf to the deep ocean basin is called the continental slope. The continental shelf break marks the beginning of the continental slope, and occurs at an average depth of 430 feet (130 meters). The dropoff moves rapidly down thousands of feet to the boundary between the continental crust and the oceanic crust. Here, the ocean depth increases rapidly, reaching several thousand meters within a few kilometers. The continental rise is the gently sloping seafloor lying at the foot of the continental slope and leading gradually into the abyssal plain of the deep ocean floor. At the base of the continental slope is the boundary between the continental crust and the oceanic crust. Sediments washing over the edge of the slope or scraping off of a subducting plate form the slope. Generally, continental slopes located at active margins, for example the Chile Trench, are steeper than those located at passive margins like those in the Drake Passage.

PLATE TECTONICS

Continental shelf wedges are thick bodies of sediment formed by deposition on a subsiding passive continental margin in shallow waters of the continental shelf. Continental accretion is the increase in volume of the area of the continental crust due to the formation of granitic and andesitic rocks. These formations occur within mobile belts. They are also formed by collisions between continents that causes plate subduction and orogeny. The continents are all oceanic islands and include Africa, Asia and Europe, North and South America, Australia, and Antarctica. Asia and Europe are part of the same landmass, in which Europe is a branchy peninsula extending from Asia. Some islands such as Ireland, Britain, Greenland, Sicily, Sumatra, Java, New Guinea, and Tasmania are *continental islands,* areas of land that rise up from the continental shelf. Continental drift is an older hypothesis introduced by Alfred Wegener and others in the early 1900s. The hypothesis asserted that several hundred million years ago there was a single continent that Wegner called Pangaea ("universal mother earth"). It began to break up in the Mesozoic Era, and the pieces drifted apart to the present positions of the continents.

The current theory of plate tectonics is similar to continental drift, but not exactly the same. The continents have been compared to ships of rock that are "drifting" on plates of rock riding over the earth's molten core. The splitting of continents happens along rift fault lines. Continental ruptures occur when there is a doming up of the continental lithosphere and its crust to create a continental rift or rift valley. One of the most dramatic examples is the Great Rift Valley that begins in eastern Africa and runs through the Dead Sea Valley to Turkey. Continental rifts can also create continental rift islandssuch as the micro-continental islands of Madagascar, some of the Seychelles, and the Kerguelen Islands. Continents have varied features, which are mostly variations of plains or mountains. In addition, there are inland seas such as the Caspian, Aral, or the Great Lakes that are virtually freshwater seas. The vast areas of the continents allow for the formation of continental air masses, which can be polar, dry, or wet. These continental air masses may be dry if coming from the interior of a continent. Others may be moist equatorial air masses.

Continental divides are mountain areas on continents from which water flows to one ocean rather than to another. In the eastern United States, the continental divide separates waters that flow eastward to the Atlantic Ocean from water that flows west and then south to the Gulf of Mexico through the Mississippi River Valley. There are similar divides on other continents for waters flowing into the Pacific, Indian, or Arctic Oceans. Continental glaciers occur in high mountain areas where the temperature remains cold even in the summer. During ice ages, continental glaciers spread from a base location to cover enormous areas of continents. Continental shields are areas of continental crust, such as the Canadian Shield (Laurentian Plateau). It is a vast area of rock of igneous and metamorphic rock, most of it Precambrian or Archaean-age. In the case of the Canadian Shield, the rock was elevated above the sea and has never been covered with sedimentary deposits. Rock in the shield was exposed by the actions of continental glaciers, enormous ice sheets that covered much of the northern hemisphere in the most recent Ice Ages.

Continent collisions happen when plate tectonics brings continents into headlong contact. The ocean between them shrinks, causing a continential suture, a continental suture is a long, narrow zone of crust deformation. The Himalayan Mountains and the European Alps are being pushed ever higher by under-thrusting and intense folding as India drives into the Asian continent or as the African continent moves toward Europe. Continents are sometimes subdivided by geographers into subcontinents, such as the Indian subcontinent. Because the continents are isolated from one another, different fauna and flora have developed on each continent.

In recent years, there has been a general rethinking of the categorical status of continents. Geographer Martin Lewis and historian Kären Wigen have argued, for example, that for the most part, our distinction of continents (Asia from Europe as a most egregious example) has been historically conditioned by social and cultural preconceptions, rather than tectonic or biogeographical considerations. Insofar as Europe, Asia, and Africa are part of one land mass, and South and North America are contiguous, the insistence of historians, geographers and others to distinguish them must be seen as part of larger historical habits including Orientalism (imposing essential definitions of East and West) and colonialism. Continents in most respects better reflect historical worldview than distinct metageographic realities.

SEE ALSO: Continental Shelf; Earthquake; Geography; Geothermal Energy; Great Barrier Reef; Rift Valley.

BIBLIOGRAPHY. Peter Farb, *Face of North America: The Natural History of a Continent* (Harper & Row, 1963); A. Hallam, *A Revolution in the Earth Sciences: From Continental Drift to Plate Tectonics* (Oxford University Press, 1973); M. W. Lewis and K. E. Wigen, *The Myth of Continents: A Critique of Metageography*. (Berkeley, University of California Press, 1997); Russell Miller, *Continents in Collision* (Time-Life Books, 1983); National Geographic Society, *Our Continent: A Natural History of North America* (National Geographic Book Service, 1976); John Reader, *Africa: Biography of a Continent* (National Geographic Society, 2001); Ron Redfern, *The Making of a Continent* (Times Books, 1983).

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Contingent Valuation

CONTINGENT VALUATION (CV) is a method used to estimate an economic value for goods and services that aren't typically bought and sold in the market. Most commonly, CV has been used to estimate values for environmental goods and services, such as endangered species, improved air and water quality, open space provision, wilderness areas, outdoor recreation opportunities, and other types of environmental amenities. To a lesser extent, CV has been applied to estimate values for cultural heritage, health care, and public education. During the last 25 years, CV has been used by many agencies with environmental responsibilities, including state and federal agencies in the United States and over 50 foreign governments and international organizations. The majority of the studies have been conducted to facilitate policy analyses, though more prominent applications have included natural resource damage assessment cases such as the Exxon Valdez oil spill.

The primary goal of the CV method is to create a hypothetical market for a good or service and elicit, via a survey, people's economic value for that good or service. In the survey, different states of the world are described to a respondent, and they are then asked about their preferences for one or more of the states described. As a simple example, a survey might describe a treatment to improve air quality, and then ask respondents how much they would be willing to pay for this air quality improvement. If respondents are truthful, their answers reflect their economic value for the described change. This value is often referred to as *willingness-to-pay,* or WTP. Conversely, the survey may ask respondents how much monetary compensation they would require in order to accept a decrease in air quality. This measure is referred to as *willingness-to-accept,* or WTA. Though asking respondents open-ended questions about their WTP or WTA is a straightforward approach, it is not the approach favored by most survey researchers working in the CV field. More often, respondents are given a choice question to elicit their preference for the good. Generally, in CV studies the choice question asks respondents to either (a) say yes or no to paying a specified dollar amount for a proposed change, (b) vote for or against a referendum that would bring about the proposed change at some additional cost to the respondent, or (c) support or not support a program that would bring about the proposed change at some additional cost to the respondent.

The CV method has been in use for over 20 years, and more than 2,000 papers have been written on the topic, though not without debate. Much of the criticism stems from the hypothetical nature of the survey and the potential bias this may induce. Some evidence has shown that what respondents state they are willing to pay in a CV survey may be considerably larger than what they actually pay, while other studies have shown that values produced from CV studies compare favorably with actual donations. Debate has also ensued as to whether respondents get moral satisfaction from paying for an environmental good, independent of the characteristics of the good itself, a concept referred to as a *warm-glow effect*. Other criticism focuses on strategic behavior on the part of the respondent by either yea-saying (saying yes in order to please the interviewer), or nay-saying (saying no even though the respondent has a positive value for the good in question).

The controversy surrounding CV use has led to a more thorough understanding of both the limitations and the appropriate uses of the method. In 1993, a panel of experts sponsored by the National Oceanic and Atmospheric Administration and chaired by Nobel Prize winners Kenneth Arrow and Robert Solow convened to review the CV method. The panel determined a set of guidelines to help ensure the reliability of CV surveys, and ultimately concluded that, when guidelines are followed, CV studies can produce reliable estimates of economic value.

SEE ALSO: Commodity; Market; Measurement and Assessment.

BIBLIOGRAPHY. Richard T. Carson, "Contingent Valuation: A User's Guide," *Environmental Science and Technology* (v.34, 2000); Myrick A. Freeman, *The Measurement of Environmental and Resource Values: Theory and Methods* (Resources for the Future, 1993); Michael Hanemann, "Valuing the Environment Through Contingent Valuation," *Journal of Economic Perspectives* (v.8, 1994); Jerry Hausman, *Contingent Valuation: A Critical Assessment* (Elsevier, 1993); Roger Perman, Yue Ma, and James McGilvray, *Natural Resource and Environmental Economics* (Longman Publishing, 1996).

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Convention on Biological Diversity (CBD)

THE CONVENTION ON Biological Diversity (CBD) is an international treaty signed by a coalition of 153 countries at the 1992 United Nations Conference on Environment and Development (UNCED). The convention became officially recognized in December 1993 and has 188 members. The United States is the only country that has signed but not yet ratified the CBD. Based on the principle of sustainable development, the main goals include "the conservation of biodiversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the utilization of genetic resources." Member countries, adopting a precautionary principle approach, are legally required to create plans for identifying and protecting biodiversity, restoring degraded areas, and preventing possible impacts of the introduction of nonnative species and genetically modified organisms into the environment. The convention also recognizes the importance of public participation and protecting the rights of traditionally marginalized communities most directly affected by environmental threats. To do this, it sets a framework utilizing both economic criteria (based on the market value of environmental resources) and noneconomic factors, such as cultural significance, to determine the value of biodiversity as well as the risks and benefits of economic growth.

The governing body of the CBD is the Conference of Parties (COP). Made up of representatives from all member countries, the COP is responsible for identifying priorities, proposing plans of action, reviewing national proposals, and coordinating with international institutions. It also has the authority to create advisory panels like the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), a group assisting with and assessing the convention's implementation. As of 2006, the COP had eight regular meetings with focuses ranging from protecting marine, forest, and agricultural diversity to examining technological cooperation and intellectual property rights. In 2002, the COP adopted a strategic plan for meeting the three goals of the convention, aiming to achieve a broad reduction in the rate of biodiversity loss by 2010.

In addition, the COP called an extraordinary meeting in 2000 to introduce a supplementary agreement to the CBD, the Cartagena Protocol on Biosafety, which came into force September 2003. By April 2006, 132 countries had ratified the protocol that established rules on the transboundary movement, handling, and use of genetically modified organisms (GMOs). Expressing the mandate of the CBD, member countries are encouraged to adopt a precautionary principle approach in assessing the potential environmental, human health, and socioeconomic risks of GMOs. There have been a number of measures taken to facilitate national capacity building, including financial support and the establishment of the Biosafety Clearing-House, an online database for international information exchange.

CONFLICTS AND OBSTACLES

Nevertheless, there are numerous obstacles to the implementation of the CBD and the Cartagena Protocol. Primarily, efforts at strengthening national mechanisms for biodiversity protection have come into conflict with the World Trade Organization (WTO) over the regulation of biotechnology. The WTO, adopting U.S. regulatory views on the safety of genetically modified products, has focused on opening international markets and protecting intellectual property rights for biotech corporations. In contrast, the Cartagena Protocol establishes a framework for countries to adopt stricter scientific criteria for determining acceptable risk, allowing the refusal of genetically modified products until their safety can be proven. In this sense, the protocol acts as a counterweight to the WTO by augmenting the bargaining power of developing countries. This conflict is evident in a recent $38.4 million biosafety project carried out in 123 countries to fulfill the requirements of the Cartagena Protocol. Sponsored by the United Nations Environmental Program (UNEP) and the Global Environmental Facility (GEF), the goals are to create national legislative and decision-making systems for biotechnology regulation.

In Guatemala, public consultations opened a space for struggle over possible environmental, human health, and socioeconomic risks and benefits of agricultural biotechnology. Although not resolving intense national disagreement, Guatemala was one of the first countries to complete the project, resulting in a protocol that could form the basis for future legislation. In October 2005, though, the U.S. Department of Agriculture (USDA) Foreign Agricultural Service began a technical review process, revising the proposed UNEP-GEF legislation to reflect U.S. regulations and excluding civil society groups. While the USDA argues that the national proposal exaggerates the potential risks of the technology and would hinder free trade, Guatemala's program representatives believe the protocol was based on sound scientific evaluation and negotiation between different civil society groups and that the suggested revisions threaten national sovereignty.

These problems also illustrate conflict within the CBD itself that arose during its negotiation from 1989–92 between southern and northern countries. During this time, debates over the control of genetic resources led to ambiguously worded articles recognizing both the sovereignty of southern countries and local communities in decision making and the authority of international trade norms. Although the environmental movement has been influential in shaping the implementation of the CBD since then, conflicts in its creation further reflect internal tensions over contrasting views of development and conservation. On one hand, the CBD adopts the tenets of green environmentalism, which critics assert reduces biodiversity to a commodity traded on the world market. In the case of biotechnology, the CBD has helped codify the rights of transnational corporations to reap the profits of biodiversity, while local communities see little benefit. On the other hand, it has created spaces for southern states and social movements to negotiate alternative views on the cultural and socioeconomic value of nature and the potential risks of current economic growth strategies to biodiversity.

SEE ALSO: Biodiversity; Biotechnology; Genetically Modified Organisms; Global Environment Facility; Invasive Species; United Nations Conference on Environment and Development; World Trade Organization.

BIBLIOGRAPHY. Convention on Biological Diversity, "Article One: Objectives," www. biodiv.org (cited April 2006); Kathleen McAfee, "Biotech Battles: Plants, Power and Intellectual Property in the New Global Governance

Regimes," in Rachael Schurman and Dennis Kelso, eds., *Engineering Trouble: Biotechnology and Its Discontents* (University of California Press, 2003); Timothy Swanson, *Global Action for Biodiversity* (Earthscan/James & James, 1997).

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Convention on International Trade in Species of Wild Flora and Fauna (CITES)

ILLEGAL TRADE IN endangered wildlife and flora is having a significant negative impact on the world's biodiversity. To try and reduce this impact, the World Conservation Union signed the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). After ten years of negotiations, the text of CITES was finally agreed at a meeting of representatives of 80 countries in Washington D.C., on March 3, 1973. It entered into force on July 1, 1975. Today, CITES has been endorsed by over 166 countries. The aim is to "protect endangered species…from overexploitation by regulating or prohibiting their international trade." This is done by subjecting selected species to certain controls and regulations, including a ban on the trading of live animals or body parts.

Appendix I of CITES bans the commercial trade of over 800 endangered species. Among the 167 Members Species, those usually threatened with extinction include the slipper orchids, leatherback turtles, cuscuses, and gorillas.

Appendix II permits trade in approximately 32,500 listed species, but requires an export permit verifying the species were legally obtained, and the contents are not detrimental to the survival of the species. While not threatened with extinction, these species nonetheless face real challenges to their survival if unregulated trade continues. Appendix III permits trade but requires exporters to declare that their shipments were acquired legally.

The trade of species listed in CITES Appendices II and III (1995–99), included over 1.5 million live birds, almost 300 tons of caviar, 1 million pieces of coral and 21,000 hunting trophies.

Since its inception, the CITES Secretariat has forged strategic alliances with other parties. For example, there is the Memorandum of Understanding between the CITES Secretariat and the Secretariat of the Convention on the Conservation of Migratory Species of Wild Animals. TRAFFIC is a wildlife trade monitoring network that assists in the implementation of CITES.

Wildlife trade is an inherently political issue, and is worth billions of dollars each year. Consequently, CITES often attracts contention, especially in light of the complex social and economic consequences that arise from the imposition of regulations on the trade of certain species. For example, following the slaughter of an estimated 700,000 elephants in 10 years (for ivory products), there was a 50 percent drop in their population numbers. CITES placed an international ban on the trade in ivory and other elephant products in September 1989. While the CITES ban on trade in elephant ivory is credited with helping elephant species recover and decreasing poaching, the remaining stockpiles (prior to the 1989 ban) offered economic opportunities to nation states that the ban prevented from exploiting. This factor, combined with rising elephant numbers, led CITES to relax its ban on the sale of ivory tusks in 2002. This has caused dismay in conservation circles, as there has since been an upsurge in illegal trafficking of elephant ivory.

Critics of CITES argue that trade is an ineffective tool for species conservation, there are no mechanisms to account for the volume of illegal trade that still occurs, nor any mechanisms to protect species that are not listed in any of its Appendices.

Nonetheless, CITES provides some protection to over 30,000 species of flora and fauna and continues to play a central role in ensuring that international cooperation is achieved to protect certain species from overexploitation and ultimately extinction.

SEE ALSO: Conservation; Elephants; Extinction of Species.

BIBLIOGRAPHY. A. Green, *Animal Underworld: Inside America's Black Market for Rare and Exotic*

Species (New York, 1999); E. Hansen, *Orchid Fever: A Horticultural Tale of Love, Lust, and Lunacy* (Pantheon Books, 2000); G. Hemley (ed.), *International Wildlife Trade: A CITES Sourcebook* (World Wildlife Fund, Island Press); International Traffic Network, *The Smuggling of Endangered Wildlife Across the Taiwan Strait: An Investigation* (U.K, TRAFFIC International, 1991); International TRAFFIC Network, *Rhino Progress? The Response to CITES Resolution Conf. 9.14* (TRAFFIC, 1997); CITES, *Equivalent Permit-Issuing (Management) Authority and Scientific Authority Directory* (CITES Secretariat, 1994); Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora, *Appendices I, II, and III to the Convention on International Trade in Endangered Species of Wild Fauna and Flora* (UNEP, 2005); Swaziland Government, *CITES Conservation of and Trade in African and Asian Rhinoceros* (Swaziland, 2004).

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Most of the world's coral reefs, while useful to humans in many ways, are in trouble mainly due to human impacts.

Coral Reefs

CORAL REEFS ARE massive and complex structures made of limestone that is deposited by living sea organisms. The reefs are mainly composed of the skeletons of tiny, fragile animals called coral. Although there are hundreds of different species of corals, they are generally classified as either "hard coral" or "soft coral." Hard corals grow in colonies. Their skeletons are made out of calcium carbonate, which hardens and eventually becomes rock (i.e., coral reefs). Soft corals are nonreef building corals often resembling plants or trees.

Coral reefs are found in over 100 countries and cover an estimated total area of 109,700 square miles (284,300 square kilometers) worldwide. Most reefs are located in oceans between the Tropics of Cancer and Capricorn, but they are also found farther from the equator in places where warm currents flow out of the tropics (such as Florida and southern Japan). Corals prefer clear and shallow waters where sunlight filters through to their symbiotic algae. Other factors affecting their growth are salinity, turbulence, and the availability of food.

Coral reefs are one of the most spectacular, complex, highly productive, fragile, and biologically diverse ecosystems on the earth. They cover less than 1 percent of the ocean floor but support around 25 percent of all marine life, including over 4,000 species of fish, 700 species of coral, and thousands of other plants and animals. The reefs are useful to humans in several ways. The rich biological diversity of reefs is a natural treasure and a key part of the natural heritage of the world. The interlinked network of species supported by coral reefs has long been a significant source of food for millions of people living in tropical coastal areas and islands. Unique chemical compounds found in coral reef organisms have been used to produce several important drugs including AZT, a treatment for people with HIV infections. Coral reefs form natural breakwaters protecting the fertile coastal lands and human settlements of many island and continental nations from the pounding of ocean waves. The beauty of the coral reefs has long been a source of wonder to people. Many countries with coral reefs generate significant portions of their income through tourism. The reefs are also directly linked with traditional spiritual and cultural values of many people who live in reef areas.

Most of the world's coral reefs are in trouble due mainly to direct human impacts, such as overfishing or destructive fishing, mining of coral and dredging of sand and gravel for construction and industrial use, soil erosion and use of pesticides for agriculture on lands draining into coastal coral reefs, intensive and ill-considered coastal development activities with hotels and infrastructure, discharge of sewage, collection of specimens by and for visitors, and international trade in ornamental corals and shells. It is estimated that around 20 percent of the reefs have been effectively destroyed beyond likelihood of recovery; 24 percent are under imminent risk of collapse; and a further 26 percent are under a longer-term threat. Long-term changes in the oceans and atmosphere, natural stresses of highly variable seasons, severe storms, earthquakes, volcanic eruptions, and increased incidence of coral diseases are other reported factors behind the reefs' destruction. Many coral reefs (approximately 40 percent) that were seriously damaged in the 1998 El Niño/La Niña global coral bleaching event are either recovering well or have recovered, especially well-managed and remote reefs. Scientists, however, fear that this recovery could be reversed if the predicted increases in ocean temperatures occur as a result of increasing global climate change.

Scarcity of resources, poor awareness, poor enforcement, inadequate political will to tackle difficult environmental problems, and lack of coordination among countries that have reefs are some of the major barriers in effective conservation of coral reefs. Many coral reef countries lack trained personnel, equipment, and financial resources to effectively conserve coral reefs, establish marine protected areas, and enforce regulations. This lack of resources is often exacerbated by a poor awareness of the problems facing coral reefs and their significance in local economies and related ecosystems.

Most of the human activities causing loss or degradation of coral reefs are believed to be the result of ignorance rather than deliberate actions. A crucial approach toward conserving the coral reefs and improving their management, therefore, is to spread awareness among government and business officials as well as the general population of the importance of coral reefs and related ecosystems and to encourage communities, companies, and governments to take steps to protect them. Community leaders and decision makers should become familiar with the issues of coral reefs, marine environments, and resource protection so that these can be reflected in planning and policy. In particular, the issue of incorporating the full environmental and waste management costs of programs and developments should be recognized and addressed early in the policy planning process.

There have been some new initiatives toward the conservation of coral reefs in recent years. The World Summit on Sustainable Development (2002) called for a major international effort to reduce losses in biodiversity, including the biodiversity on coral reefs. Some international nongovernmental organizations (NGOs) are responding to this call by combining their expertise and resources to establish networks of marine protected areas and improve management capacity, particularly in high biodiversity regions of southeast Asia and western Pacific. Some of these NGOs have developed rapid assessment methods to select sites for urgent protection and also designed tools to assist resource managers protect reefs from global change stresses.

SEE ALSO: Biodiversity; Ecosystems; El-Niño–Southern Oscillation; Global Environmental Change; Habitat Protection; Sustainable Development.

BIBLIOGRAPHY. A. Guilcher, *Coral Reef Geomorphology* (John Wiley & Sons, 1988); International Coral Reef Information Network, "What Makes Coral Reefs So Special?" www. coralreefalliance.org (cited May 2006); C. Wilkinson, ed., *Status of Coral Reefs of the World: 2004,* Vol. 1 (Australian Institute of Marine Science, 2004).

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Costa Rica

COSTA RICA IS home to approximately four million people and covers 19,344 square miles (50,100 square kilometers). Its geographical smallness belies immense physical diversity; Pacific and Atlantic oceanic influences combine with three mountain ranges to support a wide variety of plant and animal life. Within the Costa Rican parks system, an estimated 500,000 to one million species of flora and fauna are protected, and Costa Rica is ranked as one of the most biologically diverse countries in the world.

Costa Rica is often seen as an anomaly in Central America. Politically, it has a long history of democracy and has enjoyed peace in a region plagued by civil wars, most recently in the 1980s and early 1990s. Following one short civil war in 1948, Costa Rica's army was disbanded. Socially, Costa Rica has experimented with a welfare state. A social security system, labor code, and universal health care and education were all implemented in the 1940s. Economic restructuring in the 1990s and 2000s has entailed cuts to many social programs and resulted in some social unrest. In spite of these cuts, in 2003 Costa Rica ranked 47th on the United Nations human development index, highest in Central America and outranked only by three countries in all of Latin America and the Caribbean.

ECONOMICS AND ENVIRONMENT

Economically, Costa Rica has facilitated economic growth via an export-oriented economy, centered traditionally on coffee and bananas, but dominated by tourism since the early 1990s. While Costa Rica experienced a debt crisis in the early 1980s, it recovered relatively quickly compared to other countries in the region. Low prices for coffee and bananas have continued to hurt the agricultural sector, but this has been offset to some extent by continued growth in tourism and recent and rapid growth in electronics manufacturing. Nevertheless, the government grapples with internal and external deficits and internal debt.

Environmentally, Costa Rica has cultivated a "green" image and it is recognized as a leader in the region for its extensive environmental laws. Twenty-eight environmental laws were passed between 1965–85, predating much of the international attention given to the environment in the late 1980s and early 1990s. More recent laws include the 1995 Organic Law of the Environment and the 1998 Biodiversity Law. While such laws undoubtedly contribute to Costa Rica's green image, the centerpiece is its extensive system of parks and protected areas. Costa Rica protects 23.4 percent of its land in 158 protected areas recognized under the various categories used by the World Conservation Union (IUCN); this is in great contrast to the 8.3 percent of land protected in Central America and the Caribbean and the 10.8 percent protected globally.

CRITICAL PARK SYSTEM

The parks system is critical to the country's tourism industry. Costa Rica began investing in tourism in the 1950s, when it established the Costa Rican Tourism Institute, declared tourism an industry, and offered incentives for investors. Since then, tourism to Costa Rica has grown consistently. The boom in tourism began in 1986 and international tourist arrivals grew at an average of 14 percent per year until 1994, with peak growth of 27 percent in 1992. In 1999, tourist arrivals surpassed one million for the first time, and growth has continued at an impressive rate (17 percent in 2004).

Political, social, and economic stability have played a role in the development of tourism, as all are attractive to tourist and investors alike. While these factors may have influenced growth rates initially, the global rise in popularity of ecotourism has undoubtedly played a major role since the late 1980s. Costa Rica has been described as *the* ecotourist destination and as ecotourism's "poster child." In the region, perhaps only Belize equals it as a perceived ecotourism hot spot.

The Costa Rican parks system is also used for bioprospecting. The Costa Rican National Institute of Biodiversity was formed in 1989 to manage emerging bioprospecting activities. One of the most publicized deals was made with U.S.-based pharmaceutical firm Merck and Co. in a series of three contracts from 1991–99. With these and other bioprospecting deals, a portion of research budgets and Costa Rica's share of any royalties are directed to the national parks system. As with tourism, Costa Rica's parks system combined with its political, social, and economic history to attract bioprospecting deals. For example, Merck acknowledges that, in choosing a partner for biodiversity prospecting, socioeconomic features of Costa Rica were as important in the choice as was the level of biodiversity and the parks system.

While central to both tourism and bioprospecting, Costa Rica's parks system is not without problems. Environmentally, Costa Rica's national parks system is juxtaposed with degradation outside of its boundaries, particularly through high levels of deforestation, one of the highest levels in the region. Deforestation has meant that Costa Rica's protected areas often exist as isolated "islands." A 1991 restructuring of the protected areas system by joining smaller separate areas together into larger Regional Conservation Units may have partly redressed the "island" problem. Some environmental problems have been caused by ecotourism itself; the parks system is generally recognized as overtaxed by high levels of tourist visitation, especially at some sites, and as understaffed and underfunded overall. Attempts by the national park agency to increase revenues derived from tourism (e.g., by raising entrance fees) have been resisted by the tourism industry, and the park system continues to rely partially on funding from a variety of external donors, including conservation organizations and bilateral and multilateral assistance agencies.

Socially, local support for protected areas has often been lacking. Resistance has been encountered throughout the park system's history, from the establishment of the first national park in 1971. Four factors are generally identified as contributing to social tensions. First, protected areas have often been created without prior consultation with local people, who lose access to resources through parks creation. Second, compensation for lost land has often been inadequate, delayed, or nonexistent. Third, due to high population growth rates, high population density, and increased levels of private landownership, landless peasants have increasingly been forced to encroach on protected areas. Finally, restrictions on resource use in reserves work against

Impressive National Parks

The Central American country of Costa Rica has a Pacific Ocean and Caribbean Sea coastline, and has twelve distinct ecological zones. As a result, it has a wide diversity of plant and animal life, with an impressive conservation record and a large number of national parks. In recent years there have been a large number of tourists visiting the country.

Costa Rica established its national parks from the 1960s, and there are now about 35 in the country, covering 13 percent of the land area. They are maintained by the Servicio de Parques Nacionales in San José, the capital. Along with buffer zones and forest reserves, which are not fully protected, the total area regulated comes to 27 percent of the country.

The most well-known national park in the country is probably Santa Rosa, in the northwest of Costa Rica, along the west coast. It has tropical dry forest, abundant wildlife, and good beaches. It also allows campers.

Another popular national park is the Parque Nacional Volcán Irazú located around the Irazú Volcano. It last had a minor eruption in 1963, when over an inch of volcanic dust was dumped on San José. The Parque Nacional Volcán Poás which is also located around a volcano. It emitted some volcanic ash in 1989 and again in 1995, but has been quiet since. Because the parkland in both parks are largely on volcanic soil, the flora is particularly good, and there are many twisted trees in the latter, much photographed by tourists. The Parque Nacional Rincón de la Vieja has an active volcano in it, with nearly 300 different species of birds recorded in the park.

Other national parks in Costa Rica include the Parque Nacional Palo Verde, which is a major bird sanctuary; the Parque Nacional Tortugero on the Caribbean coast, where many green turtles breed; the Parque Nacional Cahuita, which has a small coastal rain forest and a coral reef; and the Parque Nacional Chirripó, which has the highest mountain in the country.

small farmers, while major logging and hydroelectric schemes continue. Rather than attempt to overcome these limitations, the government appears to rely on nonenforcement to avoid or reduce tensions with local communities, and this, combined with financial constraints, means that some protected areas exist only on paper.

Both ecotourism and bioprospecting have the potential to increase local support for parks and protected areas, through providing employment and income opportunities. However, many government policies have promoted large-scale, foreign-owned tourism development, and there is evidence of high levels of leakage and low levels of local ownership at many ecotourism sites. Bioprospecting deals in Costa Rica and elsewhere have been critiqued as inequitable, with the majority of benefits accruing to pharmaceutical companies. Local employment (in positions as "parataxonimists") is fairly minimal (only 30 people in the early 1990s), and there is the additional complication of how local knowledge is treated and valued; while parataxonimists are paid wages for their services, intellectual property rights to resultant products are ceded to pharmaceutical companies. Thus, as of yet, neither tourism nor bioprospecting appears to have met their full potential vis-à-vis benefiting local communities.

SEE ALSO: Bananas; Biodiversity; Bioprospecting; Coffee; Deforestation; Ecotourism; Protected Areas; Tourism.

BIBLIOGRAPHY. Lisa M. Campbell, "Conservation Narratives in Costa Rica: Conflict and Co-existence," *Development and Change* (v.33/1, 2002); Noel Castree, "Bioprospecting: From Theory to Practice (and Back Again)," *Transactions of the Institute of British Geographers* (v.28/1, 2003); Marc Edelman, *Peasants against Globalization* (Stanford University Press, 1999); Sterling Evans, *The Green Republic: A Conservation History of Costa Rica* (University of Texas Press, 1999); Luis Fournier, *Desarrollo y Perspectivas del Movimiento Conservacionista Costarricense* (University of Costa Rica, 1991); John Schelhas and Max J. Pfeffer, "Forest Values of National Park Neighbors in Costa Rica," *Human Organization* (v.64/4), 2005).

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Cost-Benefit Analysis (CBA)

COST-BENEFIT ANALYSIS (CBA) is an economic technique for assessing the efficiency of a given project, whether it is a policy, construction, or other activity. The general CBA methodology involves identifying all costs of implementing the project and all benefits that will arise from the project and making a comparison. CBA is widely used by business and government to assess whether or not a project should be undertaken or to select the best choice or priority ranking among a group of options.

The initial step involves identifying a baseline from which to measure costs and benefits. The baseline might be the conditions if no project is undertaken or the conditions if the best project assessed-to-date is undertaken. Next, the affected parties and region of concern must be identified. These are the stakeholders that will bear the costs and/or experience the benefits of the project. A time frame over which costs and benefits accrue is necessary to identify the full stream of costs and benefits into the future. Future costs and benefits are not equivalent in value to present costs and benefits, necessitating choice of a discount rate for calculating the present value of future costs and benefits. The U.S. Office of Management and Budget sets a discount rate of 5 percent for federal projects, but some argue that the discount rate should be lower than this for resources that are not easily replaced such as natural resources. High discount rates can make the value of resources in the future low, raising equity issues with future generations.

Once all necessary information has been gathered, each category of costs and benefits should be summed following proper discounting. If the net benefits of the next best option are known, they should be included as a cost, the opportunity cost of the project. Opportunity costs can also be considered the net benefits of how funds would be spent if the project is not undertaken. The present value of all costs should be subtracted from the present value of all benefits, giving the net present value of the project. If the result is positive, the project is economically efficient. For easier assessment across projects, a benefit-to-cost ratio can be calculated. A related technique, cost-effectiveness analysis, involves comparing costs across options for a given quantity of benefits. Cost-effectiveness analysis is used particularly when benefits are difficult to quantify but have been deemed desirable and justify costs.

GROWING USE

CBA has grown in application since the 1930s when it was introduced by the U.S. federal government for assessing proposed flood control and water projects. A wide range of state and federal legislation requires that projects meet CBA efficiency tests, including the Toxic Substances Control Act and the Federal Insecticide, Fungicide, and Rodenticide Act. The U.S. executive branch has issued orders that federal agencies must conduct cost-benefit analyses of rules to be issued, although the particular implementation of this order is controlled by the current president. Additionally, though, several pieces of federal legislation regarding environmental policy explicitly disallow the use of CBA, such as sections of the Clean Water Act, the Clean Air Act, the Endangered Species Act, and the Resource Conservation and Recovery Act. This is typically because the costs of inaction are deemed unacceptable.

While CBA is a straightforward and typical initial step in economic assessment, critiques exist. Certain shortcomings of the technique demand additional consideration or analysis, particularly when assessing environmental and social factors. The full range and extent of consequences of a project with environmental impacts are not easy to predict. Environmental and human health benefits are typically difficult and controversial to quantify in monetary terms. It is often hard to determine the full range and extent of environmental and social impacts. Furthermore, most environmental and social costs and benefits do not have readily accepted values. Therefore there is a tendency to underestimate, including only the readily identifiable values, and values employed are more difficult to justify and verify than those with documented market-determined values.

A variety of techniques have been developed by economists to determine values of environmental impacts. These include stated preference techniques such as conjoint analysis and contingent valuation that directly ask individuals questions designed to elicit preferences and willingness to pay for benefits. Travel cost and hedonic pricing techniques use revealed preferences via market expenditures to determine the values that individuals hold for various environmental amenities. Examples for estimating a park's value would include respectively determining the amount spent to visit the park and real estate price differences.

Environmental and social impacts also face problems of short planning horizons and future value discounting. When benefits are likely to accrue to future generations, such as under projects to slow climate change, discounting might lead to large future benefits assessed as low values at the present. Also, when projects permanently remove an environmental amenity, such as dams and downstream river recreation, the long-term future stream of costs to society carry little weight.

The distribution of costs and benefits and associated equity considerations do not garner explicit measurement in CBA. Therefore, costs might largely fall on one segment of the population, while benefits accrue to another. One project might provide a high net financial benefit, while a separate project provides less overall benefit but a much larger swath of society experiences some benefit. Various theories on taxation on market forces might dictate allocating all benefits to a certain segment of the population for financial return purposes. The same benefit allocated to different individuals might have different total welfare benefits. For example, based on marginal analysis and diminishing returns, one might expect that someone who already has a large amount of a given resource will not benefit as much from an additional unit of that resource as would someone who has very little of it.

SEE ALSO: Clean Air Act; Clean Water Act; Contingent Valuation; Discount Rate; Efficiency; Endangered Species Act; Federal Insecticide, Fungicide, and Rodenticide Act; Resource Conservation and Recovery Act.

BIBLIOGRAPHY. Diana Fuguitt and Shanton Wilcox, *Cost-Benefit Analysis for Public Sector Decision Makers* (Quorum/Greenwood Publishing, 1999); Nick Hanley and Clive Spash, *Cost-Benefit Analysis and the Environment* (Edward Elgar Publishing, 1993); Per-Olov Johansson, *Cost-Benefit Analysis of Environmental Change* (Cambridge University Press, 1993); Richard Layard and

Stephen Glais, eds., *Cost-Benefit Analysis* (Cambridge University Press, 1994).

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Cotton

COTTON REFERS TO a plant and also to the fibers from the plant. Cotton plants are shrubs in the genus Gossypium, characterized by seed capsules ("bolls"); in some species the seeds are attached to cellulose fibers. The fibers, which may have evolved to help disperse the seeds by attracting nest-building birds, attracted early human interest because they are flat, convoluted and so spinnable into thread. This property led to a remarkable history which included pivotal roles in ancient trade, the Industrial Revolution, New World slavery, the pesticide revolution, the spread of genetically-modified crops into developing countries, and world trade disputes. Cotton is the world's most widely used natural fiber, with a popularity that cuts across class, culture, and geography. However, its history has a dark side, and the political economy and ecology of cotton today are problematic.

Four Gossypium species were domesticated in prehistory. The diploid New World species G. *barbadense* and G. *hirsutum* were being used for textiles by 3600 B.C. (Barbadense in Chile, Hirsutum in Mexico). Sea Island cotton is a famous variety of G. *barbedense*, noted for a long staple (fiber length) that binds into thread especially well. Cultivation of G. *barbadense* is mostly restricted to lowland areas. G. *hirsutum* is more amenable to widespread production; hirsutum fibers are somewhat shorter (although still longer than Old World cottons). The Old World gave us the tetraploid species G. *herbaceum* and G. *arboreum* (tree cotton), both of which may have originated in Africa. Both were in use in the Indus Valley by around 2000 B.C. New World hirsutum varieties have mostly replaced local arboreum and herbaceum in cotton production in the Old World, largely due to colonial agricultural programs.

India dominated the global market for cotton products for over one thousand years; Greek and Roman ships sailed under sails of Indian cotton. Early writers, including Herodotus, described the wondrous wool-bearing tree of India, leading Europeans to depict the plant as a chimera with actual sheep growing on it. Once oceanic trade routes connected Europe to the East Indies in early 1500s, commerce in cotton textiles greatly increased. India continued to dominate this trade, providing high-quality calicoes and muslins were that highly desired in Europe.

Cotton was instrumental in the Industrial Revolution. By the end of the 18th century, England—which previously had engaged only in small-scale, cottage-based textile production—had assumed dominance of cotton weaving. This was the combined result of key inventions, the emergence of

Cotton has been interwoven with more important and troubling threads of history than perhaps any other plant.

capitalists, and state policy. Key inventions from the 1770s–1870s included the spinning jenny (which boosted thread weaving), the water frame (which wound the thread onto rollers), the "mule" (which allowed these functions to be powered by steam engine), and the power loom. These inventions facilitated the development of textile factories, organized by early capitalist entrepeneurs. The state provided protection by banning the East India Company from importing calicoes. England's demand for cotton to feed its textile industry stimulated production of hirsutum cotton in the U.S. south, especially after the 1793 appearance of Whitney's gin, which allowed rapid separation of fiber from seed. Cotton became a key driver of U.S. economic expansion, accounting for half of exports by the mid-1800s. These events also led to a sharp rise in demand for slave labor in the southern states, raising the cost of slaves and stimulating slave trading after the 1807 ban on this activity.

The ecological problem in cotton cultivation is predation by a wide range of insect pests, including weevils and bollworms that devour bolls, and "sucking insects" that feed on sap. Cotton absorbs more insecticide than any other single crop, and in some areas it uses as much as all other crops combined. Cotton is the ultimate "pesticide treadmill" crop; its pests often develop resistance to insecticides and force development and use of new pesticides. In India, with the largest area in cotton cultivation, this crop accounts for five percent of farmland but absorbs over 40 percent of pesticide. Pesticide resistance is a severe problem that continues to play a role in suicides by bankrupt Indian cotton cultivators.

These problems of the cotton pesticide treadmill have created a niche for crop genetic modification, a major early accomplishment of which was the insertion of an insecticide-producing gene into cotton (and several other crops). "Bt cotton" (named for the bacterium *Bacillus thuringiensis* in which the gene originated) was widely adopted in the United States in the late 1990s, and by the early 2000s it was leading the march of genetically modified crops into developing countries, especially China and India.

Cotton has also been at the center of global trade disputes. During an era of trade liberalization and reduction of agricultural subsidies in some countries, the United States has continued lavish cotton subsidies, leading U.S. farmers to expand production despite low global prices. It has been pointed out that U.S. cotton subsidies were literally (if indirectly) killing farmers in Africa and elsewhere, and this situation has galvanized opposition among developing countries. In 2004 the World Trade Organization ruled the U.S. subsidy illegal (in a challenge filed by Brazil), but by two years after the ruling, little had changed.

In a major public relations campaign, advertisements sang that cotton was "the fabric of our lives." This is perhaps truer than most people realize, as this plant and fiber has been interwoven with more diverse, important, and troubling threads of our history than perhaps any other plant.

SEE ALSO: Boll Weevil; Cash Crops; Commodities.

BIBLIOGRAPHY. P.A. Fryxell, *The Natural History of the Cotton Tribe* (Texas A&M University Press, 1979); Beverly Lemire, *Fashion's Favourite: Cotton and the Consumer in Britain, 1660–1800* (Oxford University Press, 1991); Tirthankar Roy (ed.), *Cloth and Commerce: Textiles in Colonial India* (Sage, 1996); Glenn Davis Stone, "Biotechnology and Suicide in India," *Anthropology News* (v.43, 2002); Daniel Zohary and Maria Hopf, *Domestication of Plants in the Old World* (Oxford University Press, 2000).

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Cradle-to-Grave Regulation of Hazardous Waste

THE TERM *CRADLE-TO-GRAVE* refers to an environmental policy of managing hazardous industrial wastes from their point of generation (cradle) to their final disposal location (grave). The cradle-to-grave provisions for managing hazardous waste are found in Subtitle C of the Resource Conservation and Recovery Act (RCRA), which regulates the generation, transportation, storage, treatment, and disposal of hazardous wastes. RCRA, enacted in 1976, was a departure from earlier legislation such as the Clean Water Act and Clean Air Act, which primarily regulated pollutants at the "end-of-pipe."

All companies, big and small, generate wastes, ranging from everyday items such as fluorescent lights and batteries to industrial wastes such as paints, plating solutions, and pesticides. In the United States, it was once legal to dispose of hazardous wastes in unlined landfills or dumps, where they often contaminated lakes, streams, and underground aquifers.

RCRA, an extension of the Solid Waste Disposal Act of 1965, was enacted in response to increasing concerns over the health dangers posed by the disposal of industrial wastes. Its waste management provisions were a departure from other environmental legislation. Its goals are threefold: to make sure that wastes are handled in a manner that protects human health and the environment; to reduce the generation of hazardous waste; and to encourage recycling and conservation of natural resources. RCRA is especially concerned with mitigating the impacts of waste disposal in landfills or dumps, where wastes can seep into groundwater and contaminate drinking water supplies.

There are six basic elements of hazardous waste management under RCRA: (1) generators must identify the types of wastes produced; (2) wastes must be managed safely on site; (3) wastes must be tracked using a manifest system to ensure that wastes reach their final destination; (4) all hazardous waste treatment, storage, and disposal facilities (TSDF) must be permitted to ensure their safe operation; (5) TSDFs must follow U.S. Environmental Protection Agency (EPA) guidelines for acceptable disposal and treatment options; and (6) generators, transporters, and TSDFs are subject to government enforcement action if regulations are not followed.

A generator must first determine if it has generated a s*olid waste,* defined in part as "any garbage, refuge, sludge … or discarded material" whether or not the waste is in a solid, liquid, or gaseous form. The generator must then determine if it has generated a "hazardous waste."

A solid waste may be determined to be hazardous if it either exhibits one of four hazardous characteristics (ignitibility, corrosivity, reactivity, or toxicity), or it is on one of four lists of waste. The lists of wastes are referenced as the F-list (nonspecific source wastes), the K-list (specific source wastes), the P-list, and the U-list (wastes from discarded chemicals). Common F-listed wastes are degreasers or cleaning solvents. An example of a K-listed waste is waste from pesticide manufacturing. P- and U-listed wastes are virgin products that have been discarded because they can no longer be used for their intended purpose.

Wastes must be transported using a hazardous waste manifest, which notes the name of the generator, the type of waste generated, the name of the transporter, and the name of the disposal facility. The manifests must be signed at each stage.

To encourage recycling, there are reduced recordkeeping and management requirements for some wastes such as used oil and scrap metal. In addition, large quantity generators of hazardous waste must certify that they have a plan in place to reduce hazardous waste generation.

Congress expanded RCRA in 1984 with the Hazardous and Solid Waste Amendments (HSWA). These amendments placed restrictions on the kinds of wastes that could be put in a landfill, specified permitting deadlines for TSDFs, and expanded RCRA's scope to include small waste generators. It also placed restrictions on the export of hazardous waste, to discourage generators from avoiding stringent U.S. waste disposal requirements.

Congress allows individual states to manage their own hazardous waste program. However, the state's program must be at least as stringent as the federal program. California and Minnesota are two examples of states that have more stringent waste disposal requirements than the federal government.

SEE ALSO: Groundwater; Landfills; Resource Conservation and Recovery Act; Waste, Solid.

BIBLIOGRAPHY. James McCarthy and Mary Tiemann, "Solid Waste Disposal Act/Resource Conservation and Recovery Act "(Congressional Research Service, 2005); Robert Percival, *Environmental Regulation: Law, Science, and Policy*(Aspen Law and Business, 2000); U.S. EPA, "15 Years of RCRA: Building on Our Past to Protect Our Future" (GPO, 2001); U.S. EPA, "RCRA Orientation Manual" (GPO, 1998).

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Critical Environmental Theory

CRITICAL ENVIRONMENTAL THEORY broadly refers to critical theories of society that attempt to illuminate the relationship between advanced industrial power and the domination of nature in connection with ideological issues of race, class, gender, and species. With the rise of modern environmentalism as a powerful social movement, critical environmental theories have also begun to chart the modes and meanings of resistance posed by environmental groups in an attempt to better understand the environmental movement's evolution, its successes, and failures. Additionally, since the early 1990s, ecocriticism and green studies have increasingly gained currency within the humanities, producing a large body of work by transdisciplinary scholars who seek to interrogate the politics of representation as regards the relationship between culture and nature and human and nonhuman species.

Ecocriticism is more narrowly associated with related disciplinary developments in the field of literary studies. However, the Association for the Study of Literature and the Environment, which is the primary organization for the development of ecocriticism, is composed of a wide range of praxis-based alliances between academic literary critics, activists, environmental educators, and artists concerned with natural themes. In this way, the academic movement for ecocriticism emulates other politicized scholarly movements such as Marxism, feminism, and critical race studies that have attempted to utilize institutional and noninstitutional positions to respond to perceived social crises by furthering debate, articulating new values, and organizing political collectives. Thus, ecocritics hope to promote awareness of ongoing environmental crises in academia, as well as to ultimately generate wider environmental literacy and social transformation in order to foster a more sustainable world characterized by ecological well-being. There are two distinct traditions of critical environmental theory, based in social theory and literary hermeneutics respectively, though there is ultimately significant overlap.

Critical environmental theory that aims at the emancipatory critique of societal domination of nature has its roots in the social scientific tradition of critical theory begun by the Frankfurt School. As part of their radical critique of Enlightenment ideology, capitalism, and the industrial production of mass culture during the 20th century, Frankfurt School theorists such as Herbert Marcuse, Max Horkheimer, and Theodor Adorno made important conceptual contributions that helped found the basis for critical environmental theory's contemporary approach and goals. Drawing in part upon Marx's critical social theory, which made its own nascent gestures toward environmental critique, these theorists analyzed how a dialectical relationship existed between the societal domination of external nature (the environment) and societal domination of internal nature (the psyche). In this way, they theorized that the growth of consumer capitalism was symptomatic of the oppression of peoples and environmental destruction.

EXPOSING THE POLITICAL MACHINE

Unlike Marx, however, the Frankfurt School theorists maintained less optimism for the prospect that social progress could be achieved through rationally planned economic and technological growth. Drawing upon Max Weber's ideas, which linked the establishment of modern society to the normalization of instrumental rationality and the naturalization of bureaucracy and hierarchy, Frankfurt School theorists also developed a critical environmental theory that attempted to expose the ideological workings of the political machine imposed by the ruling class.

Marcuse perhaps went furthest in this respect by claiming that modern industrialism produced nothing less than a one-dimensional technological society characterized by its need for total administration, further arguing that a hallmark of this form of society is its general desire to interpret life instrumentally as a natural resource form of commodity. In opposition, he offered theories advocating the free play of biological and psychological instincts as part of a historical struggle for the liberation of individuals' subjectivity, including the future realization of the subjectivity of nature itself. In this way, Marcuse anticipated environmentalists' critique of anthropocentrism, as well as the movement for animal rights.

These theories influenced radical environmental theorists and leftist activists during the 1950s, 1960s, and 1970s, and have helped to articulate a vision for militant environmental practices. While not a member of the Frankfurt School proper, Murray Bookchin, the founder of the important critical environmental theory known as Social Ecology, branched from the ideas of Marcuse, Horkheimer, and Adorno to craft a rigorous form of anarchist ecological politics. In his monumental book *The Ecology of Freedom*, Bookchin retained the Frankfurt School's emphasis upon the relationship between human oppression and environmental crisis, as well as the centrality of domination and hierarchy as political concepts, but refuted the idea that these concepts could be applied to nature directly. Rather, in Bookchin's social ecological turn, environmental crises arise out the social malformations that are produced through institutionalized human domination of other humans.

Therefore, in his view, the only way to arrive at a more sustainable and humane society for nonhuman animals is through the dismantling of current social forms and norms in order to engage the organic reconstruction of egalitarian, spontaneous, and mutualistic communities. While social ecology remains well regarded within some environmental circles, largely through the ongoing work of the Institute for Social Ecology in Plainfield, Vermont, the competing popularity of environmental theory known as Deep Ecology—which Bookchin declared to be a dangerously noncritical (and even "eco-fascistic") theory in a series of diatribes during the 1980s—has greatly reduced the role critical social ecological theory plays amongst environmental activists at present. On the other hand, there is renewed academic interest in the environmental potentials of Frankfurt School lineage critical theory, including work by or about Jurgen Habermas, William Leiss, Timothy Luke, Douglas Kellner, and Steven Best.

Another major branch of critical environmental theory has emerged among literary critics, where scholars use the term *ecocriticism* to define a recent transdisciplinary field that studies the relationship between literature, aesthetics, and the physical environment. While various historical figures have been hailed as forerunners of the ecocriticism movement, the 20th-century literary critic Kenneth Burke is arguably the first to have rigorously theorized ecocritical methods in books such as *Attitudes Towards History* and *Permanence and Change*.

Alternatively, many ecocritical texts point to Joseph W. Meeker as the field's progenitor. In his 1972 book *The Comedy of Survival*, Meeker theorized the study of *literary ecology,* which he defined as the analysis of the biological relationships and themes of literary works, and the attempt to discover the ecological role played by literature in the evolution of the human species. Meeker's views on the science of ecology and evolutionary theory are now best considered as dated, however, and his reputation has been diminished overall. Still other ecocritics trace the founding of their project to William Rueckert, who is considered to have first coined the term *ecocriticsm* in his 1978 essay "Literature and Ecology: An Experiment in Ecocriticism." In Rueckert's view, ecocriticism should methodologically utilize the concepts and findings of scientific ecology in order to interpret literature. Yet, exactly how natural science is to be properly used to study cultural texts has proven extremely difficult to determine. As a result, literary critics, even those with an interest in environmental themes, were not quick to adopt Rueckert's terminology, as they feared that ecocriticism implied an expertise in ecological science that most English scholars lacked.

STUDIES IN ECOCRITICISM

In 1992, the Association for the Study of Literature and the Environment (ASLE) was formed, and a year later the Association launched the publication of *ISLE: Interdisciplinary Studies in Literature and the Environment*, which along with its younger British counterpart, *Green Letters*, has become a preeminent ecocritical journal. While ecocriticism must still be considered a marginal academic movement overall, since the last decade ASLE significantly expanded its membership to include affiliated chapters in the United States, Canada, the United Kingdom, India, Japan, Korea, and Germany. Additionally, it has held a number of major international conferences on the topic of ecocriticism, and is now discussed seriously in universities of every continent.

Initially, ecocriticism's major agenda was to reaffirm the genre of nature writing and to identify important works that were primarily environmentally oriented. An emphasis was also placed on outdoors experiences in order to move ecocriticism outside of the academy, connect theory with practice, and link culture with nature. In his 1995 book *The Environmental Imagination*, Buell crucially outlined a methodological ecocriticism, in which he signaled four ways that literature could be categorized as environmental in an ecocritical sense: the nonhuman environment serves as a textual presence and not just a setting or frame for the plot; the interests of human characters are not the sole legitimate interests of the story; an ethical orientation exists in the narrative in which there is demonstrated a human accountability to the environment; and there is an implicit or explicit depiction of the environment as nonstatic, evolutionary, or otherwise engaged with some form of historical process.

Along with these criteria, many ecocritics called attention to work that either influenced the mainstream environmental movement that had emerged in society since the 1960s, or could be linked in some fashion to that movement itself. In this way, many anthologies of primary literature, critical essays, and other related theoretical works were released in an attempt to map the emerging field and legitimate its venture. Thus, alliances were made with other scholars who theorized diverse fields like ecofeminism, ecotheology, environmental history, deep ecology, and other modes of environmental philosophy and environmental education. Yet, on the whole, ecocriticism's early stress was on highlighting its prophets and practitioners, most often in the context of the literary traditions of American and British Romanticism, as well as other recent American nature writing exemplified by authors such as Gary Snyder, Terry Tempest Williams, Annie Dillard, Edward Abbey, and Wallace Stegner.

Unfortunately, the unintended consequence of ecocriticism's self-linkage to the ideals and rhetoric espoused by mainstream environmentalism—particularly in its long-standing American celebration of pristine "wilderness" places—was that the field lacked social diversity and often took a surprisingly uncritical stance toward its own ostensible subject-matter, instead favoring praise narratives that celebrated the aesthetic experience of being outdoors in nature. By 1999, a crisis began to erupt and as had happened in other social movements such as environmentalism and feminism themselves, a second wave of ecocritics began to emerge who criticized the movement as overly white and privileged. While it remains unclear as to what the end result of this recent criticism will be, it has generated significant controversy and heightened attention to acknowledged problems. Thus, ecocriticism has increasingly moved to include previously unattended topics such as urban environments, environmental racism, social justice literature, post-colonialism, anti-imperialism and globalization, and comparative international ecocritical studies.

REFORMATION OF ECOCRITICISM

As ecocritics have been challenged about their right to speak for and provide definitive representations of the environment, wilderness, and nonhuman animals, there has been a greater opportunity for cross-cultural knowledge about how different peoples relate to and understand nature. On the other hand, the critique of the social construction of nature has led some ecocritics toward more reactionary positions. Hence, a major ideologue for the movement, Leo Marx, has derided ecocriticism for its disavowal of anthropocentrism as the main reason for environmental conservation and for its adoption instead of an ecocentrism that attaches intrinsic value to nonhuman beings. Still others, such as John Elder, have strategically moved away from more radical ethical positions to advocate ecocriticism that advocates for a more moderate view of human stewardship over the earth. This shift can also be seen in the work of Glen Love, who rejects a strong anti-anthropocentrism in favor of complex analyses of what it means to be human in the world. For Love, this means bringing ecocriticism full circle and attempting to base it once again in the scientific knowledge of biology and ecology, which he believes can provide the universal foundation to escape the relativistic perils of postmodern social constructionism, as well as forms of hubristic anthropocentrism in which the human is divorced from the natural order.

Ecocriticism is ultimately concerned with revealing the roots of global environmental crises and with reconstructing a more just and sustainable world in which culture and nature work harmoniously.

Changes in the field, then, must be understood as responding not just to the discipline's inner dynamics, but also to the needs of present environmentalist politics. Therefore, ecocritics' desire to adopt a scientifically based ecological literacy and ideology of stewardship perhaps reflects a larger turn in the environmental community away from the deep ecological theories and practices that were dominant during much of the 1980s and 1990s.

SEE ALSO: Deep Ecology; Ecofeminism; Environmental Racism; Nature Writing; Social Ecology; Sociology.

BIBLIOGRAPHY. Joni Adamson, Mei-Mei Evans, and Rachel Stein, eds., *The Environmental Justice Reader: Politcs, Poetics, and Pedagogy* (University of Arizona Press, 2002); M.P. Branch and Scott Slovic, eds., *The ISLE Reader: Ecocriticism, 1993–2003* (University of Georgia Press, 2003); Lawrence Buell, *Future of Environmental Criticism: Environmental Crisis and Literary Imagination* (Blackwell Press, 2005); M.P. Cohen, "Blues in the Green: Ecocriticism Under Critique," *Environmental History* (v.9/1, 2004); Greg Garrard, *Ecocriticism (New Critical Idiom)* (Routledge, 2004); Cheryl Glotfelty and Harold Fromm, eds., *The Ecocriticism Reader: Landmarks in Literary Ecology* (University of Georgia Press, 1996); G.A. Love, *Practical Ecocriticism: Literature, Biology, and the Environment* (University of Georgia Press, 2003); Dana Phillips, *The Truth of Ecology: Nature, Culture, and Literature in America* (Oxford University Press, 2003).

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Croatia

HISTORICALLY PART OF the Austro-Hungarian Empire, the Croat people joined the Serbs in creating the eastern European nation of Yugoslavia in the post–World War I period. At the end of World War II, Yugoslavia became a Communist state, but ethnic and religious differences continued to haunt the federation. After the dissolution of Yugoslavia, the Croats battled for complete independence from the Serbs. Although Croatia declared independence in 1991, the country did not achieve complete sovereignty until 1998 when the United Nations (U.N.) stepped in to mediate the conflict. Geographically, Croatia is a land of alternating plains and low mountains. The mainland section of the Adriatic coastland stretches for 1,102 miles (1,777 kilometers). Another 2,516 miles (4,058 kilometers) of the coast surrounds the Croatian islands. With its Mediterranean climate, the coastal area experiences mild winters and dry summers. The continental climate in the rest of Croatia results in hot summers and cold winters. Destructive earthquakes are a threat.

Within the Federation of Yugoslavia, Croatia was outranked only by Slovenia as a major industrial power. The breakup of the federation and the ensuing civil strife put Croatia in the position of having to struggle to regain its economic health. After centuries of exploitation, the wealth of natural resources—including oil, small amounts of coal, bauxite, low-grade iron ore, calcium, gypsum, natural asphalt, silica, mica, clays, salt, and hydropower—is helping Croatia to reach economic stabilization in the twenty-first century. Tourism, banking, and public investments have provided additional assets in economic progress. Even with a per capita income of $11,600, 11 percent of the 4,500,000 population of Croatia live below the poverty line. Unemployment remains high at approximately 19 percent. On general quality-of-life issues, the U.N. Development Program (UNDP) Development Reports rank Croatia 45th among the nations of the world.

Environmentally, Croatia suffers from air pollution caused by numerous metallurgical plants, and coastal areas are heavily polluted by industrial and domestic waste. Croatia's infrastructure is still recovering from the long years of war, and significant resources are directed toward the removal of land mines that serve as a constant reminder of the recent strife.

Croatia's forests are at risk from acid rain, and nine of the 76 mammals endemic to Croatia are threatened with extinction, as are four of the 224 bird species endemic to the area. Before the 1970s, Croatia's forests were being steadily depleted. Subsequently, Croatia passed the Forest Act and incorporated components of the Helsinki Convention of Forests into Croatian law. All wood cutting in the forests requires a special permit, and loggers must leave at least two old or dried trees per 2.47 acres (one hectare) to promote biological diversity.

As in most industrialized nations, the percent of the Croatian workforce involved in agriculture is low at 2.7 percent. Most of the farming in Croatia takes place in the east and was traditionally under the control of large, socially owned agribusinesses. Environmentally unsound agricultural management led to the excessive use of chemicals and severe land degradation. However, considerable ecological progress is now underway in Croatia. With 7.5 percent of its land protected, Croatia is above the average for Europe and Central Asia. Approximately 95 percent of the forests now demonstrate a natural composition, and the extensive grasslands are relatively free of fertilizers and chemicals.

The Croatian Parliament adopted the Declaration of Environmental Protection in 1992, aimed at correcting harmful practices of the past and moving Croatia in a more environmentally responsible direction. As a result, the Croatian government began passing a body of legislation designed to protect the environment. For example, in 1994, the Nature Protection Act and the Environmental Protection Act established guidelines for reducing environmental threats and established goals for promoting natural resources and sustainable development. In that same year, the Agricultural Land Act attempted to check the use of harmful substances in agriculture while promoting improved land management. The following year, the Air Protection Act identified measures for air quality and improvement. Other laws established guidelines for water management, regulated hunting and breeding of wildlife, and promoted the protection of marine life.

The Croatian government currently participates in a trilateral agreement with Italy and Slovenia to protect the environment of the Adriatic Sea and coastal areas. Croatia is also a party to the World Bank Mediterranean Action Plan in which a number of southeastern European nations have joined together to reduce pollution from land sources and improve water quality for the region. Croatia is involved in the Adriatic-Ionian Initiative, which works to promote environmentally responsible development in the area. On a broader scale, the Croatian government has committed itself to environmental responsibility by participating in the following international agreements: Air Pollution, Air Pollution–Sulfur 94, Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. Croatia has signed but not ratified the Air Pollution–Persistent Organic Pollutants agreement and the Kyoto Protocol.

SEE ALSO: Deforestation; Earthquakes; Land Degradation; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. CIA, "Croatia," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Environmental Protection and Physical Planning, "CBD Strategy and Action Plan—Croatia," www.biodiv.org (cited March 2006); Ministry of Environmental Protection and Physical Planning, "CBD First National Report—Croatia," www.biodiv.org (cited March 2006); UNDP, "Human Development Reports: Croatia," wwwhdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Croatia," *Little Green Data Book,* www.worldbank.org (cited March 2006); World Bank, "Environment at a Glance: Croatia," www.worldbank. org (cited March 2006); World Bank, "Environment in South East Europe," www.seerecon.org (cited March 2006).

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WILLIAM CRONON IS one of the most distinguished and influential contemporary environmental historians, receiving numerous honors for both his research and teaching. He is currently the Vilas Research Chair and the Frederick Jackson Turner Professor of History, Geography, and Environmental Studies at the University of Wisconsin-Madison.

Born September 11, 1954, in New Haven, Connecticut, William Cronon received his B.A. (1976) from the University of Wisconsin, Madison. He holds an M.A. (1979), M.Phil. (1980), and Ph.D. (1990) from Yale, and a D.Phil. (1981) from Oxford University. Cronon's earliest book, *Changes in the Land: Indians, Colonists and the Ecology of New England* (1984) documented the differences in ecological practices between Native Americans and European settlers. Contrary to common perceptions at the time, he argued that the introduction of European farming techniques impoverished the land through the cutting of forests, stripping of topsoil, and changes to waterways. In addition, Old World animals took more than they returned to the land. This analysis is counterposed to Native American practices.

Nature's Metropolis: Chicago and the Great West (1991) examined the economic and ecological relationships between Chicago and the region from Wisconsin to the Pacific, arguing that Chicago's location made it an ideal gateway city between the West and the industrial and financial centers of New York and the east coast. He focuses primarily on three commodities—grain, lumber, and meat—and documents Chicago's role in the ecological degradation of the western frontier. He also links the decline in Chicago's processing industries to the pushing back of the frontier. In 1992, he co-edited *Under an Open Sky: Rethinking America's Western Past*, a collection of essays on the prospects of western and frontier history in American historiography. In *Uncommon Ground: Rethinking the Human Place in Nature* (1995), a collection edited and introduced by Cronon, his approach shifted from an economic history of people/nature interactions to a cultural and symbolic history of people's perceptions of the environment. He specifically critiques the concept of "wilderness," showing why it was important in forging the identity of the western frontier, and also how and why this concept changed through history. The concept of wilderness was constructed as an "other" to civilization and a realm of pure nature, fueled by a romantic quest to escape the confines of industrial capitalism. Cronon documented its symbolic place in North American history, but also pointed out its ironies and its misleading role in framing contemporary environmental practices. One its most ironic implications was the fact that national and state parks, viewed by urbanites as sites of sublime wilderness experience, were constructed through expelling Native Americans from those areas, often violently. The collection has therefore been influential for anthropologists studying conservation issues, especially from a historical perspective.

Most recently, Cronon's research has centered on a history of Portage, Wisconsin, exploring how people's senses of place is shaped by their narratives about their homes, lives, and the landscapes they inhabit. In the process, he has written a number of articles on the role of oral history in understanding peoples's senses of place and space. He is also finishing a book titled *Saving Nature in Time: The Past and the Future of Environmentalism* on the changing relationships between environmental history and environmental movements, and what the two might learn from each other.

SEE ALSO: Deforestation; Meat; Native Americans; United States, Midwest; Wilderness.

BIBLIOGRAPHY. William Cronon, *Nature's Metropolis: Chicago and the Great West* (Norton, W. W. & Company, 1995); William Cronon, *Uncommon Ground: Rethinking the Human Place in Nature* (Norton, W. W. & Company, 1995); William Cronon, *Under an Open Sky: Rethinking America's Western Past* (Norton, W. W. & Company, 1994).

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Crop Plants

CROP PLANTS ARE vegetables that are grown primarily for food or fodder. They include species of the *Liliopsida* (monocot) family such as maize, rice, garlic, and onions, and the *Magnoliopsida* (dicot) family, such as lettuces, beans, cabbages, and potatoes. Crop plants provide a large proportion of the nutrition required by humans and animals. New varieties have been introduced into large-scale production in recent decades, as the products of countries once considered remote now earn international recognition. Crop growing has become a large, resource-intensive industry in developed and

When large fruit plantations are created, they have often been worked by groups of transient migrant workers.

developing countries, with extensive use of chemical pesticides and similar products aimed at destroying agricultural pests. Some farms have become organic, which prohibits the use of pesticides. In less developed countries, farmers tend to use whatever technology and local knowledge is available to boost productivity.

Growing crops successfully requires different configurations of inputs and labor, including plowing, fertilizing materials, irrigation, and the need to leave soil fallow at intervals. The invention of the plow and its powering by animals considerably assisted in the growth of crop planting. Rotating crops has helped to mitigate the problems of poisoning or depleting the soil, and the need to let it lie fallow. Selection of hardy specimens has helped crops become more productive and useful. The provision of irrigation has assisted in promoting wet rice paddy farming and, with fish introduced into the ditches, provides an additional source of protein. In regions with favorable climates, two or more growing seasons for crop plants are possible. For nomadic people, swidden (slash-and-burn) farming may be used to clear comparatively fertile ground that is then used until its value decreases. Despite all of the accumulated knowledge and technology used to assist in growing crop plants, sudden climatic changes or infestation by pests can dramatically reduce harvests or even eradicate them entirely.

Industrialization of agriculture has inspired the creation of single-crop or cash crop farming. Such farming renders the farmer vulnerable to changes in the terms of trade and the vagaries of international marketing and business. In traditional forms of agriculture, farmers will grow a staple crop (such as rice or wheat) and will grow various others to provide nutritional and culinary variety. Excess of the staple crop is sold to a merchant, who then typically markets it in urban areas.

When single crops are grown, the farmer's livelihood becomes subject to the risks facing that crop and market variations in demand and price. It also tends to place extra pressure on the fertility of the soil. Since farmers rarely have the capacity to do more than grow their crops, intermediaries often capture the additional added value available from prepared foods using those crops as inputs, leaving the farmers comparatively poor.

Large-scale crop growth has significantly changed the landscape of much of the settled land of the plant. Croplands are increasingly regularized and homogenized to facilitate the movement of machinery and the application of technological solutions. When large fruit plantations are created, they have often been worked by groups of transient migrant workers; sugar cane plantations of the Caribbean, for example, provided an economic imperative for the movement of slaves from Africa to the Americas. Grown crops become part of national and regional cultures, especially when they are used in localized signature dishes, which can be highly culturally specific. The thought of corn or wheat or rice farmers can have a powerful hold on the imagination, impeding rational discussion, causing difficulty when organizing multilateral trade agreements on agricultural products.

SEE ALSO: Agriculture; Agroecosystems; Rice; Sugar; Wheat.

BIBLIOGRAPHY. James F. Hancock, Plant Evo*lution and the Origin of Crop Species* (CABI Publishing, 2004); John M. Poehlman and David A. Sleper, *Breeding Field Crops* (Blackwell Publishing Professional, 1995); Joseph Smartt, *The Evolution of Crop Plants* (Blackwell Publishers, 2000).

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Crossbreeding

CROSSBREEDING IS THE process of mating two strains of a particular plant or animal species to produce offspring that display desirable characteristics. This process remains popular within agriculture in particular, because of the phenomenon of heterosis (also known as hybrid vigor), which dictates that the hybrid offspring tend to perform better than their parents. However, mating the hybrid offspring as a new generation is generally less successful, and there is a need to retain the purity of the family line of the original parents for subsequent crossbreeding. Successful heterosis requires a suitable level of complementarity between the specimens. While most large cities of the world contain populations of crossbred dogs, which show the vigorous fertility of so many crossbreeding encounters, there are nevertheless limits to the ability of creatures to mate with each other and produce viable offspring. Further, the desirable characteristics identified by breeders may also be accompanied by less desirable characteristics which may not be immediately evident.

While crossbreeding is most commonly associated with agriculture and agronomy, it is used intensivly in animal performance industries, such as racehorse management and pet modeling. There is also an undercurrent of supposedly scientific research and ideology purporting to demonstrate the superiority of some groups of people over others and advocating the maintenance of the "purity" of human races.

In recent years, the issue of crossbreeding has received increased attention as part of the larger effort to modify the genetic material of plants or animals in desirable ways. This has enabled some hybrid plants to obtain the ability to fix nitrogen, for example. The intensive methods used in modern agriculture, combined with programs of crossbreeding and genetic manipulation, has led to significant levels of consumer unrest in some societies. Although crossbreeding and its related techniques can be used to improve the quality of products, marketing pressures often instead produce entirely homogeneous and tasteless items that are visually appealing but nutritionally inferior. The relative superiority of genetic manipulation in place of crossbreeding means that the latter has been largely supplanted in most parts of the world. However, it remains popular in industries in which individual animals or plants are of considerable economic value, for example among beef cows.

SEE ALSO: Animals; Genetically Modified Organisms (GMOs); Nitrogen Fixation.

BIBLIOGRAPHY. S. K. Banga, *Hybrid Cultivar Development* (Springer-Verlag, 1998); Amarjit S. Basra, ed., *Heterosis and Hybrid Seed Production in Agronomic Crops* (Haworth Press, 2000); Sandy Miller Hays, "How Now, Beef Cow?" *Agricultural Research* (v.39/11, 1991).

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Croton River Aqueduct

THE CROTON RIVER Aqueduct was built in 1837–41 under the supervision of Chief Engineer John B. Jervis and is one of the oldest dams of the modern United States. It is 38 miles long and located in the southeastern part of the state of New York. It is part of a system of waterworks that is used to transport water to New York City. This includes tunnels, one of which passes beneath the Harlem River; Highbridge, which is a Roman style aqueduct; and the New Croton Aqueduct, which was built 1885–91. The aqueduct was hailed as a huge engineering success of its day, and three former and current presidents of the United States attended its opening, when the 50-foot-high fountain in City Hall Park was turned on in October of 1842. The reservoir that received the water had a capacity of 180 million gallons.

As the city has grown, the intensity of demand for water has grown at an enormous and unpredictable rate. Future planning for water demand and maintenance of the existing system are important and complex issues. In its early years, New York was built mostly from wooden houses, which were vulnerable to the rapid spread of fire. Available water sources included wells and cisterns, which may have been suitable for domestic use, but were inadequate to fight fire.

The growth of industry also added to the demand for water, and pollution became a significant problem. Cholera and yellow fever threatened the people of New York. The Croton River Aqueduct helped to solve these problems until it became superseded and, in 1940, the Commissioner for Parks and Recreation ordered it to be drained and filled. The New Croton Dam continues to supply up to 10 percent of the city's need for water.

The pressure to maintain water quality and regularity of supply has become even more intense as the result of demand for housing and development within the Croton watershed area. The land is available at comparatively cheap rates and is all the more attractive for the pressure on permits elsewhere in the vicinity. Local public and private sector groups have consulted to plan for future development. Water management requires representatives from areas under numerous jurisdictions and technical experts from a variety of disciplines. Consequently, competing interests seek to exploit and protect a scarce resource.

SEE ALSO: United States, Middle Atlantic; Water; Water Demand; Watershed Management.

BIBLIOGRAPHY. "Croton Aqueduct," *Civil Engineering* (v.72/11–12, 2002); Jeffrey Kroessler, *Old Croton Aqueduct: Rural Resources Meet Urban Needs* (Hudson River Museum, 1992); Alex Philippidis, "Croton Watershed under Review," *Westchester County Business Journal* (v.38/8, 1999).

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Cryptosporidium

CRYPTOSPORIDIUM IS THE genus of parasitic protozoans that cause cryptosporidiosis, a diarrheal disease of humans found worldwide and transmitted locally through contaminated drinking water. Outbreaks occur frequently in dairy farming regions because young cows readily transmit the disease via feces. The organism was discovered in 1907, but it is considered an emerging infectious disease because physicians first observed its role in human illness during the 1970s. Cases of diarrhea are now frequently attributed to this parasite, and the infection is endemic in many developing countries. *Cryptosporidium* may infect large portions of local populations and may be severe, persistent, or fatal among those with compromised immune systems such as AIDS patients. In the 1980s, increasing rates of cryptosporidiosis were associated with the spread of HIV. Even those with healthy immune systems experience acute symptoms, including abdominal cramps and frequent, watery diarrhea as well as fever and nausea for one to two weeks.

CRYPTOSPORIDIUM CARRIERS

A wide variety of livestock and vertebrate wildlife species carry *Cryptosporidium*, and their feces are the primary source of the parasite in water supplies. The oocyst stage of the *Cryptosporidium* life cycle is the agent of transmission; its hardy shell allows it to survive for long periods and under a variety of conditions outside the body of the host. The practice of permitting cattle near streams is most commonly blamed for the deposition of *Cryptosporidium* oocysts in water. Livestock exclusion, and particularly exclusion of young cows, from stream areas may help keep oocysts out of drinking water and therefore prevent outbreaks; however, oocysts may travel through groundwater or soil as well. Feral pigs and free-ranging deer also carry the parasite and shed oocysts in their feces, and so may be important contributors to contamination in areas where their populations are high. *Cryptosporidium* has been found even in protected watersheds far from human habitation and agricultural activities.

Cryptosporidium oocysts may persist even in treated water; they survive outside the body of host organisms and are resistant to chemical disinfection methods such as chlorination. Filtration is the only means of removing oocysts from water, but it is not absolutely reliable. Outbreaks have occurred where filtration systems were in compliance with federal water safety standards, and one study has suggested that up to 97 percent of surface waters in the United States contain *Cryptosporidium*.

HISTORICAL OUTBREAK

The most notable outbreak of cryptosporidiosis occurred in Milwaukee, Wisconsin, in April 1993. Public health investigators believe that spring runoff carried *Cryptosporidium* oocysts from nearby abattoirs and cattle grazing establishments into Milwaukee's rivers and hence to Lake Michigan, the source of the drinking water supply. Over 400,000 individuals contracted the disease, and several patients with immune deficiencies continued to suffer symptoms over a year after the initial exposure. Though filtration plants were operating within legal standards, changes in turbidity should have alerted managers to the need for corrective measures. The outbreak cost the city several million dollars, strapped local health facilities, and left key public service agencies understaffed. Since the 1980s, the U.S. Congress has amended the Safe Drinking Water Act to mandate additional checks against *Cryptosporidium* contamination. Water treatment facilities must now test more frequently for water turbidity, but this is not a failsafe against outbreaks.

SEE ALSO: Acquired Immune Deficiency Syndrome; Cattle; Deer; Drinking Water; Livestock; Water Quality.

BIBLIOGRAPHY. Joan Aron and Jonathan Patz, eds., *Ecosystem Change and Global Health* (Johns Hopkins University Press, 2001); George E. Dissmeyer, ed., *Drinking Water from Forests and Grasslands: A Synthesis of the Scientific Literature* (USDA, 2000); Ronald Fayer, ed., *Cryptosporidium and Cryptosporidiosis* (CRC Press, 1997); Dennis Juranek, "Cryptosporidiosis: Sources of Infection and Guidelines for Prevention," *Clinical Infectious Diseases* (v.21, 1995).

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Cuba

UNDER REPRESSIVE COLONIAL Spanish control, the slave population of Cuba fueled the coffee and sugar plantations of the colonial period, creating massive human and environmental damage. Spanish hegemony ended during the Spanish American War (1898), leaving the United States in effective indirect control of the island nation, which lived under a series of dictators until the revolution in 1959. Under Fidel Castro during the period since, the economy of the island came to depend on support from the Soviet Union, whose collapse led to the subsequent withdrawal of several billions of dollars in annual subsidies from the Cuban treasury. The following recession in the early 1990s was exacerbated by an ongoing economic embargo by the United States.

The developmental situation of Cuba is complex. While Cuba has a per capita income of only $3,300, resulting in an income ranking of 157th among 232 counties, its health and human development conditions are relatively high by global standards and extremely high compared to other Caribbean nations. The United Nations Development Program (UNDP) Human Development Reports rank Cuba 52nd of 232 countries on overall quality-of-life issues, and access to health and education is higher than anywhere else in the region.

Located 93 miles (150 kilometers) south of Key West, Florida, Cuba is bordered by the Caribbean Sea and the North Atlantic Ocean, resulting in a coastline 2,316 miles (3,735 kilometers) long. The Guantanamo Bay Naval Base, covering an 18-mile (29-kilometer) area, is located at the southeastern section of the island. While it is geographically part of Cuba, it is leased by the United States. Cuba has limited access to freshwater sources. The tropical climate is moderated by trade winds. The dry season, which lasts from November to April, is followed by a six-month rainy season.

The terrain of Cuba is generally flat with rolling plains except in the mountainous southeast. Droughts are frequent in Cuba, and the island experiences hurricanes on an average of one every two years. Generally occurring from August to November, many hurricanes leave massive environmental damage behind. Cuba's rich natural resources include cobalt, nickel, iron ore, chromium, copper, salt, timber, silica, and petroleum. Over a third of the land is arable, and 21.2 percent of the workforce is engaged in agriculture.

The major environmental issues in Cuba are air, water, and soil pollution, deforestation, and the loss of biodiversity. Extensive soil degradation is partially the result of both past and present irresponsible waste control practices of the sugar industry. The poor air quality is largely a byproduct of liquid industrial waste such as torula yeast, which is toxic. When such contamination reaches streams, it is transported out to sea.

POLLUTION AND OTHER PROBLEMS

Agriculture and other industries also contribute to pollution on the island. The cement industry emits dust and smoke; chemical and metallurgical industries produce acid steams, smoke, and soot; and mining companies release dust into the air and byproducts into the water. Consequently, Cuba's bays are polluted, and beaches and coastal areas have eroded. Salinization also causes major difficulties in low-lying coastal areas.

In 2006, a Yale University study ranked Cuba 41st of 132 countries on environmental performance, well above its income group and slightly above its geographic group. The lowest ranks were assigned in the fields of air quality and sustainable energy. Over three-fourths of the Cuban people live in urban areas, and the country generates 0.1 percent of the world's carbon dioxide emissions despite the fact that there are only 16 passenger cars per 1,000 people on the island. The state protects 69.1 percent of Cuban land. Of 31 endemic animal species, 11 are endangered, and 18 of 86 endemic bird species are in the same precarious situation.

RESPONSIBILTY FOR THE ENVIRONMENT

In 1976, the Cuban constitution assigned the responsibility for the environment to both the state and the population. Since that time, specific environmental efforts have included the establishment of the National Commission for Environmental Protection and the Rational Use of Natural Resources (1977), the creation of similar agencies in provinces and municipalities in 1980, the Environmental Protection and Rational Use of Natural Resources Act (1981), and the National Protection System (1990). An extensive system of national parks and protected areas was created to promote biological diversity. In 1993, Cuba's National Program on Environment and Development established 214 objectives and 816 actions designed to protect the environment and promote rational use of natural resources. The following year, the Ministry of Science, Technology, and the Environment was created to implement environmental policy. Laws were revised again in 1997. Unfortunately, enforcement is difficult, and the protective institution is considered ineffectual by many environmentalists.

Cuba has expressed commitment to the global environment by participating in the following international agreements: Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. The government has signed but not ratified the Marine Life Conservation agreement.

SEE ALSO: Caribbean Sea; Endangered Species; Hurricanes; Pollution, Air; Pollution, Water; Salinization; Trade Winds.

BIBLIOGRAPHY. Fidel Castro, *Tomorrow Is Too Late: Development and the Environmental Crisis in the Third World* (Ocean Press, 1993); CIA, "Cuba," *The World Factbook,* www.cia.gov (cited April 2006); Sergio Díaz-Briquets and Jorgé Pérez-López, *Conquering Nature: The Environmental Legacy of Socialism in Cuba* (University of Pittsburgh Press, 1999); Franklin W. Knight and Teresita Martinez-Vergne, eds., *Contemporary Caribbean Cultures and Societies in a Global Context* (University of North Carolina Press, 2005); Mark Kurlansky, *A Continent of Islands: Search for the Caribbean Destiny* (Addison-Wesley, 1992); UNDP, "Human Development Reports: Cuba," www.hdr.undp.org (cited April 2006); World Bank, "Cuba," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Cultural Ecology

CULTURAL ECOLOGY IS the study of how or cultural groups interact with their biophysical environment. With deep roots in the disciplines of geography and anthropology, cultural ecology is an interdisciplinary approach to understanding the origins and development of human–environmental relations in places where people depend on their immediate environment for sustenance and symbolic meaning. The cultural ecology approach argues that human–environmental relations are tied dynamically to demography, technology, food production, and social organization.

Cultural ecology is closely associated with the work of Julian Steward. When Steward first coined the phrase in 1955, he sought to understand "the effect of environment upon culture," but later clarified his ideas by saying that cultural ecology "is the study of the processes by which a society adapts to its environment." By stressing human–environmental interaction, Steward pursued a compromise between environmental determinism (which he felt over-emphasized the role of the environment in shaping culture) and possibilism (which he felt neglected ecology).

Stewart argued that cultural ecology provided a methodology to study adaptive processes: how certain cultural traits—what he called the *cultural core*—related to specific (or what he called *relevant*) features of the natural environment. By examining cultural traits most closely tied to subsistence activities and economic arrangements, and by scrutinizing how they interacted with the relevant environment, Steward was able to show why hunters, pastoralists, or farmers in dissimilar environments and in distinct historical periods shared or did not share cultural traits. Although the scope and intent of cultural ecology has changed, Stewart's emphasis on adaptive process remains central to the cultural ecology approach.

Scientific revolutions in quantitative and biological sciences pushed cultural ecology in new directions during the 1960s. In his seminal 1968 book *Pigs for the Ancestors*, anthropologist Roy Rappaport used a cultural ecology approach (also known as ecological anthropology) to study the Maring peoples of Papua New Guinea. By examining human behavior and its functional relationship with the environment, Rappaport showed that belief systems and their associated rituals served as self-regulating mechanisms that kept people below the carrying capacity of their habitat—that is, in balance with their ecosystem. Rappaport's innovation was to regard the Maring as "a population in the ecological sense" and, thus, amenable to study as part of an ecosystem like any other social mammal. Contemporaneous cybernetic models involving systems, information networks, feedback loops, homeostasis, and perturbation combined with biological analogies such as trophic exchanges, stress, and niche to examine the role of culture in maintaining social harmony in bounded natural ecosystems.

This approach helped solidify the notion of culture as learned behavior transmitted through practice. Work by Rappaport, Marvin Harris, and others at what became known as the Columbia School suggested that many aspects of culture—such as specific religious beliefs that were assumed to be historically contingent—had deeper functional and environmental origins because they kept social groups in balance with one another and their ecosystem. Regardless of its limitations, Rappaport's brand of cultural ecology had a large impact on the study of human–environmental relations.

CRITICISM

By the 1970s, Rappaport's "neofunctional" view of cultural ecology faced severe criticism from all sides. Because neofunctionalists focused on relatively isolated groups already deemed to be adapted, it was difficult to understand the adaptive process itself; behaviors were simply judged to be adaptive since the people studied were considered to be isolated and self-regulating. The argument became circular and teleological. How could we study maladaptive groups, or come to know maladaptive processes? How did people reach their self-regulating condition? Did it make sense to assume people were bounded spatially or isolated culturally and economically? What about differences within the groups? As scholarly concerns shifted to nonisolated groups, Third World development, and peasant studies during the era of the Vietnam War, the cultural ecology approach became less appealing.

Yet even during this period, geographers such as Harold Brookfield, Piers Blaikie, and Karl Butzer—as well as anthropologists such as John Bennett, Robert McNetting, Emilio Moran, and many others—kept cultural ecology significant because they sought to explain social and environmental change and the relationship between the two. In the work of these scholars, small and isolated groups were avoided. Instead, they examined larger and more complex societies undergoing demographic, environmental, or social change. Concerns shifted from seeing culture as a regulating black box to a dynamic social and individual force that made decisions by weighing and rejecting alternatives.

Behavior was not viewed as strictly functional, but the outcome of a social process that engaged a larger political economy. Scholarly research concentrated on how people responded to change, how they adjusted their behaviors, how they intensified land and resource use, and adopted or rejected new technologies. Scholars found that an "adaptive dynamic" existed between people, their cultural beliefs, social values, knowledge, forms of social organization, economic opportunities, population growth, and environmental change (which they themselves were partly responsible for). Understanding how people made adjustments in their environmental practices to remain socially viable became the challenge for cultural ecologists.

Over the last decade, cultural ecology has broadened to examine more complex aspects of society–nature relations. Greater attention to the geographic notion of scale—particularly how local adaptive processes are mediated by regional and global political economies—became an important topic of research. The biophysical environment also received greater attention by cultural ecologists and is viewed as increasingly complex, nonlinear, and less predicable. Many cultural ecologists today deconstruct notions of culture by examining environmental discourse and the origins, circulation, and deployment of local knowledge. Cultural ecologists commonly investigate livelihoods as they relate to peoples' access to natural resources. They seek to understand the role of customary rights of access to resource commons in traditional resource management, and how state-centered policies affect this relationship. Cultural ecologists no longer consider social groups as homogenous units devoid of class, racial, ethnic or gender differences. Gendered knowledge and differential access to and control over resources, for example, have become important focuses within cultural and related political ecology approaches to society-environment relations. Contemporary cultural ecology also brings its core foci to study biodiversity, environmental knowledge, and conservation policy to enhance innovative forms of nature conservation that promote social justice.

SEE ALSO: Adaptation; Culture; Rappaport, Roy.

BIBLIOGRAPHY. Thomas J. Bassett and Karl S. Zimmerer, "Cultural Ecology" In *Geography in America at the Dawn of the 21st Century*, Gary L. Gaile and Cort J. Willmott, eds., (Oxford University Press, 2003); Benjamin Orlove, "Ecological Anthropology," *Annual Review of Anthropology* (v.9,1980); Karl W. Butzer, "Cultural Ecology," In *Geography in America*, Gary L. Gaile and Cort J. Willmott, eds., (Merrill Publishing Company, 1989); Emilio F. Moran, *Human Adaptability: An Introduction to Ecological Anthropology* (Boulder: Westview Press, 2000); Roy A. Rappaport, *Pigs of the Ancestors: Ritual in the Ecology of a New Guinea People* (Yale University Press, 1968); Julian Steward, *Theory of Culture Change* (University of Illinois Press, 1955).

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Culture

OF ALL OF the words in the English language, *culture* and *nature* are two of the most complicated and multi-faceted, making any discussion of "culture" in the context of environment–society relations fraught with complexity. The Latin word *cultura*, from which "culture" is derived, had the primary meaning of cultivation or husbandry, the process of tending natural growth, especially crops or animals. The concept was eventually extended to the process of human development, and "culture" was often used in the 18th century as a synonym for "civilization." In the late 17th century, Matthew Arnold introduced the notion of culture as *high* *culture,* that which is beautiful, sublime, and perfect, the best of what has been thought and said. In this view, culture is embodied by extraordinary works of literature, painting, music, and philosophy. More recently, social scientists have argued by contrast that "culture is ordinary," and that popular or mass culture is also worthy of study.

In 1952, anthropologists Alfred Kroeber and Clyde Kluckhohn catalogued 164 definitions of culture. One common definition is culture as a distinctive, "total way of life" including meanings, values, norms, and ideas embodied in institutions, social relations, belief systems, customs, and material artifacts. Clifford Geertz argued that culture should be understood as "webs of meaning" coded in symbolic forms, such as artifacts and rituals, which can be interpreted like a text. Culture in this view is concerned with the production and exchange of meanings between members of a group. Culture is also often thought of as a way of organizing society through a system of signs or signification, and a set of stories that a society tells itself about itself. It is learned rather than biological or innate, but is often learned unconsciously, passed through generations by instruction, example, and imitation. Culture shapes awareness, perception, and the way an individual makes sense of the world, and thus is also intimately linked to knowledge and representation.

WHAT IS CULTURE?

Many "common sense" ideas about culture have been critiqued and refined in recent years. For example, some social scientists have recently stressed that culture should not be thought of as an object, and that meanings can be challenged and can change. Culture is shared, but also contested, and some members of a society almost always have more power or ability to shape meanings than others. Moreover, culture is differentiated; members of a society of different genders, status, occupation, and age have particular roles and types of knowledge. Different cultures, or subcultures, can exist within a larger society; these boundaries are not fixed.

Culture is neither just a set of material objects that characterize a particular group (sometimes referred to as material culture), or just a bunch of abstract ideas and symbols, but also includes the relationship between the two. Some sociological views have suggested that culture is distinct from behavior, but others have insisted on the centrality of *cultural practice*. In this view, meanings are important and powerful because they organize and regulate social practices. A few critics have gone so far as to argue that "there is no such thing as culture," by which they mean that "culture" is not an adequate final explanation for actions or behaviors, but instead is something that itself needs to be explained. A less extreme version of this approach is to emphasize *cultural mobilization* or *cultural politics*, that is, to ask how the idea or category of "culture" gets deployed, and what gets accomplished by invoking "culture."

As might be expected given the complexity of the term "culture," many different approaches can be taken to the relationship between culture and the environment.

EARLY CULTURAL ECOLOGY

In its early formulations, cultural ecology, with its focus on humans as part of their surrounding ecosystems, tended to examine small tribes in isolation from the rest of the world. Cultural ecologists explored how their cultures—including traditions, rituals, and religions—were adapted to the environment and functioned to keep them in balance, or equilibrium, with their surroundings. For example, Roy Rappaport argued that the ritual cycles of pig sacrifice and warfare of the Tsembaga Maring of New Guinea functioned to prevent environmental degradation, even though the Maring themselves were not aware of that function. This type of approach was eventually criticized for focusing only on small, rural groups of people; for ignoring the fact that even these groups have been influenced by larger histories and processes of colonialism, state policies, and regional and national markets; and for its assumptions, which have been challenged by new developments in ecology, that ecosystems are always in equilibrium.

Despite these criticisms, this early work contained valuable insights whose influence can be seen in a number of themes in contemporary studies of culture–environment relations. Key among these is the recognition that members of different cultures perceive, experience, know, and manage their external environments in different ways. What looks "degraded" and barren to one group of people might look vibrant and alive to another. For example, researchers have shown that Chinese state officials in Inner Mongolia see shifting sand dunes as "wasteland," whereas local Mongolian herders value the same sand dunes for environmental, practical, and aesthetic reasons. Han Chinese see crop cultivation on the pastures as "opening up the wasteland," while Mongolians call the same process "shattering the land."

A related finding from culture–environment research is that many practices that have looked irrational, backward or destructive to Western observers actually turn out to be quite suitable for the contexts in which they are practiced. One extensively studied example is shifting cultivation—or "swidden" agriculture—a practice in which farmers grow crops for several years and then move on to new fields, leaving fields fallow for up to several decades as forest cover and soils reestablish to become suitable for crops again. Until recently, shifting cultivation was looked down on as "primitive" (as reflected in its other name, "slash and burn agriculture"), and blamed for being unsustainable and for destroying forests. However, detailed research has shown that shifting cultivation has had a long, successful, and sustainable history in many places. It also maintains a remarkable degree of agrodiversity. One study found that the managed forests around "swidden" fields on the island of Borneo contain up to 800 edible plants and are home to more than 100 species of edible ground fauna and several hundred species of birds. Although shifting cultivation can lead to soil erosion under some circumstances, modern "scientific" agriculture—with its much simpler biological structure, much smaller number of species, and use of industrially produced fertilizers and pesticides—has in many ways much more environmentally harmful effects.

A related finding is that a great deal of knowledge is embedded in the management of fields as well as surrounding second-growth forests in shifting cultivation. More generally, different cultures have different specialized systems of knowledge about various aspects of the surrounding environment. This is reflected in language. One well-known example is that most English speakers distinguish cold weather precipitation simply as "snow" or "sleet," whereas avid skiers make finer distinctions between different types of snow. The Inuit of the Artic circle have many more terms that make even finer and more complex distinctions, reflecting how their culture conceptually classifies, perceives, experiences, and knows the world.

ETHNOBOTANY

Ethnobotany is also concerned with the conceptual classification schemes of different cultures, in particular with systems of naming and use of plants for food, clothing, shelter, ritual, and medicine. In many parts of the world, average people can name and know how to use far more species of plants than can the average American, suggesting a different day-to-day relationship with the natural world. The Chácabo Indians of the Amazon, for instance, have 305 uses for the 360 species of vascular plants in the forest surrounding their village. Ethnobotanists have found that specialized healers or shamans among some cultural groups encode extensive, specialized knowledge of the properties of many plants in a language of myth, dream, and magic. More than half of all modern medicines are either derived or modeled on compounds from wild species, and today pharmaceutical companies are actively prospecting for plants that could be used to produce medicines. This has produced a new respect for the extent of the cultural knowledge of groups of people formerly thought of as "primitive," but it has also created new problems and disputes about intellectual property and adequate compensation.

What happens when culture is analyzed not just as a transparent fact, but also as an idea that can be mobilized for various purposes? In thinking about their own culture's relationship with the environment, writers in the West have often used other cultures as a foil. This has generally taken one of two forms. First, some have argued that Western culture—or civilization—is superior to others because it is more modern and scientific, and that it has been uniquely able to develop the scientific knowledge and techniques needed to protect the environment. This view, which still persists today, is often at the basis of policies that take control of environmental management out of the hands of local people in the developing world. On the flip side, other writers have blamed Western civilization for an underlying alienation of humans from nature, which is seen as being at the root of environmental ills today.

INDIGENOUS KNOWLEGE

This search for alternatives has also often turned to indigenous peoples, who are sometimes portrayed as ecologically noble. Groups such as the Kayapo of the Amazon are represented as living in a harmonious and nonexploitative relationship with the natural world. Their attitudes toward nature are seen as holistic and organic rather than mechanistic and individualistic. It is important to distinguish between two views about traditional—or native—cultures and the environment. One is the recognition that different cultures have specific beliefs and practices that grow out of particular relationships with the natural world, which are often environmentally benign. The second is a "noble savage" view that members of these cultures are automatically programmed to do only that which is ecologically wise.

This latter, romantic view has a number of problems. First, it is easy to find empirical evidence of environmentally destructive practices caused by groups of people portrayed as ecologically wise. Second, these representations can have the effect of denying that these people have their own unique history. When certain cultures are portrayed as being so "close to nature" that they get collapsed into nature itself, the people of those cultures are denied full humanity. Third, claims about indigenous or traditional ecological knowledge are often anachronistic. For example, Tibetan exiles frequently claim that, guided by their Buddhist beliefs, Tibetans have always been aware of ecological interdependence and the need to safeguard the environment. However, the concepts of "ecology" and "environment" are actually thoroughly modern and rather recent. While sets of cultural practices may have had the effect of what we would today call environmental protection, attributing these to the modern notion of "ecology" is to impose a concept on practices driven by other cultural beliefs and values. Nevertheless, many marginalized groups of people today find it very useful to invoke ideas about the inherent ecological friendliness of their cultural beliefs and practices. In many cases, this helps them to negotiate politically both for respect and for their right to continue living in their traditional territories.

What we call the environment, or nature, can only be known through cultural frameworks, or "cultures of nature." This is true not just of indigenous peoples living in remote forests, but also of wealthy, urban citizens of industrialized countries such as the United States. For example, the American view of nature is often thought of as "wilderness areas" being untouched by human modification, despite the fact that the movement to set aside wilderness areas only came after the removal of Native Americans

SUV Irony

Sport Utility Vehicle (SUV) advertising shows that some members of a society (in this case, corporations) have a disproportionate ability to shape cultural meanings, including cultures of nature. SUVs are often associated with safety, security, freedom, and individuality. But print and television advertisements also depict SUVs off-roading in storms through vast, uninhabited territories, scaling impossible mountaintops, and conquering all challenges posed by nature. Brand names such as "Explorer," "Mountaineer," and "Pathfinder" make the vehicles attractive in their ability to bring the driver closer to a particular conceptualization of "nature" (a wild place without people), while overcoming environmental obstacles that might lie in the way. These advertisements work in part by appealing to already-existing American cultural notions of nature, which call for an escape from the city into wilderness, as a place for solitude, truth, and self-discovery. Ironically, the SUV comes to embody a certain culturally-constructed idea of a desirable relationship with nature, while obscuring its own actual environmental effects. However, like all cultural ideas and practices, these meanings are subject to challenge and change; they are not fixed forever.

to reservations. This ideology can be traced back in part to the way that European colonists saw the land they encountered as "natural" in the sense of being untouched by human influence. They failed to see that the landscapes had actually been thoroughly shaped by Native American cultural practices. These included the annual burning of extensive sections of forest, which made the forest open and park-like, and helped attract and increase the population of game animals including elk, deer, turkey, and quail. The ideology of wilderness obscures not only Native American cultural transformations of the landscape, but also the history of violence through which they were removed. It also helps to produce a binary view of wilderness, land that is "worth saving," vs. land that is already spoiled by human modification and thus beyond redemption. This has contributed to the American environmental movement's strong focus on some issues, while ignoring others.

CULTURE SHAPES THE ENVIRONMENT

Finally, culture shapes the environment in many ways, even in realms which aren't immediately connected to "nature." A good example is American automobile culture. U.S. automobile use has a tremendous environmental impact. Among other things, the burning of gasoline produces pollutants that react in sunlight to form tropospheric ozone and smog, which are harmful to human health. Transportation accounts for roughly one-third of all carbon dioxide emissions, contributing significantly to a rise in global average surface temperatures, which are projected to cause significant sea level rise, increased intensity of severe weather events, disruption of water supplies, spreading of malaria, and the loss of species. Rapid expansion of roads fragments ecosystems and causes loss of habitat, thus contributing to the loss of biodiversity. Despite these well-known environmental effects of driving cars, American driving habits are remarkably resistant to change.

This is due in part to the cultural meanings that Americans associate with cars, none of which have to do with environmental degradation. For one, driving is understood as a source of freedom: the freedom of movement, the pull of the open road, and the expectation of new experiences are all central to the imagination of America in movies, literature, and advertising. These images manage to prevail over other possible meanings of the car, such as the division of home from workplace, lengthy commutes, congestion, and environmental impacts. Cars have also become a way for people to express themselves as individuals and to announce their status, particular lifestyle, and socioeconomic class. In the United States, cars are also associated with rites of passage and coming of age.

Car culture is not limited to the car itself, but also includes the way the system of highways, parking lots, and layout of the suburbs has been historically structured around the automobile. This in turn was shaped by specific economic and political forces, such as various subsidies that made the cost of driving an individual car less than taking public transportation. As soon as American society started to be "locked in," there were huge returns for producing and selling cars and for their infrastructure, products, and services. This led to a change in the way Americans think about and use space and time, how they socialize, and how and where we live. It makes possible the separation of business and industrial districts, and of retail outlets from city centers.

Culture—both our own and others—is intricately connected to the environment. Cross-cultural examinations are useful in showing that there is usually more than one meaning, explanation, set of values, and way of managing or relating to the natural world. Using the same analytical tools on ourselves shows that what is familiar is not necessarily universally accepted. Indeed, many of the environmental ideas and practices that we take for granted as natural are actually culturally specific.

SEE ALSO: Adaptation; Cultural Ecology; Nature, Social Construction of.

BIBLIOGRAPHY. William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (Norton, 1996); James Fink, *The Automobile Age* (MIT Press, 1990); Toni Huber and Poul Pedersen, "Meterological Knowledge and Environmental Ideas in Traditional and Modern Societies: The Case of Tibet," *Journal of Royal Anthropological Institute* (v.3, 1997); Adam Kuper, *Culture: The Anthropologists' Account* (Harvard, 1999); Helaine Selin, ed., *Nature Across Cultures: Views of Nature and the Environment in Non-Western Cultures* (Kluwer

Academic Publishers, 2003); Dee Mack Williams, "The Barbed Walls of China: A Contemporary Grassland Drama," *Journal of Asian Studies* (v.55, 1996); Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (Oxford, 1983); Alexander Wilson, *The Culture of Nature: North American Landscape from Disney to the Exxon Valdez* (Blackwell, 1992).

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Currents, Ocean

OCEAN CURRENTS ARE horizontal layers of seawater that move. There are three types of currents: coastal, surface layer, and deepwater. Coastal currents occur immediately adjacent to the shore. Wave action, gravity, and hydrostatic pressure generate such currents. Longshore currents, the ebb and flow of tidal currents, and dangerous rip current are common examples of coastal currents. Freshwater inflow from rivers, friction with the seafloor, and irregular coastlines add to their variability. Surface layer currents and deepwater currents occur farther offshore.

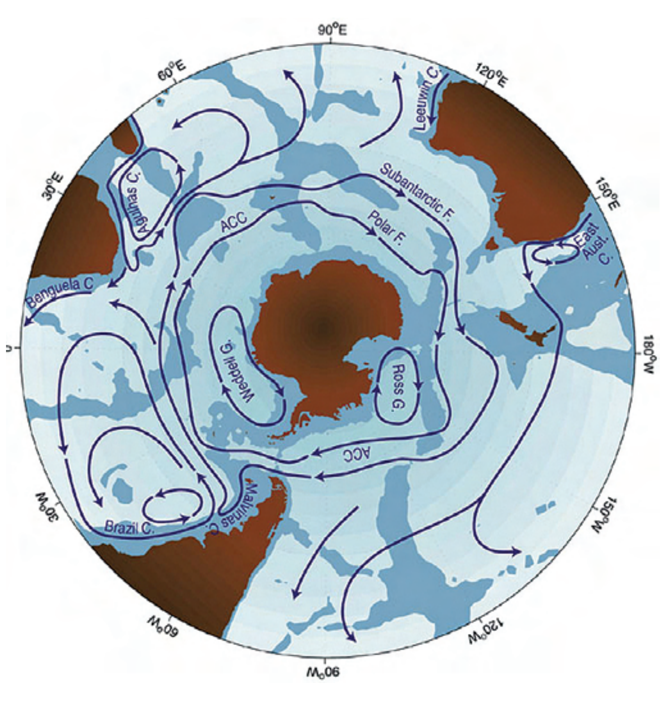
The sinking of cold, salty water in polar regions creates deepwater currents. These currents bring oxygen to marine life at great depths. The sinking of surface water and the upwelling of deepwater makes up a "conveyor belt" that includes both surface layer and deepwater currents. The belt slowly exchanges water between ocean basins. Climate experts believe that fits and starts in this conveyor belt may explain climate shifts over intervals of 1,000 years or more. Upwelling and downwelling also alter nutrient levels of the water that affect marine ecosystems and fishing patterns.

Surface layer currents are the most understood of the three currents. Persistent winds drive them. When winds blow across the ocean surface, friction transfers energy from the wind to the water. The transfer depends on the velocity of the wind, surface tension of the water, and roughness of the surface. Friction transfers kinetic energy into the water, and also transfers kinetic energy downward in progressively lesser amounts, so that wind-driven currents are usually restricted to the upper 1,300 feet (390 meters) of the oceans and generally to even shallower depths. The speed of the resulting current is about 3 to 4 percent of the wind speed.

The largest surface layer currents form gyres in subtropical latitudes. Gyres are large water circulation systems that flow around the peripheries of the oceans in the subtropical latitudes. The currents flow clockwise in the northern hemisphere and counterclockwise in the southern hemisphere. The trade winds and the westerlies create the gyres. Besides these winds, the Coriolis effect, configuration of landmasses, and higher sea levels near the centers of the gyres affect the flow of the currents. Separate subtropical gyres are present north and south of the equator in each ocean except in the Indian Ocean, which has only a southern gyre. Each gyre has an equatorial current, which absorbs energy from the tropical sun and flows parallel to the equator, a warm western current that delivers the tropical heat to polar latitudes, and a cold eastern current that returns to the equator.

The fastest and deepest currents are the warm western currents. There are five such currents: the

Strong winds drive the the world's largest current, the Antarctic Circumpolar, from west to east around Antarctica.



Gulf Stream (in the North Atlantic), the Japan or Kuroshio Current (in the North Pacific), the Brazil Current (in the South Atlantic), the Agulhas Current (in the Indian Ocean), and the East Australian Current (in the South Pacific). There are also five cold eastern currents: the Canary Current (in the North Atlantic), the Benguela Current (in the South Atlantic), the California Current (in the North Pacific), the West Australian Current (in the Indian Ocean), and the Peru or Humboldt Current (in the South Pacific). The world's largest current is the Antarctic Circumpolar Current. This eastward flowing cold current encircles the Antarctica, but contributes cold water to the southern gyres.

Surface layer currents have much the same effect on climate in their areas as do the winds that generate them. For instance, warm ocean currents warm nearby air and tend to add water vapor to the air through evaporation. Thus, coastal areas next to warm currents tend to have humid climates. Conversely, cold ocean currents add little moisture to the nearby air. When the cool, dry air travels over a continent, it results in very little precipitation on the coast. Fog may form over both types of currents, but is more frequent over cold currents due to the chilling effect they have on the overlying air. The circulating gyres moderate global temperatures. As a result, equatorial areas are cooler and higher latitudes are warmer than they might be otherwise. An example is the mild temperatures imparted to northwestern Europe and Scandinavia by the North Atlantic drift, a branch of the warm Gulf Stream. The temperatures of these regions are much warmer than the same latitudes in Canada.

SEE ALSO: Beaches; Oceans; Tides.

BIBLIOGRAPHY. Robert E. Gabler, James F. Peterson, and L. Michael Trapasso, *Essentials of Physical Geography* (Brooks/Cole, 2004); Tom Garrison, *Oceanography: An Invitation to Marine Science* (Brooks/Cole, 2001); Open University, *Ocean Circulation* (Butterworth-Heinemann, 2001); Dr. Steve Rintoul, "Oceanography and Global Climate Change," www.science-in-salamanca.tas.csiro.au (cited May 2007).

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Cuyahoga River

THE CUYAHOGA RIVER runs north for 100 miles in northeastern Ohio before emptying into Lake Erie. The river flows through areas of heavy industry and high population densities, especially in its last 40 miles. The negative effects of industrial wastes spilled into the river have been devastating. The river surface was literally set aflame in 1936 when sparks from a blow torch set fire to oils and material on the surface. Although the incident was widely noted at the time, remedial action to any significant degree was negligible. In 1952, boats on the river and an office building were also set aflame. Further destruction occurred in the 1960s as the river continued to serve as a refuse dump for industrial wastes, flammable oils and other liquids, and sewage overflow. Pollutants from the Cuyahoga and other rivers feeding into Lake Erie were largely responsible for that Great Lake during that time to be declared dead.

In 1969, another fire on the Cuyahoga was noted nationally. This time, a groundswell of public outrage against environmental degradation resulted in a host of legislative actions aimed at reversing the destructive trends. One of the major pieces of legislation to be enacted was the Clean Water Act, which grew out of the 1977 amendment to the Federal Water Pollution Control Act of 1972. The Clear Water Act set the goals for regulating the discharge of all forms of pollutants into the rivers and lakes in the United States. In addition, the act authorized the Environmental Protection Agency to set wastewater standards for industry and municipalities. The Clean Water Act set in motion the mechanisms for the creation of other laws aimed at stopping environmental degradation. Of greatest pertinence to the Cuyahoga River was the enactment of the Great Lakes Water Quality Agreement of 1972 and its renewal in 1978, which brought together the governments of the United States and Canada to work together to reduce the deposits of pollutants into the Great Lakes. The general aim of the agreement is to commit each country to restore and maintain the chemical, physical, and biological integrity of the Great Lakes Basin Ecosystem. At the time of its enactment, many in the scientific community had grave doubts in particular about the prospects for

Lake Erie, which for years had lost virtually all of its fish and plant species to the ravages of pollution. Fortunately, the lake did make a remarkable turnaround and is now considered to be in a generally healthy state.

The improved health of Lake Erie and the other Great Lakes could not have been accomplished without considerable remediation in the condition of the rivers that feed into them. In 1988, the lower 45-mile course of the Cuyahoga River was designated as one of 43 Areas of Concern around the Great Lakes. With this designation, the Cuyahoga is covered by a Remedial Action Plan (RAP) created to guide local officials in implementing effective anti-pollution measures. The RAP aims at restoring and protecting 14 specific beneficial uses for the river, uses that had been lost due to damage by pollution. The uses include a number of particular points regarding fish and animal life, restrictions on dredging, control of algae, improvement of drinking water sources, safety of public beaches, and improvements in the conditions of both industry and agriculture along the course of the river.

SEE ALSO: Clean Water Act; Erie, Lake; Lakes; Pollution, Water.

BIBLIOGRAPHY. David Beach, *The Greater Cleveland Environmental Book* (Orange Blossom Press, 1998); William Donohue Ellis, *The Cuyahoga* (Landfill Press Inc., 1998); Peter S. Schultze, ed., *Measures of Environmental Performance and Ecosystem Condition* (National Academy of Engineering, 1999).

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Cyprus

IN 1960, THE island of Cyprus obtained independence from Britain after years of organized resistance. Three years later, ethnic tensions between the Greek Cypriot majority and the Turkish Cypriot minority led to violence in Nicosia, the capital city. United Nations peacekeepers were deployed in 1964, but sporadic violence continued. After intervening to put down a Greek-led revolt a decade later, the Turks gained control of a third of the land area of the island, proclaiming it the Turkish Republic of Northern Cyprus. However, other nations have refused to recognize Turkey's claim to this area. An attempt by the United Nations to resolve differences failed in 2004, and the island of 780,000 people continues to operate under divided loyalties.

Cyprus operates dual economies. With a per capita income of $21,600, the Republic of Cyprus is considered the 48th richest nation in the world. On the other hand, northern Cyprus is classified as the 109th richest with a per capita income of only $7,135. That income is heavily dependent on remittances from Turkey. In the Republic of Cyprus, the service sector accounts for more than three-fourths of the Gross Domestic Product, with tourism and financial services dominating the economy. Agriculture plays a more important role in northern Cyprus, employing 14.5 percent of the workforce as compared to 6 percent in the Republic of Cyprus. Likewise, unemployment is higher in the north (15.6 percent versus 3.8 percent), as is inflation (19.1 percent versus 2.5 percent). All Cypriots have access to safe drinking water and improved sanitation. The United Nations Development Program (UNDP) Human Development Reports rank Cyprus 29th in the world in overall quality-of-life issues.

Bordered by the Mediterranean Sea, Cyprus has a coastline of 402 miles (648 kilometers). Northern and southern Cyprus is generally mountainous with plains in the central area and along the southern coast. The temperate and Mediterranean climates produce hot, dry summers and cool winters. Cyprus experiences droughts and moderate earthquake activity. Natural resources include copper, pyrites, asbestos, gypsum, timber, salt, marble, and clay earth pigment. Less than 8 percent of the land area is arable.

In the absence of natural reservoir catchments and prolonged dry periods, the entire island suffers from a lack of fresh water sources. Because sea water has intruded into the largest aquifer, increased salinization has become a problem in the north. Sewage and industrial wastes have polluted the water, and coastal areas are experiencing degradation. Irresponsible urbanization has led to a loss of biodiversity. In 2006, a study by scientists at Yale University ranked Cyprus 29th in the world in environmental performance, well above the relevant income group but slightly below the relevant geographic group. The lowest score was received in the category of air quality. Nearly 70 percent of the population live in urban areas, and there are 404 passenger cars per 1,000 people. Intense urbanization has also led to an increase in the rate of carbon dioxide emissions per capita metric tons from 5.2 in 1980 to 8.3 in 2002.

The Framework Law on the Environment and the Protection of Nature provides a foundation for all environment policy in Cyprus. Specific legislation includes: Control of Water Pollution, Control of Atmospheric Pollution from Industrial Sources, Agrochemicals, and Pollution of Public Spaces. The Ministry of Agriculture, Natural Resources, and Environment is the governmental agency responsible for promoting sustainable development and resource protection and management. This ministry coordinates the environmental activities of the Council of Ministers that are involved with implementing policies and monitoring compliance in the areas of responsible water use, water conservation, waste storage and treatment, water development, desalinization, pesticide and fertilizer control, air and water quality control, environmental impact assessment, industrial pollution control, and the protection of wetlands and biodiversity.

Cyprian commitment to global environmentalism is demonstrated through participation in the following international agreements: Air Pollution, Air Pollution–Persistent Organic Pollutants, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, and Ship Pollution.

SEE ALSO: Carbon Dioxide; Pollution, Air; Salinization; Urbanization.

BIBLIOGRAPHY. CIA, "Cyprus," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); "The State of Environment in Cyprus," www.sat.uoa.gr (cited April 2006); UNDP, "Human Development Report: Cyprus," www.hdr.undp.org (cited April 2006); World Bank, "Cyprus," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Czech Republic

AFTER WORLD WAR II, Czechoslovakia, a member of the Austro-Hungarian Empire before WWI and an independent state in the inter-war period, came into the sphere of the Soviet Eastern Block. In 1968, a liberalization effort was stymied by Soviet invasion, leading to political protests and, ultimately, to harsh repression. After the collapse of the Soviet Union in 1989, the so-called velvet divorce resulted in the creation of the Czech Republic and Slovakia as separate entities. The Czech Republic is a small (30,450 square miles [78,866 square kilometers]) landlocked nation with a varied topography. The country is subject to flooding that is often detrimental to the environment. In July 1997, for instance, in the eastern part of the country, the entire Moravian area was flooded, including agricultural areas and industrial and municipal landfills along the Morava River. As a result, toxic substances were released into the environment. Unlike the hilly Moravian area, Bohemia in the western section of the Czech Republic is made up of rolling plains, hills, and plateaus set amidst low mountains. Economically, the Czech Republic has progressed much faster than most of the former Soviet satellites, and growth has been fostered by extensive trade with Germany and strong domestic and foreign investment. Czech natural resources include: hard coal, soft coal, kaolin, clay, graphite, and timber. With a per capita income of $18,100, the Czech Republic is ranked as the 58th richest nation in the world. The quality of life is predictably high in the Czech Republic, and the United Nations Development Program (UNDP) Human Development Reports rank the nation 31st in the world.

Extensive air and water pollution in Bohemia and in northern Moravia currently threaten the health of the Czech people, and acid rain has damaged the forests. With a heavily urbanized population (84 percent) and 357 passenger cars per 1,000 people, carbon dioxide emission is high at 11.6 metric tons per capita. Since the Czech Republic joined the European Union (EU) in 2004, the country is in the process of bringing industrial practices in line with those of other EU nations, a move that is predicted to reduce pollution. Despite existing problems, a 2006 study by Yale University ranked the Czech Republic fourth in the world in environmental performance, placing it above most other countries in its geographic and income groups. The Yale ranking was particularly high in the fields of water resources (96.7), natural resource protection (97.9), and overall environmental health (97.3). Approximately 16.1 percent of land in the Czech Republic is protected. Of 161 bird species endemic to the country, only two species are threatened. Mammal species are at greater risk, however, with eight of the 81 species threatened.

Because of extensive industrial growth, the government of the Czech Republic has been forced to deal with environmental problems and promote sustainable development without curtailing economic growth. In 1995, the government adopted the State Environmental Policy, a revision of an earlier law, and charged the Ministry of the Environment with implementation of environmental protection laws that included the National Policy on Mineral Resources, the National Strategy of Regional Development, the National Strategy for Industry, the State Energy Policy, the State Program of Support for the Use of Renewable Resources of Energy, the State Program for Energy Savings, the Strategy for Agricultural Policy, and the National Program for Health and the Environment. The Czech government also implemented Environmental Impact and Strategic Impact Assessments to evaluate environmental policies. Additionally, the Council for Sustainable Development was created under the Ministry of the Environment.

At the local level, the Czech Republic has established the Network of Healthy Cities and the Association of Municipalities to promote environmental responsibility. Internationally, the Czech Republic has participatied in the following agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Acid Rain; Floods and Flood Control; Pollution, Air; Pollution, Water; Sustainable Development.

BIBLIOGRAPHY. CIA, "Czech Republic," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Jiri Hlavacek et al., *Country Report: Czech Republic* (Ministry of the Environment, 2002); Ministry of the Environment, "State Environment Policy, January 2001," www.env.cz (cited March 2006); UNDP, "Human Development Reports: Czech Republic" www.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Czech Republic," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www. yale.edu (cited March 2006).

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Dams

FEW TECHNOLOGIES HAVE had more significant and persistent ecological impacts than dams. Almost every major river in the world has at least one large dam obstructing its flows. China alone has built over 22,000 large dams on rivers within its national territory, most of which have been constructed over the past three decades, and is nearing completion of the largest human-made structure in the world, the Three Gorges Dam. While varying in size and type, all dams share the goal of obstructing the flowing water of a river or stream in order to provide an array of perceived benefits to human communities. The most important of these include the conversion of flowing water into electricity (hydropower), the storage of water for irrigated agriculture, and the control of floods. Dams also engender an array of social and environmental consequences. Depending on size and location, dams create reservoirs, cause massive displacements of people, block fish migration routes, and significantly alter the hydrology and ecology of flowing rivers.

While the construction of dams to divert or block a river's flows is a technology dating back 5,000 years, the 20th century witnessed an unparalleled expansion in the scope and size of impoundments. The construction of Hoover Dam, a 220 meters high hydroelectric project built on the Colorado River in the western United States in the 1930s, ushered in the era of large dams. Over 40,000 large dams—defined as those with height of 15 meters or more—have been constructed on the world's rivers, the vast majority since 1950. In total, the water stored behind dams in reservoirs amounts to 10,000 cubic kilometer (roughly five times all the volume of the world's rivers combined) and covers an estimated land area of 400,000 square kilometers (about the size of California). There are three primary types of impoundments—embankment, gravity, and arch dams—that are designed based on the local geology and topography of a dam site. Most dams (80 percent) are earth and rock embankments, typically built across wider river valleys where dam fill materials are readily available.

As the scale of a dam increases, the scope, duration, and intensity of its social and environmental impacts also become amplified. The largest dams—such as the massive Itaipu impoundment on the Paraná River in South America, the Columbia River's Grand Couleee in the western United States, the Volga's Kuibyshev Dam in the Russian state of Samara, the Volta's huge Akosombo Dam in Ghana and, most recently, the Three Gorges Dam on the Yangtze River in China—have collectively displaced millions of people, inundated thousands of hectares of land, and brought about host of other socioecological effects. However, numerous dams and accompanying systems of weirs, barrages, and levies have for centuries served important roles in flood control, enhanced agricultural production, and urban water supply in nearly every region of the world.

In terms of human–environment relations, it is difficult to separate dams' social and ecological impacts. Both are closely intertwined, especially in those regions of the world where people remain partly or wholly dependent on the resources conferred by unobstructed rivers. In the equatorial zones such as the Amazon and Congo Basins and parts of monsoonal Asia such as the Mekong basin, millions of livelihoods remain crucially dependent on freshwater fisheries and floodplain agriculture, practices whose sustainability and integrity are in turn intimately linked to annual riverine flow cycles. The social and biophysical impacts of dams, particularly larger dams that produce significant reservoirs of stored water, can be usefully organized into (1) those effects experienced primarily near the dam site, the dam's reservoir, and related upstream regions, and (2) those effects experienced primarily downstream of the dam, oftentimes extending to a river's delta and estuarine regions.

An initial and obvious impact of river impoundment is the inundation of vast hectares of riverine lands and the consequent displacement of people living in these areas. While state agencies in charge of dam construction often pledge dam-affected peoples compensation in the form of new housing structures, agricultural lands, and cash payments, numerous relocation programs throughout Africa, Asia, and Latin America have failed to deliver on promised compensation plans. Official resettlement areas are typically inferior to traditional riverine lands in terms of agricultural productivity, and the long-term inhabitants living in these areas resent displaced peoples. This was the experience of the more than 100,000 Nubians resettled due to construction of the Aswan High Dam on the Nile River. The resettlement communities lacked basic amenities, exposed the displaced people to new diseases, and were agriculturally inferior to their previous lands.

A reservoir also represents a radical alteration of a river's hydrological and ecological functioning. While retaining some of the biophysical characteristics of a river, a reservoir essentially causes a shift

Dam Busters

The film *The Dam Busters* (1954), based on the book of the same name by Paul Brickhill (1951), highlighted the World War II Operation Chastise on May 17, 1943, in which British planes bombed the German dams using "bouncing bombs."

The British had been keen on bombing the German dams in the Ruhr to disrupt their enemy's war efforts, with the initial plan to drop a 10-ton bomb from 40,000 feet. However it was not yet possible to achieve, and large heavy nets in the reservoirs by the dams meant that torpedoes would not be effective either. This led the British scientist Barnes Wallis to come up with the idea of a "bouncing bomb" after seeing boys skimming pebbles over pools of water.

The breaching of the dams was planned not only to destroy them as a source of hydroelectric power, but more importantly to prevent the flow of water to industry and nearby cities, as well as flood some of the factory areas nearby. When the bomb was designed, it was decided to launch the air raid in May, when the water levels would be at their highest.

With only a few technical problems, Guy Gibson led the first formation of the "Dam Busters" over to Germany, with two others following. The Möhne dam was successfully breached; the Eder Dam was breached with the last bomb of the attacking formation, but the bombs were not able to breach the Sorpe and Ennepe Dams. In all, 53 of the 133 British air crew involved were lost, with three bailing out and becoming prisoners of war. The value of the operation was flooding much arable land, killing large numbers of livestock and showing the Soviet Union that Britain was prepared to launch risky operations to harm the German war effort.

from a flowing to a standing water environment. The shift from flowing water to largely stagnant water results in a host of hydrological, biological, chemical, and ecological transformations. Levels of dissolved oxygen and other key water chemistry parameters are irrevocably altered within reservoirs. The species composition and numbers of fish and other aquatic organisms shift to reflect a more lake-like ecosystem, resulting in the drastic reduction or extirpation of those species adapted to riverine environments. Dams can virtually eliminate migratory fish species whose routes from ocean to spawning grounds are blocked. The annual run of adult salmon and steelhead trout in the Columbia River Basin in the United States' northwest region has declined from a population of 10–16 million in the mid-19th century to an estimated 1.5 million in 2006, due almost entirely to the basin's 130 dams. France's runs of Atlantic salmon on many of its rivers suffered a similar fate due to dams built throughout the latter 19th century.

In many tropical reservoirs, such as Lake Kariba on the Zambezi River in southern Africa, invasive or undesirable plant species such as the water hyacinth and giant salvinia have proven difficult to manage. In addition, the filling of a reservoir after dam construction, which can take any where from several months to two or more years before completion, can have serious ecological consequences in terms of habitat destruction. In the case of the Kariba and Cahora Bassa dams on the Zambezi River in southern Africa, built in the late 1950s and early 1970s, respectively, dam authorities and governments undertook efforts to capture and relocate indigenous fauna (particularly large mammal species) prior to inundation, but numerous animals drowned during the filling period.

Reservoirs also produce economic and recreational benefits for some social groups. In the western United States, for example, massive reservoirs on the Colorado River (such as Lake Mead and Lake Powell) are important sites of recreational activity such as sport fishing and boating. Dams and reservoir levels are frequently managed to allow for downstream recreational activities such as rafting. In many tropical areas, the damming of flowing waters has resulted in very productive reservoir fisheries. However, many of these fisheries have proven a mixed blessing to local communities. At the Ubolratana reservoir in Northeast Thailand, constructed primarily as a hydroelectric facility in the 1960s, a lack of management and unsustainable harvesting rates have led to over fishing and relative poverty for reservoir communities dependent on fisheries for their livelihoods.

The social and ecological impacts of dams are closely intertwined, especially where people are dependent on rivers.

The water storage functions of dams also engender a host of social and ecological consequences, particularly impoundments designed to promote irrigation development. Throughout the 20th century, numerous governments—particularly those presiding over arid regions—perceived dams' water storage function as a crucial means of promoting irrigated agriculture and, eventually, boosting agricultural production. Massive investments in irrigation systems—consisting of a series of smaller weirs, barrages, and channels downstream of the primary impoundment to divert water to nearby agricultural lands—accompanied the so-called Green Revolution in agriculture in much of the Third World in the 1960s and 1970s. While the result of these investments has in many areas boosted overall agricultural production, irrigation development has also contributed to environmental degradation and social disruption.

One of the most serious environmental impacts of irrigation systems is salinization, or the increased presence of salts in agricultural soils associated with irrigated agriculture. The evaporation of water from reservoirs, canals, and fields can lead to increased concentrations of salts in irrigation water, which in turn increase the risk of adding salts to farming areas. Farmers often deliver more irrigation water to flush out saline soils, but this runs the risk of increasing the salinity of ground water. If improperly drained—poor drainage has been a dilemma for irrigated agriculture for decades—salts tend to accumulate in the groundwater below agricultural fields, adding to the problem. Saline water from irrigated fields, when returned to river channels, also contributes to degraded water quality in downstream reaches. Salinization has plagued the extensive irrigation systems built first by the British and later expanded by post-independence governments in northwestern India.

In addition, dams and irrigation systems often create favorable conditions for the genesis and spread of vectors (such as snails or insects) for debilitating diseases like schistosomiasis and malaria. Increased incidence of both diseases, which have a direct impact on human health and indirect economic impacts in terms of reduced labor availability, has followed the construction of water development infrastructure in many parts of North and West Africa, south Asia, and southeast Asia. Among communities living near the gigantic Volta Reservoir in Ghana, rates of people infected with urinary schistosomiasis skyrocketed in the years immediately following construction of the Akosombo Dam in 1965.

Itaipu Dam

The Itaipu Dam on the Parana River in Paraguay, South America, has been listed as one of the Seven Wonders of the Modern World by the U.S. magazine *Popular Mechanics* in 1995.

Generating power for Paraguay and Brazil from the dam's hydroelectric plant, the company that controls it is Itaipu Binacional, taking its name from what was originally an isle that was in the river close to the construction site.

Planning for the dam started in the 1970s with Sapena Pastor, the Paraguayan foreign minister, and Juracy Magalhaes, the Brazilian foreign minister, signing the "Ato do Igacu" (Igacu Act) on July 22, 1966, allowing them joint exploitation rights for the resources generated by the hydroelectric plant. Work on the dam began in 1970, and on October 14, 1978, the route of the Parana River was changed to allow the riverbed to dry so that work could begin on the dam itself. The reservoir for the hydroelectric plant was formed in October 1982, and on May 5, 1984, the first electricity was generated from the plant.

The undertaking had been vast. The reservoir was the largest in Paraguay and the seventh-biggest in Brazil. About 40,000 workers labored on the project. The electricity generated for Brazil was the equivalent of 434 thousand barrels of petroleum being burned every day. Following the success of the Itaipu Dam, the Yaciretá Dam was constructed on the Parana River on the borders of Paraguay and Argentina, with power gradually coming on tap, with the hope that it might be completed by 2008.

State-sponsored irrigation projects typically demand a series of reforms in the way that agricultural production is organized and managed. Irrigated agricultural demands an entirely different set of practices and technologies than rain-fed agriculture, and recipient communities are typically ill prepared to adopt these new techniques. Furthermore, the expenses associated with training farmers in new techniques and maintaining functioning irrigation infrastructure frequently outweigh the economic benefits associated with such projects. Such has been the case with numerous large-scale irrigation schemes such as the Mahaweli project in Sri Lanka, the arid regions of northern Mexico, and Kenya's Bura irrigation project on the Tana River.

While the impoundment of rivers generates significant biophysical changes in the area immediately upstream of the dam site, downstream hydrologic and ecological alterations are equally significant. Dams, by removing the fine and coarse sediment normally transported by flowing rivers, often result in significant morphologic adjustments to the river channel. The increased scouring of sediment-free waters can lead to downstream bank erosion and ultimately, to changes in river channel morphology, gradient, and sinuosity. Dams' blockage of sediment and nutrient flows can also significantly alter downstream water quality. Depending on factors such as the location where water is extracted and delivered to the channel below a dam and the relative volume of flows allowed downstream, a dam can produce major effects on river temperature, concentration of heavy metals and minerals, dissolved oxygen and other gases, turbidity, and nutrient load.

Perhaps most significant in terms of human–environment relations, dams can profoundly alter the timing, duration, and magnitude of seasonal flooding. In those regions where floodplains constitute important sites of agricultural and fisheries production, in particular the tropical and monsoonal zones of Asia, Africa, and Latin America, the disruption of annual flooding cycles has disrupted farming schedules, dried out floodplain forest ecosystems, and destroyed important fish habitats. Formerly productive floodplains that provided fish, plant materials, and other economically important resources to nearby communities in the southern United States' Mississippi River Delta, have been devastated as a result of upstream water projects.

Large dams can also have significant impacts on the delta and estuarine regions of a river system. In estuaries, many aquatic species have adapted to specific salinity gradients where the fresh water of the flowing river meets the tidally influenced saline water of the ocean. Moreover, numerous marine species depend on the tremendous amount of nutrients delivered by rivers to their estuaries. Dams cut off this important food source. Egypt's productive sardine fishery—dependent on annual plankton blooms spurred by floods that brought nutrients to the mouth of the Nile—in the Mediterranean Sea went into a precipitous decline in the years following closure of the Aswan Dam in the early 1970s on the Nile River.

EXPRESSIONS OF POWER

Dams are also expressions of political, economic, and symbolic power. Dam building is a big business, with an annual expenditure of between $32 and $42 billion during the 1990s. Despite these enormous investments, many, if not a majority, of the world's large dams constructed in the 20th century have been plagued by large cost overruns, construction delays, and unrealized economic benefits due to less than expected electricity production or water storage capacity. Beyond their potential economic benefits and costs, dams often serve a symbolic role, as representations of nationalism and humanity's ability to control nature. For dam promoters and builders, they are magisterial testaments to economic development and scientific progress. Prime Minister and nationalist leader Jawaharlal Nehru famously declared in the early 1950s that dams were the "temples of modern India" that would fuel agricultural development and industrialization. Similarly, the Akosombo Dam on the Volta River in Ghana and the Cahora Bassa Dam on the Zambezi in Mozambique both became important symbols of national economic development in post-independence Africa.

Dams have emerged as important foci in local and global struggles over environmental degradation and livelihood disruption. Northern-based nongovernmental organizations (NGOs) such as the U.S.-based International Rivers Network (IRN) and the Canada-based Probe International have formed coalitions with numerous NGOs and people's organizations across the globe to oppose a host of specific dam projects. Dam-affected peoples and their advocates have pointed out the disproportionate social and environmental costs borne by those communities whose fisheries-based and agricultural livelihoods are destroyed by the construction of large dams. These struggles culminated in the creation of the World Commission on Dams (WCD) in the late 1990s. The WCD—an organization founded by the World Bank and the World Conservation Union (IUCN) and made up of representatives from states, the dam industry, and dam critics—published a comprehensive report in 2000 calling for a more participatory approach to the construction of large dams. The report was highly critical of many of the world's large dam projects over the past half century, noting that many had failed to achieve their stated objectives in terms of electricity generation and irrigation coverage and had resulted in profoundly negative impacts on displaced communities without providing just compensation.

SEE ALSO: Aswan High Dam; Floodplains; Floods and Flood Control; Hydropower; Irrigation; Rivers; Three Gorges Dam; Salinization.

BIBLIOGRAPHY. William Adams, *Wasting the Rain: Rivers, People, and Planning in Africa* (University of Minnesota Press, 1992); Sanjeev Khagram, *Dams and Development: Transnational Struggles for Water and Power* (Cornell University Press, 2004); Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (Zed Books, 2001); Geoffrey Petts, *Impounded Rivers: Perspectives for Ecological Management* (John Wiley & Sons, 1984); Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (Penguin, 1993); Richard White, *The Organic Machine: The Remaking of the Columbia River* (Hill and Wang, 1995); World Commission on Dams, *Dams and Development: A New Framework for Decision-Making. The Report of the World Commission on Dams* (Earthscan, 2000).

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Dandelions

THE DANDELION, *TARAXACUM officinale,* is one of the most common plants in the world. Its Latin name, *Taraxacum,* derives from the Persian word for "bitter herb." *Officinale* implies that the plant has some beneficial or pharmaceutical value. The dandelion is probably better known by its many common names, including *Blowball, Puff-Ball, Clock Flower, Cankerwort, Lion's Tooth, Irish Daisy, Monk's Head, Priest's Crown, Swine Snout, Wild Endive,* and *Sin in the Grass.* The Spanish refer to it as *diente de leon*; the French as *pis-en-lit*; the Chinese as *pu gong ying*, or "earth nail," because of its deep taproot; and Native Americans as *Chicoria*.

Considered an "invasive weed" by many, the ubiquitous dandelion can be found in virtually every corner of the earth, due to its ability to survive in a wide range of climates and poor soil conditions. Easily identified by its yellow flower perched atop a tall stalk and its round, fluffy ball of white down and seeds, which are easily dispersed by the wind, the plant has been cursed by those who want to remove them from their lawns and praised by others

Dandelions have a checkered past, but throughout history humans have used it for food and medicine.

who boast about its nutritional and medicinal qualities. The plant is especially attractive to children, who like to blow the fluff ball of seeds into the air.

Dandelions have a checkered past, but throughout history, humans have employed the plant primarily as a source of food and medicine. Many believe that the plant originated in Asia, where it was initially used as a medicinal herb. During the 10th and 11th centuries, Arab physicians were praising the plant for its medicinal qualities. The dandelion was also present in ancient Europe. According to myth, Theseus ate a dandelion salad after killing the Minotaur. The Romans, as well as the Gauls and Celts, used the plant as a source of food. The Anglo-Saxons and the Normans used it for both food and medicine. It could also be found cultivated in monastery gardens. In Medieval times, the French referred to the plant as *dent-de-lion,* or "lion's tooth," in reference to the jagged, curved points on the leaves that resembled the predator's teeth. Saxon serfs soon corrupted the name to "dandelion."

European explorers and colonists brought the plant to the Americas for a variety of reasons. Dandelions came to Mexico and the Spanish hinterlands with the conquistadors, who used it for food and medicine. English colonists planted dandelions in their gardens to use as a "salet." German settlers carried the plant to Pennsylvania and used it as an early spring source of vitamins and nutrition. In Canada, the French brought dandelions to use as a food and health remedy. In time, Native Americas began to use the plant in a variety of ways. The Iroquois used it for stomach problems and water retention; the Cherokee made tea from the root to calm the nerves; and the Pillager-Ojibwa employed the plant as a cure for heartburn.

Medicinally, the dandelion has many important benefits, but its most common application is as a strong diuretic, hence the French name, *pis-en-lit,* or Piss-in-the-Bed. As an edible plant, dandelion is high in vitamin A and C and also copper and iron. All parts of the plant (leaves, flowers, and root) can be consumed. The leaves contain about 4 percent potassium, which is more than either broccoli or spinach. The roots can be roasted and used as a coffee substitute. Many species of wildlife, including deer, elk, bear, and geese, as well as several species of songbirds, depend upon the dandelion for food.

Although dandelions have historically benefited humans, today they are largely considered a nuisance, especially in Europe. The U.S. Forest Service lists the dandelion as an "invasive and exotic" weed.

SEE ALSO: Columbian Exchange; Invasive Species; Weeds.

BIBLIOGRAPHY. Bradford Angier, *Field Guide to Edible Wild Plants,* 9th ed., (Stackpole Books), 1983; C.S. Haughton, *Green Immigrants* (Harcourt Brace Jovanovich, 1978); Kelly E. Hertlein, "Dancing in Dandelions," Ethnobotanical Leaflets, southern Illinois University Carbondale, www.siu.edu (cited May 2006); Invasive.org, "Invasive and Exotic Weeds," www.invasive.org (cited May 2006); Innvista, "Dandelion," www.innvista.com (cited May 2006).

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Danube River

THE DANUBE RIVER is the second longest in Europe, at 1771 miles—only the Volga River is longer. It has been an important international waterway for many years, and in the ancient world represented the northern border of the Roman Empire as the river Danuvius.

The catchment area for the river is in southern Germany, where two streams, the Breg and the Brigach, combine to form the river near Donaueschingen, a small town on the eastern slopes of the Black Forest. The river then passes through the Swabian and Franconian mountains, passing the Bavarian plateau and then reaching its northernmost point at Regensburg, the capital of the Upper Palatinate. It then flows south through Passau into Austria, passing through Linz to Vienna, where, to reduce the threat of flooding, the river is diverted through a man-made canal. From there it goes into Slovakia, passing through Bratislava, Slovakia's capital. From there is flows through Komarom, Estergom and Budapest across the Great Alfold Plain until the Iron Gate Gorge, where a massive hydroelectric scheme was developed during the 1970s.

In eastern Hungary, it joins with its tributaries, the Drava, the Tisza and the Sava, with the Lower Danube flowing through Vukovar, in Croatia, then to Novi Sad, capital of the Serbian province of Vojvodina, then passes through Belgrade. It then goes between the Walachian Plain of Romania and the Danubian Plain of Bulgaria. It later splits into three channels heading into the Black Sea. According to legend, this delta region is one of the possible burial grounds for Attila the Hun.

The Danube has long been an important route of commerce through Europe, with large numbers of ships transporting produce and letters. Many barges now transport supplies, and there are also a number of tourist cruises. The Rhine-Main-Danube Canal now connects with the Danube, enabling ships to travel from the English Channel to the Black Sea; and in 1994, the river was declared one of the ten Pan-European transport routes.

Since Roman times, many battles have taken place along the Danube. The river protected Vienna from attack during its siege by the Turks in 1683. Napoleon's capture of Ulm on October 20, 1805, allowed the French to cross the river, and the battle of Wagram on July 5–6, 1809, was fought on the east bank of the river. During World War I, Austrian soldiers held most of the river. In World War II it provided a route for German supplies. The breakup of Yugoslavia saw fighting in Vukovar in 1991; and in 1999, NATO planes bombed the bridges over the Danube.

As well as hydroelectricity at places such as the Iron Gate Gorge, some ten million people in Europe get their drinking water from the Danube. Although in medieval times, many people lived from fish caught from the river, this only continues in the delta region.

The Danube has also been associated with the Danube School of landscape painting from the sixteenth century, and the subject of the musical waltz by Johann Strauss the Younger (1825–99), *An der schönen blauen Donau*, better known in English as the "Blue Danube." There is also *The Waves of the Danube* by the Romanian composer Ion Ivanovici (1845–1902).

The river is now protected by the International Commission for the Protection of the Danube River; and the Danube Delta became a UNESCO World Heritage Site in 1991.

SEE ALSO: Albania; Austria; Bulgaria; Croatia; Czech Republic; Germany; Hungary; Hydropower; Italy; Poland; Romania; Serbia and Montenegro; Slovakia; Slovenia; Switzerland; Ukraine; UNESCO; Volga River.

BIBLIOGRAPHY. Claudio Magris, *Danube* (Collins, Harvill, 1989); *Great Rivers of the World* (National Geographic Society, 1984).

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Darwin, Charles (1809–82)

CHARLES ROBERT DARWIN (1809–82) was born on February 12, 1809, at Shrewsbury, England, the son of Robert Waring Darwin, a physician, and Susannah Wedgwood, daughter of pottery manufacturer Josiah Wedgwood. His grandfather was Erasmus Darwin, a respected physician and active naturalist who had published a theory of evolution (*Zoonomia*) in the 1790s, which as a boy Darwin discussed at length with his grandfather.

Darwin studied medicine at the University of Edinburgh and theology at Cambridge University, from which he graduated with a bachelor's degree. Abandoning his plan to become an Anglican priest, he joined a scientific expedition on board the *H.M.S. Beagle* on a voyage circumnavigating the globe.

Between 1831–36 Darwin served as a naturalist on the Beagle. In 1839 he published *Voyage of the Beagle* (*Journal and Remarks*). The book described research travels in Brazil, Uruguay, Argentina, and Chile, collecting specimens of plants, animals, and minerals while the survey crew on board the *Beagle* was preparing naval charts.

As Darwin collected data on the natural world, he was forced to conclude that the world was much older than about six thousands years. After visiting the Galapagos Islands, he began to develop the theory of evolution. He was influenced by Charles Lyell's theory of uniformitarianism in *Principles of Geology* and by Robert Malthus' *Essay on the Principles of Population* and its view of a struggle for existence among individuals competing for food and reproductive opportunity.

Darwin published his theory of evolution as the theory of the mutation of species in *Origin of the Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859). He argued that species of fauna and flora have developed from a common ancestor. The mechanism for the mutation of the members of a species into another species is natural selection that was similar to the way breeders or growers utilize certain species for selective breeding. Natural selection takes place among the enormous numbers of individuals in a species struggling for survival. Eventually, enough changes take place that new species emerge. Geographic isolation and genetic drift are two mechanisms that make the development of species change possible.

The publication of *Origin* was met with approval by some and disapproval by others. Darwin, who was constantly ill after his return to England, was publicly defended by his "bulldog," Julian Huxley.

Darwin had not discussed human evolution in the *Origin*; however, he did in *The Descent of Man and Selection in Relation to Sex* (1871). His last major work was *The Expressions of the Emotions in Man and Animals* (1872).

Darwin died at Downe, Kent, England on April 19, 1882. He was buried in a state funeral at Westminster Abbey.

SEE ALSO: Evolution; Galapagos; Genetic Diversity.

BIBIOGRAPHY. Philip Appleman, ed., *Darwin: A Norton Critical Edition* (W. W. Norton, 1970); Charles Darwin, *The Autobiography of Charles Darwin*: 1887 (Barnes & Noble, 2005); Jonathan Howard, *Darwin: A Very Short Introduction* (Oxford, 1982); Jonathan Miller, *Darwin for Beginners* (Pantheon Books, 1982);

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Lord Alfred Russel Wallace

Although Darwin is the man credited with the theory of evolution, Lord Alfred Russel Wallace independently formulated his theory on natural selection which predated that of Darwin.

Alfred Wallace was born in Monmouthshire, Wales, in 1823, and attended a one-room school for six years, forced to leave for financial reasons. The young Wallace read voraciously, and at age fourteen, he became an apprentice for his brother who was a surveyor. It was a period when many landowners required accurate maps, and Wallace spent many years mapping the county of Bedfordshire and also parts of Wales. He became upset by the social injustices he saw, and also became heavily influenced by men like Charles Darwin and Alexander von Humboldt. Their books encouraged him to become interested in natural history.

In 1848, Wallace had the opportunity to go to Brazil with a naturalist friend, Henry Walter Bates. Wallace spent four years in Brazil; Bates was in the region for eleven years. Wallace wrote his first books on the Amazon and then headed to the East Indies.

Wallace was in the Malay Archipelago from 1854 until 1862, traveling from island to island, collecting zoological specimens and formulating his own views about the origin of species. His first work on the East Indies was published in 1855, and included his view that "every species has come into existence coincident both in space and time with a pre-existing closely allied species." In 1858, a paper published under the names of Darwin and Wallace was entitled "On the Tendency of Species to Form Varieties; and on the Perpetuation of Varieties and Species by Natural Means of Selection." There have been subsequent academic disputes over whether or not Wallace came up with the ideas before Darwin. It was soon after that Wallace developed what became known as Wallace's Line—the boundary that separated Australian fauna from that in Asia.

In 1862, having collected 125,000 animal specimens, Wallace returned to England and started writing about his experiences, his major works being *The Malay Archipelago* (1869), and *Contributions to the Theory of Natural Selection* (1870). Wallace went on lecture tours and later received many awards from scientific bodies; he died in 1913, at age 90.

DDT

DDT IS AN organochlorine insecticide used mainly to control mosquito-borne malaria and as an agricultural insecticide. It is available in several different forms: aerosols, dustable powders, emulsifiable concentrates, granules, and wettable powers. It is a colorless crystalline substance that is practically insoluble in water, but highly soluble in fats and most organic solvents. For many years it was one of the most potent and widely used pesticidal chemicals. It was first synthesized in 1874 by Othmai Ziedler. In 1939, Swiss scientist Paul Herman Muller discovered its use as an insecticide, for which he was awarded the 1948 Nobel Prize. The United States began to produce large quantities of DDT (dichlorodiphenyl-trichloroethane) to control vector-borne diseases such as malaria and typhus abroad. It was widely used by the Allied forces in malaria-prone jungles of southeast Asia. After 1945 it was extensively used as an agricultural insecticide. DDT was popular because of its low cost, effectiveness, persistence, and versatility.

DDT was largely responsible for eradicating malaria from Europe and North America. In countries like India, where millions used to die of malaria, its use almost eradicated the disease by the mid-1960s. A resurgence of the disease has occurred there and in many other tropical countries, however. DDT was less effective in tropical regions due to the continuous vigor in life cycle of mosquitoes and poor infrastructure; also because of the microbial resistance to drug treatment, the spread of the deadly malarial variant called *plasmodium falciparum,* and mosquito resistance to DDT. Currently, in Africa, about a million people die of malaria every year.

Since 1991, a number of researchers have been able to detect elevated levels of 1, 1, 1-trichloro-2, 2-bis (P-chlorophenyl) ethane (DDT) and its isomers in the air close to South Haven, Michigan. DDT is slightly to moderately toxic to mammalian species when it enters the digestive system through the mouth. In animal tests, it was found that DDT causes chronic adverse effects in the liver, nervous system, kidney, immune systems, and reproductive system. Its carcinogenic effects show increased liver and lung tumor production. As in other animals (including humans), birds are exposed to DDT through food chain. Fish and other aquatic animals obtain DDT from contaminated water bodies, the result of runoff from agricultural use. Because of the adverse effects of DDT, its use has been banned in developed countries; Sweden and Norway in 1970, followed by the United States in 1972. As of 2006, DDT has been used in tropical countries where mosquito-borne malaria and typhus are serious health problems.

SEE ALSO: Malaria; Pesticides; Pests, Agricultural.

BIBLIOGRAPHY. M. Heindorf, J.K. Taylor Morgan, R. Christmas, and C. Vanderdort, *DDT Concentration in the Soil and Air of South Haven, Michigan* (USEPA Great Lakes National Program, 2001); C.J. Keeler, *Lake Michigan Urban Air Toxics Study* (EPA/600/SR-94/191, November 1994); Irvine Reed, *Fight Malaria with DDT* (USEPA Atmospheric Research and Exposure Assessment Laboratory, 2002).

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Death of Nature

THE DEATH OF nature is an evocative metaphor that has been deployed by a number of writers and political activists in order to capture the form of modern social relations with the natural world. In his celebrated book, *The End of Nature: Humanity, Climate Change and the Natural World* (1989), Bill McKibben implicitly suggested this process of death in his argument that nature has somehow ceased to exist.

Of course, when McKibben talks about the end of nature, he is actually referring to the end of a specific way of understanding nature. This mode of understanding depicts nature as a pristine realm that is somehow separate from society and cut off from human control and intervention. According to McKibben, in the modern industrial era—an era of nuclear weaponry and DDT, of elevated carbon dioxide in the atmosphere and holes in the ozone layer, of genetic engineering and animal cloning—the notion of a timeless, unspoiled nature has become redundant.

While McKibben's work illustrates how industrialization has led to the elemental, or material, death of nature, it is Carolyn Merchant's *The Death of Nature: Women, Ecology and the Scientific Revolution* (1980), that provides the definitive account of how nature has *died*. Carolyn Merchant is professor of environmental history, philosophy, and ethics at the University of California–Berkeley. According to Merchant, the nature (or world) that has died is an organic one, and recognizes the necessary interdependencies that exist among humans, animals, and the entire physical universe. The organic worldview—suggesting as it does social dependence on the environment—is synonymous with cultures of care and respect in human dealings with nature. This type of understanding of, and disposition toward, the natural world has its antecedents in ancient and medieval scientific frameworks and belief systems, but has recently experienced a resurgence within deep-green thinking and politics.

Merchant's compelling account of the death of nature charts how the organic view of the world has been usurped by the more *mechanical* understandings of nature promoted within modern science and industrial society. According to Merchant, the rise of classical science and commercial capitalism have provided new knowledge about and metaphorical frameworks for understanding nature—knowledge and frameworks that have facilitated a belief in human independence from and dominance over the environment.

On Merchant's terms, the death of nature is not so much an absolute condition (or elemental change) in the condition of nature, but a new, rationally inspired way of understanding and experiencing the natural world. Consequently, while Merchant does chart how nature has been physically transformed by modern science and industrial urbanization, she is primarily concerned with how these material processes were (and continue to be) enabled by cultural and metaphorical practices that serve to *deaden nature,* and in so doing expose the environment to unchecked socioecological exploitation.

The idea of the death of nature remains a potent metaphor for understanding the profound ways in which human society has changed its ideological apprehensions of the environment, and how this has in turn led to the widespread physical transformation of the natural world. As with all metaphorical devices, however, many now writing about environmental history and the philosophies of nature are keenly aware of the dangers associated with claiming the death of nature. These concerns are based upon the realization that to talk of the death of nature suggests the existence of a natural world that can be dominated, totally controlled, and somehow separated out from human history. The search, it appears, is now on for new ways to understand nature as a simultaneously threatened entity of, and dynamic force within, human history.

SEE ALSO: Deep Ecology; Ecosystem; Industrialization; Urbanization.

BIBLIOGRAPHY. Bill McKibben, *The End of Nature: Humanity, Climate Change and the Natural World* (Random House, 1989); Carolyn Merchant, *The Death of Nature: Women, Ecology and the Scientific Revolution* (HarperSanFransisco, 1980; rpt. 1990); Carolyn Merchant, *Reinventing Eden: The Fate of Nature in Western Culture* (Routledge, 2004).

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Death Rate

THE DEATH RATE, also commonly known as the mortality rate, refers to the number of deaths within a population, most typically expressed by the number of deaths per 1,000 individuals of the population per year. While the mortality rate offers a general level of mortality, it can also be used to act as a measure of deaths in relation to a specific cause, such as natural disasters, incidents of a particular disease, age or gender groups, or infants and mothers. Therefore, a number of death rate measurements are in existence, each with their own distinct nuances. These include: the crude death rate, that is, the total number of deaths per 1,000 of the population; the infant mortality rate, a measure of the number of deaths of newborns (less than one year old) per 1,000 live births; the perinatal mortality rate, which counts the number of neonatal deaths per 1,000 births; and the maternal mortality rate, that is the number of maternal deaths from childbearing per 100,000 live births. Other detailed mortality rates exist, including the standardized mortality rate (SMR). The SMR refers to the total number of deaths per 1,000 of the population of a distinct age group, such as those aged over 65 years, or aged between 16 and 65.

INFLUENCES OF DEATH RATE

Within a country or a region the level of the death rate, just like the birth rate, is subject to numerous influences. These include dramatic events such as wars and armed conflicts, occurrences of natural disasters (such as typhoons, earthquakes, or floods), levels of poverty, levels of economic development, dietary habits, and the size and scope of healthcare services. Thus, in nations that experience high death rates, such as those within the African continent, it is not unusual to find that the health care infrastructure is lacking in comparison to those found within developed nations. However, even within developed nations, the death rate for social groups can differ due to their ability to afford comprehensive medical care and insurance.

Even in an affluent society such as that of the United States, the death rate is much higher for members of the laboring classes than white-collar workers; they are less able to afford health afford premiums and expensive medical care. Moreover, in societies like the United States, where people often eat fatty fast food, levels of heart disease inflate the national death rate. Consequently, national governments attempt to educate and encourage more balanced dietary habits and healthier living, aiming to lower the death rate among particular social groups most at dietary risk, and society as a whole.

One of the most significant influences upon the death rate is the infant mortality rate. In nations like Angola, Afghanistan, and Sierra Leone, places with the three highest levels of infant mortality in the world, their death rates are much greater than the worldwide average (about 8.9 per 1,000). In Angola, for instance, the death rate is about 25 per 1,000, and in Afghanistan about 21, a result of armed conflicts, poverty, and a lack of adequate medical care outside of urban areas. However, in both places the infant mortality level is also above the global average, with about one in five Angolan children and one in six Afghani children dying before their first birthday.

The factor that has the greatest influence upon any nation's death rate is disease, especially those of a cardiovascular, infectious, or respiratory nature. Access to medical care is therefore vital in ensuring the death rate remains low, and it is common to find low death rates in nations that are economically developed, where healthcare provision for both children and adults is mandatory and easily accessible. Diseases such as cholera, malaria, influenza, and typhoid have little impact within places like Europe and North America, but remain potent killers in Africa and other poverty-stricken regions of the world where healthcare is minimal. However, economic development does not mean a nation becomes immune from death by disease. In recent years, HIV/AIDS has had an impact upon many developed world nations' death rates, although the greatest impact of the disease is also within areas of the world where education of disease, and not just medical care, is not widely provided. Diseases like HIV/AIDS have profoundly impacted the death rates of nations in Africa. However, with wealth come incidents of disease with the potential to increase nominally the death rate, such as deaths from road traffic accidents and liver cirrhosis from alcohol abuse, a significant factor on rates of death in places like Russia.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Birth Rate; Disease; Health.

BIBLIOGRAPHY. Committee on International Relations, U.S. House of Representatives, *China's Birth Rate, Death Rate, and Population Growth: Another Perspective* (Congressional Research Service, 1977); Jean Dreze, *The Economics of Famine* (Edward Elgar, 1999); Simon Wood and Roger Nisbet, *Estimation of Mortality Rates in Stage-Structured Population* (Springer-Verlag, 1991).

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Debt

DEBT IS GENERALLY defined as a sum of money or some other valuable that is owed by one individual (or group) to another. Debt is created when a person or company turns over a sum of money to be repaid at a later date, usually with interest.

The recorded history of private debt can be traced back to the second millennium B.C.E., although debts between individuals almost certainly date back much further than that. The existence and rules for dealing with debt appear in the Torah (all debts must be erased every 7, and every 50 years) and are subsumed into both Christianity and Islam, together with prohibitions on "usury," which at least initially simply forbade the charging of any interest. However, the need for ready cash to pay for raising armies and maintaining royal lifestyles drew monarchs into taking out loans from wealthy banking families when they were unable to raise sufficient tax revenues to meet their immediate needs. These private debts, together with the needs of the trading houses of northern Italy, created a demand for a new kind of financial service that both encouraged enterprising individuals to find ways to circumvent the usury laws and created new financial institutions that were to become essential for large-scale public borrowing.

By the 12th century, bills of exchange were in use in Genoa, and negotiable bills that were transferable to a third party appeared by the 14th century. These instruments, together with predictable revenue streams from taxation, allowed the earliest public debts to be taken out by the Venetian state in the 12th century, using future revenue from the salt taxes to guarantee the loans. In northern European city states a different system developed that involved selling redeemable, life or perpetual annuities. These loans were generally secured on some immovable asset such as the town itself, and interest was designated as a "gift" to avoid charges of usury. The monarchies of Europe began to imitate these urban loans by the 16th century, with the nascent state bureaucracies taking over the role of issuing annuities and ensuring reliable repayment of the loans. The creation of public banks in the 16th century and of chartered trading companies in the 17th provided new forms of public borrowing, secured by shares in trading companies or government issued bonds.

PUBLIC DEBT

Public debt is also known as government debt and occurs when any level of government (national, regional or local) takes out a loan. Generally, governments borrow money by issuing securities or bonds, although governments that are considered high risk may turn to commercial lending institutions and international lending institutions such as the IMF or World Bank. Government bonds are generally issued in the national currency if that currency has a strong track record of stability. Government bonds are gen-

Many societies view personal debt as immoral, but some modern economists see it as beneficial to the economy.

erally regarded as "risk-free" because governments have the power to raise taxes, reduce spending, and even print money to pay the bond when it matures. The primary risk associated with such bonds is that of fluctuations in the value of the currency over the life of the bond. Consequently, countries in which the currency is not stable may be forced to issue "sovereign bonds" in a more stable foreign currency. While this makes the bonds more attractive to borrowers, there is the risk that the government may not be able to purchase sufficient foreign currency to redeem the bonds when they mature.

The accumulation of pubic debt, particularly in a state with limited assets or poor economic prospects, can lead to the threat of default on the loans. In the 18th century, the Spanish government defaulted on its loans seven times, and in 1917 the revolutionary government of Russia repudiated the debts of the previous Imperial regime. More recently, the very high levels of debt accumulated by many developing countries have resulted in the intervention of intergovernmental organizations such as the IMF to prevent default and restructure the loans.

Tolerance for relatively high levels of government debt arises largely from Keynesian economic theory which asserts that government borrowing in times of economic slowdown provides capital for increased government spending. That spending in turn supports employment and fuels consumption, creating an economic recovery. At that time the loans can then be repaid. These theories became very popular in the 1930s and 1940s and had great influence on the Bretton Woods institutions (the IMF, the World Bank, GATT and the gold standard), which were created at the end of WWII to manage and stabilize global finances in the wake of the war and the Great Depression.

The problems associated with high levels of public debt largely depend upon the financial stability and economic strength of the government involved. In absolute terms, the world's largest debtor nations are in the developed world; however, strong economies, stable governments and substantial real assets make these debts manageable. During the 1990s the Clinton administration in the United States proved that even very large public debts could be paid off during periods of sustained economic growth. The greatest danger to developed countries with high levels of public debt occurs when much of that debt is external, leaving the country vulnerable to political and economic decisions made by foreign governments. For developing countries, high levels of public debt pose a rather different problem. If the ratio of interest payments (debt servicing) to government income becomes too high, it drains revenue from domestic public services, infrastructure, and industrial development. This depresses economic prospects and makes future loans riskier. In addition, as these countries generally have loans in foreign currencies, poor economic prospects lower the value of the domestic currency relative to the currency in which the loan was made and thereby increases the size of the loan (see Debt Crisis).

PRIVATE OR CONSUMER DEBT

Private debt as a transaction between two individuals has been around for a long time, but like public debt, it did not become a widespread phenomenon until the advent of public banking. Private debts can either be unsecured, in which case the ability to secure a loan will depend upon the creditworthiness of the individual; or they can be secured loans, where another asset owned by the borrower is used as security for the loan. Real property such as houses, land, and business assets are the most common forms of security. Secured loans tend to be offered at lower interest rates than unsecured loans, and interest rates also rise as the credit worthiness, determined by previous credit history, of an individual declines.

Historically, personal debt has been viewed by many societies as immoral, but modern economic perspectives often see consumer debt as beneficial to the economy as it increases domestic production and enhances economic growth. Governments may even encourage debt through tax relief for certain types of interest payments, if the loans are used in ways that encourage consumption of domestic products (for example mortgage interest relief in the United States).

The most common forms of secured personal debt are mortgages. However, there has been a large increase in unsecured personal debt in most developed countries over the past few decades, and the rising use of credit cards, payday loans, tax rebate loans, and consumer financing has led to record levels of private debt in many developed countries.

THE DEBT CRISIS

The most serious debt-related problem in the modern global economy, however, is the debt crisis afflicting many developing nations. Public borrowing by developing governments became common in the post-WWII period as international organizations such as the IMF and World Bank provided a secure framework for infrastructure and development loans. By 1970, the 15 mostly heavily indebted countries owed an average of 9.8 percent of their GNP in international loans. However, these loans were at preferential rates, made only for projects that were judged necessary for economic development and were held by non-profit organizations. By 1987, those same countries owed an average of 47.5 percent of their GNP. The 1970s saw radical changes in the international financial markets that were to greatly affect not only access to loans, but also the terms on which those loans were granted.

The initial impetus to increased borrowing by developing nations was the oil crisis of 1972–74, when the price of oil quadrupled over a two-year period. This increased price put tremendous pressure on the industrialization programs of countries that relied heavily on oil imports and at the same time sent a huge volume of "petro-dollars" into the coffers of the international banking community. Eager to recirculate this money, the banks began to offer low interest loans to even relatively high-risk borrowers, including many developing nation governments. For oil-importing countries, this provided capital to continue the development programs regardless of the increased cost of oil, and for those few countries that were oil exporters, the money was borrowed on the basis of the oil revenue bonanza to come. However, the second oil crisis of 1979–80 closely followed by the interest rate hikes of the early 1980s, and the deep global recession of 1981–82 left many developing countries with insufficient income to pay back their loans on schedule. These loans, often made for current consumption rather than to build economic capacity, also came at a time when the global economy had been destabilized by the ending of the Bretton Woods system and when there had been an overall decline in the terms of trade for products from the developing world. As countries came increasingly close to defaulting on their loans, the IMF emerged as the guarantor of creditworthiness for developing countries regardless of the lender. Part of the new guarantee process involved countries undergoing IMF structural adjustment programs, which were designed to address balance of payment problems generated by internal problems such as high inflation, structural inefficiencies, and large budget deficits. The IMF program was designed to reduce current consumption so that capital could be invested in future economic growth.

However, in the case of heavily indebted countries, it merely freed money to flow out of the country and back to the lenders, and led to austerity programs at home that had potentially devastating effects on human and physical capital as food and transport subsidies were reduced, health and education programs cut back, and taxes raised, even as public sector employees were laid off. In addition, requirements for increased export income often shifted agricultural production from local food supplies to export crops, increasing local food costs. Since the 1980s, the focus of the international financial community has been to restructure this debt to reduce the chances of large scale default. A wide variety of programs, including debt for nature swaps; debt for asset swaps, which give creditors the ability to buy physical assets in the debtor country at a deep discount; and cash buy backs, which allow the creditor to buy back the loan at a deep discount. More recently, as it has become apparent that such programs are only having a minimal impact on debt reduction, particularly in the poorest countries, the concept of debt forgiveness through programs such as the Millennium Development Goals is becoming increasingly common.

SEE ALSO: Capitalism; Consumer, Econonomic; Consumption.

BIBLIOGRAPHY. June Fletcher, *House Poor* (Collins, 2005); John Isbister, *Promises Not Kept: Poverty and the Betrayel of Third World Development* (Kumarian Press, 2006); James Scurlock, Maxed Out (Simon & Schuster, 2007).

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Debt-for-Nature Swaps

DEBT-FOR-NATURE SWAPS OCCUR when a creditor reduces or forgives a country's external debt in exchange for the debtor country redirecting a portion of its debt repayment to conservation and other environmental projects. In commercial swaps, a commercial bank donates or sells at a discount a country's debt to an international nongovernmental organization (INGO). The INGO (most commonly Conservation International, World Wildlife Fund, and the Nature Conservancy) separately negotiates a contract with the debtor government. The INGO cancels the original debt, and the debtor government pays a percentage of the original debt toward conservation projects.

A bilateral swap operates similarly, except that the creditor is a country. INGOs play a role either as an intermediary in the debt transaction or by designing conservation projects. In both commercial and bilateral swaps, resultant funds for conservation are paid in local currency and managed by an in-country NGO or conservation trust fund. Although multilateral lending institutions are prohibited from participating as creditors, the World Bank provides technical assistance.

HISTORY OF DEBT

Debt-for-nature swaps are part of a larger history of debt renegotiations that became necessary in the early 1980s, when debt-ridden third world nations were unable to meet repayment schedules. The first debt-for-nature swap occurred in 1987, when Bolivia owed $650,000 to a commercial bank. Conservation International purchased this debt for $100,000 with funds provided by the U.S. Agency for International Development (USAID). In return for cancellation of the original $650,000 debt, Bolivia created a $250,000 endowment to support the Beni Biosphere Reserve. A Bolivian foundation managed the endowment.

The Paris Club, a consortium of 19 creditor countries that sets debt restructuring policies, first permitted bilateral swaps in 1990. Creditor countries in North America and Europe, including Germany, Holland, Finland, and Canada, have participated in bilateral swaps. Also in 1990, the Enterprise for the Americas Initiative endorsed U.S. debt-for-nature swaps with select Latin American countries that met financial austerity and democratic governance criteria. In 1998, the Tropical Forest Conservation Act promoted U.S. swaps with countries containing significant tropical forests, including the Philippines, Bangladesh, and Latin American and Caribbean nations.

Debt-for-nature swaps are touted as beneficial for creditors, debtors, and nature. However, they do incur high transaction costs and require cooperation among multiple governmental agencies. To date, commercial and bilateral swaps have provided over $117 million and $1 billion for nature, respectively. The majority of beneficiary countries are Latin American, such as Costa Rica, Belize, and Ecuador. Swaps in Peru alone have endowed $57 million for conservation. Other beneficiaries include Madagascar, Vietnam, Jordan, and Moldova. Thirty beneficiary countries have created conservation trust funds. The largest swap provided $570 million for environmental restoration in Poland.

One justification for swaps is that external debt causes deforestation, since debtor nations attempt to repay debts via commercial agriculture and logging. Thus, reducing debt decreases environmental threats. However, concrete links between external debt and deforestation rates are inconclusive. Moreover, swaps to date have diminished total third world debt by less than 1 percent.

Another justification is that debt-for-nature swaps provide funding for on-the-ground management of "paper parks." Yet creditors worry that beneficiary nations depend too heavily upon external funding for parks. Debtor countries, on the other hand, express sovereignty concerns because of the broad role of INGOs in swaps; these intermediaries are seen as an external (and even neocolonial) authority, beyond the control of both the state and local people. Moreover, though swaps involve complex contracts, their enforceability is often unclear. So while swaps have put a tangible value on nature and have provided significant funding for the environment in countries that otherwise have little, questions still remain.

SEE ALSO: Debt; Deforestation; Developed ("First") World; Nature Conservancy; Undeveloped ("Third") World; World Bank; World Wildlife Fund.

BIBLIOGRAPHY. Alan Thein Durning and Lisa Stark, eds., *How Much Is Enough?: The Consumer Society and the Future of the Earth* (Norton, W. W. & Company, 1992); William Ginn, *Investing in Nature* (Island Press, 2005); Edward O. Wilson, *The Future of Life* (Knopf Publishing Group, 2003).

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Deciduous Forest

DECIDUOUS FORESTS ARE dominated by tree species that drop their leaves and become seasonally dormant in response to challenging environmental conditions. Broad-leaved tree species of temperate deciduous forests drop their leaves in autumn to avoid the tissue-damaging winter temperatures and water stress of frozen soils. In the dry tropics, deciduous tree species shed their leaves to avoid the drought stress and injurious high temperatures associated with the dry season.

Temperate broad-leaved deciduous forest largely occurs in the northern hemisphere, chiefly eastern North America, western and central Europe, and eastern Asia. A small region of the southern Andes supports the southern hemisphere's only occurrence of temperate deciduous forest. Evergreen coniferous tree species, like pine (*Pinus*), spruce (*Picea*), fir (*Abies*), and hemlock (*Tsuga*) also grow in most temperate deciduous forests. Tropical deciduous forest, also called tropical dry forest, occurs in Central and South America, India and southeast Asia, and Africa, comprising 42 percent of tropical forests worldwide.

Temperate deciduous forests of the northern hemisphere are composed of closely-related tree species in general, such as oak (*Quercus*), maple (*Acer*), beech (*Fagus*), ash (*Fraxinus*), basswood or lime (*Tilia*), birch (*Betula*), and elm (*Ulmus*). Temperate deciduous forests, especially those in eastern North America, are noted for their structural and taxonomic diversity. European deciduous forests are lower in richness of tree species than are eastern North American and Asian deciduous forests due to past glacial history. The east-west tending mountains of Europe formed a barrier to the tree species migrating from the glacial advance, differing from the generally northeast-southwest tending Appalachian Mountains of eastern North America, which did not impede migration. The temperate deciduous forests of the Great Smoky Mountains of eastern North America, near the southern terminus of the Appalachian Mountains, support 130 species of flowering trees and 11 species of conifers, more in total that grow in all of Europe.

Temperate deciduous forests are vertically stratified, separated into four or more distinct vegetation layers from canopy to forest floor. The uppermost canopy or *overstory* stratum consists of the dominant trees of the forest. Immediately below the overstory" is the *understory*, stratum containing "overstory replacements and subdominant species that do not recruit to the overstory. A shrub stratum of woody, non-arboreal species may occur beneath the understory stratum. Finally, an *herb* stratum—consisting of small-stature vascular plants and mosses—rises to a meter or so above the forest floor. The herb layer, among all the vegetation strata in temperate deciduous forests, supports the highest diversity of plant species in the forest. Diverse vegetation also supports diverse animal life, including birds, mammals, amphibians, reptiles, and insects. Insects, especially caterpillars that feed on leaves of deciduous trees, form an important food base for neotropical migrant bird species in eastern North America. Neotropical migrants, like warblers, typically overwinter in tropical forests of Central and South America but nest and rear young in temperate deciduous forests where insect food is abundant.

Human impact on deciduous forests has been heavy. Tropical deciduous forests have been largely degraded or converted to agriculture and rangeland. Temperate deciduous forests have been converted to agriculture or urban and suburban land use. These forests are further impacted by stressors such as acid precipitation and nitrogen deposition, root causes of forest decline.

SEE ALSO: Boreal Forest; Cloud Forest; Deforestation; Forests.

BIBLIOGRAPHY. O.W. Archibold, *Ecology of World Vegetation* (Chapman & Hall, 1995); Michael G. Barbour, Jack H. Burk, Wanna D. Pitts, Frank S. Gilliam, and Mark W. Schwartz, *Terrestrial Plant Ecology* (Benjamin/Cummings, 1999); Jessica Gurevitch, Samuel M. Scheiner, and Gordon A. Fox, *The Ecology of Plants* (Sinauer Associates, 2006); Robert Leo Smith and Thomas M. Smith, *Ecology and Field Biology* (Benjamin/Cummings, 2001); Heinrich Walter, *Vegetation of the Earth* (Springer-Verlag, 1973).

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Decision Science

DECISION SCIENCE (DS) originated in Great Britain during World War II, when mathematical or quantitative approaches were used to solve logistic problems during military operations. Since then, it has evolved to be applicable to the management of all aspects of a system, product, or service. It is now considered an important input to decision-making in a wide variety of applications in business, industry, and government. The growing complexity of management since the 1940s has necessitated the development of sophisticated mathematical techniques for planning and decision-making. DS involves the quantitative evaluation of alternative policies, plans, and decisions and has become centered in the structured decision-making process cycle. It may also be called Operations Research (OR, American), Operational Research (OR, United Kingdom), Systems Science, Mathematical Modeling, Industrial Engineering, Critical Systems Strategic Thinking, Success Science (SS), and Systems Analysis and Design.

The study of DS involves the application of mathematical methods and tools for solving problems relating to the allocation of scarce resources subject to certain constraints. It contributes to the understanding of human decision-making as well as the development of methods and tools of analysis. Usually the problems deal with determining the least cost or greatest profit, subject to constraints such as some required quantities, capacity to manufacture or store, and available resources over a large number of variables.

The fundamental part of DS modeling is the "systems approach" to problem solving that indicates that the context of organizational problems is as important as the stated problem. The modeling process helps to improve operations through the use of scientific methods and the development of specialized techniques. It often involves defining a problem, collecting information, making decisions based on them, taking action, monitoring and evaluating the results of the implementation, and checking for new problems iteratively. There are two approaches to the decision process—sequential model or nonsequential model. The sequential model requires following certain linear steps, while the nonsequential model has certain phases that have a circular relationship. Orville G. Brim and others proposed one of the early sequential models in *Personality and Decision Processes, Studies in the Social Psychology of Thinking* (1962). They proposed following six steps as part of the methodology: Identification of the problem, obtaining necessary information, production of possible solutions, evaluation of such solutions, selection of a strategy for performance, and implementation of the decision.

However, a more realistic model should allow the various parts of the decision process to vary in order. One of the most accepted nonsequential models was proposed by Mintzberg, Raisinghani, and Théorêt in 1976 in "The Structure of 'Unstructured' Decision Processes," *Administrative Sciences Quarterly*. They identified the decision process to have three phases: identification, development, and selection. In this model, one may cycle through one or all of the phases in any order until an acceptable solution is found.

IDENTIFICATION AND DIAGNOSIS

The identification phase consists of identifying the problems or opportunities (decision recognition routine) and diagnosis routine—using the existing information and identifying new information to clarify and define issues. The development phase defines and clarifies the options and involves two steps—a search routine to find ready-made solutions and a design routine at developing new solutions or modifying existing ones. The selection phase involves three routines: a screen routine, to eliminate subobtimal alternatives; an evaluation-choice routine, to evaluate different alternatives and use judgment, bargaining, and analysis; and an authorization routine, to gain approval for the solution selected.

Most of the environmental problems are complex in nature; this makes the DS approach appear the most suitable for achieving suitable decisions. In the context of the environment, DS involves methodical procedures for integrating information about physical and social phenomenon, environmental processes, available options, the effects of different options on environmental and social conditions, and human values. Decision science often helps to improve the decision process as it helps in making explicit judgments about information (environmental policy) that involves diverse, conflicting, and changing values with scientific uncertainty. It involves participants in making the decisions, and therefore makes it potentially more acceptable and causes less contention among the participants.

Conversely, however, since many or most environmental decisions explicitly or implicitly involve reallocation of control or rights to environmental goods or services, or the control or shifting of externalities, benefits, or risks, critics charge that DS merely creates a depoliticized gloss for inherently political decisions. So too, as the science of risk analysis and perception has evolved, the importance of effective or emotional components of decision-making have become better understood. Their incorporation into DS remains somewhat unclear. For these reasons, while DS remains a potentially important component for environmental decision making, its role is not without concern or controversy.

SEE ALSO: Environmental Accounting; Research Methods; Risk; Science and Technology Studies; Uncertainty.

BIBLIOGRAPHY. Garry D. Brewer and Paul C. Stern, eds., "Decision Making for the Environment: Social and Behavioral Science Research Priorities," Panel on Social and Behavioral Science Research Priorities for Environmental Decision Making, Committee on the Human Dimensions of Global Change (National Research Council, 2005); Robert T. Clemen, *Making Hard Decisions: An Introduction to Decision Analysis* (PWS Pub. Co., 1991); John A. Lawrence, Jr. and Barry A. Pasternack, *Applied Management Science: A Computer-Integrated Approach for Decision-Making* (John Wiley & Sons, 2002).

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Decomposition

DECOMPOSITION IS THE process by which organic matter and its associated nutrients and minerals are recycled through the biosphere by soil organisms. Three-fourths of all terrestrial carbon is present in soil, and various soils have different levels of carbon storage and decomposition rates.

Put simply, decomposition is the breakdown of complex organic molecules into simpler organic molecules by soil organisms, particularly bacteria and fungi. Decomposition begins when dead organic material such as plant leaves, roots, and wood, soil animals, soil microbes, plant root exudates, and soil animal excretions are deposited onto and into soil. Plant material accounts for the majority of organic matter, and thus carbon, added to soil organic matter pools in most ecosystems. Soil animals such as worms, insects, and small mammals mix the surface litter with deeper soil layers. This physical mixing breaks the fresh organic matter into smaller pieces in a process termed *comminution*, which increases the surface area available for microbial attack. Decomposer bacteria and fungi then become more active on the organic matter fragments, and decomposition proceeds more rapidly. The bacteria and fungi release specialized enzymes that cleave (depolymerize) bonds between complex organic molecules. Depolymerization breaks complex carbon compounds into simpler molecules such as single glucose units that are more easily metabolized by the microbes as energy and carbon sources. Some common decomposer bacteria include *Bacillus*, *Pseudomonas*, and *Clostridium*, which are active in decomposing cellulose. The brown and white rot fungi (*Basidiomycetes*) are common fungal decomposers that specialize in decomposing celluloses and lignin, respectively. Microbes also decompose organic molecules in soil that are not derived directly from plant matter, such

Decomposition is the breakdown of complex organic molecules into simpler organic molecules by organisms.

as organic compounds exuded from soil animals, dead bacteria, and fungal hyphae, or carbon stored as humus (described below). Soil animals such as earthworms that ingest organic matter aid in decomposition by inoculating organic matter with decomposer microbes, and by dispersing microbial inocula to organic matter hotspots.

The simpler organic compounds that result from decomposition may be used by microbes for energy or growth, mineralized by other microbes into inorganic nutrients and minerals, or incorporated into highly complex organic carbon compounds called *humus* that decompose very slowly. The byproduct of microbial decomposition under aerobic (sufficient oxygen) conditions is carbon dioxide (CO_2), which may remain in soil pores, dissolve in soil water to form carbonic acid, or diffuse from soil into the atmosphere. Thus, the rate of gaseous CO_2 released from soil is often used as a proxy to estimate microbial decomposition rates.

Decomposition rates vary seasonally and across scales from landscapes to biomes. The rate of organic matter decomposition depends upon organic matter quality (which influences how easily it is decomposed); community composition and activity of decomposer microbes and other soil organisms; and soil physical conditions, particularly temperature and moisture. Decomposition generally proceeds faster in warm, moist climates with deciduous vegetation, and slower in cooler, drier climates with evergreen vegetation. Recent scientific studies suggest that warming of the global climate may speed up the decomposition of organic matter stored in soils of high-elevation and high-latitude ecosystems such as boreal forests and tundra.

SEE ALSO: Biological Oxygen Demand; Boreal Forest; Composting.

BIBLIOGRAPHY. Dirk Bryant, Daniel Nielsen, and Laura Tangley, *The Last Frontier Forests: Ecosystems and Economies on the Edge* (World Resources Institute, 1997) Clare Foster, *Compost* (Cassell, 2002); K. Killham, *Soil Ecology* (Cambridge University Press, 1994).

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Deep Ecology

NORWEGIAN philosopher Arne Naess coined the term *deep ecology* in the short essay "The Shallow and the Deep, Long-Range Ecology Movement: A Summary" (1973). As the title of the paper suggests, this was at once a positive formulation of a new, deep ecology and a critique of what he disparagingly termed *shallow ecology*. These divergent "ecologies" were not divisions within scientific ecology, but branches of the environmental movement. Consumed with the search for piecemeal solutions to particular issues such as pollution and resource depletion, shallow ecology failed to ask deeper questions about the causes of ecological problems and therefore could never hope to solve the ecological crisis itself. Deep ecology, on the other hand, offered a wholesale normative critique of human society, and particularly the human relationship with nonhuman nature.

The bookends of Naess's philosophy of deep ecology are *self-realization* and *ecocentrism*. These two ideas are interrelated and arise out of the (scientific) ecological understanding of the living (and nonliving) world as comprised of interrelated, interdependent, and mutually constitutive beings. The philosophy of deep ecology is thus at once *naturalistic* in that it is derived from ecological science, and *holistic* as it appeals to the relationships between all beings, constituting a whole, living earth. Deep ecology offers a corrective against the (related) dominant Western, modern views that the human species is separate from nonhuman nature and that human individuals are in any sense separate from other living beings (other humans included). "Self-realization," for Naess, is the logical conclusion of any truly deep ecological questioning—when we realize the interconnectedness of all things, it becomes evident that any concept of the self must expand beyond the individual to include all things. Promoting Naess's ideal of self-realization, Fox states that:

> When we realize we are related to the whole, alienation drops away and we identify more widely with the world of which we are a part. Another way of expressing this is to say that we realize a larger sense of self; our own unfolding becomes more bound up with the unfolding of other entities.

So while deep ecology purports to offer a planetary-scale solution to the ecological crisis, the locus of normative change is the human individual.

ECOCENTRISM

Ecocentrism, the second key component of Naess's deep ecology, is a logical derivation of self-realization. Once an individual realizes that he or she is not a narrow, enclosed self and properly identifies with all of nature, anthropocentric (human-centered) thought or action becomes illogical.

Although Naess never writes in a polemical tone, the rhetoric of deep ecology is incontrovertibly divisive and dualistic. The most prominent example is the binary ecocentric/anthropocentric division, which maps directly onto the deep/shallow ecology division. Environmentally-sensitive individuals either possess deep ecological understanding or they do not; they either practice deep ecology or they do not.

Deep ecology was relatively unheard of in North America until 1985, with the publication of Devall's and Session's *Deep Ecology: Living as if Nature Mattered*, which presents a platform for the deep ecology movement. Unlike Naess's earlier work, the platform was intended to be less an *ecophilosophy* and more a set of principles that deep ecologists could rally around, regardless of philosophical or religious positions. The platform was based on the fundamental tenet that nature has "intrinsic value … independent of the usefulness of the nonhuman world for human purposes." Beyond this fiat of intrinsic value, which is basically a restatement of the deep ecology commitment to *nonanthropocentrism*, the platform called for a reduction in human population, a decrease in human interference in the natural world, a change in policies, and a personal "obligation directly or indirectly to try to implement the necessary changes." So the deep ecology platform at once codified a new grounding for many American environmentalists (ecocentrism) and recalled resonant themes within the movement (overpopulation, leaving "nature" to its own devices, and direct political action).

Although summarizing Naess's early writing on deep ecology is a relatively straightforward task, the same cannot be said of its American derivatives. Once deep ecology took root in North American literature, it quickly erupted into a diverse and rather amorphous catchphrase, summoned by different writers to mean quite different things. Although it is impossible to say exactly where it has had the strongest influence, deep ecology has made an indelible mark on the contemporary North American wilderness preservation movement.

Mick Smith argues that American deep ecologists rely on increasingly "scientistic routes" to arrive at their normative proposals, employing biologically determinist explanations of human behavior. This is due largely to the influence of Paul Shepard, who over the course of three decades wrote volumes of work speculating on the biological basis for human attitudes and behaviors toward nature. Sessions approvingly paraphrases Shepard's thesis:

> Humans are genetically programmed for wild environments, and…modern urban humans who have not bonded with wild nature are ontogenetically stuck, remaining in some ways in an adolescent stage of human development.

Smith finds that a culture of hubris and unreflexive scientism has inhibited the growth of a self-critical, pluralistic politics within the deep ecology movement.

Problematic as it may be, the North American variety may be truer to the spirit of Naess's intent than the more scholarly European deep ecology. As Katz, Light, and Rothenberg observe, "Naess has often stressed that he is more interested in deep ecology as a political and social *movement* than as a philosophy."

SEE ALSO: Biocentrism; Bioregionalism; Naess, Arne.

BIBLIOGRAPHY. Bill Devall and George Sessions, *Deep Ecology: Living as if Nature Mattered* (G.M. Smith, 1985); Warwick Fox, *Toward a Transpersonal Ecology* (Shambhala, 1990); Ramachandra Guha, "Radical American Environmentalism and Wilderness Preservation: A Third World Critique," in J. B. Callicott and Michael Nelson (eds), *The Great New Wilderness Debate* (University of Georgia, 1999); Eric Katz, Andrew Light, and David Rothenberg (eds), *Beneath the Surface: Critical Essays in the Philosophy of Deep Ecology* (MIT Press, 2000); Andrew McLaughlin, "For a Radical Ecocentrism," in Andrew and Yuichi Inoue, eds., *The Deep Ecology Movement: An Introductory Anthology* (North Atlantic, 1995); Arne Naess, "The Shallow and the Deep, Long-Range Ecology Movement: A Summary," *Inquiry* (v.16, 1973); George Sessions, "Postmodernism, Environmental Justice and the Demise of the Ecology Movement?" *Wild Duck Review* (v.5, 1995); Mick Smith, *An Ethics of Place: Radical Ecology, Postmodernity, and Social Theory* (State University of New York, 2001); Peter Van Wyck, *Primitives in the Wilderness: Deep Ecology and the Missing Human Subject* (State University of New York, 1997).

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Deer

MEMBERS OF THE *Cervidae* family, deer are ruminant animals—meaning they are hooved and digest their food through a process of *rumination* on regurgitated cud; and possessing antlers, rather than horns. Indigenous to most of the world, some of the more than 30 species of deer can be found on every continent.

Throughout human history in North America, white-tailed deer and mule deer have been closely tied with human land use, economic activities, and cultural values. Unlike many other wildlife species, deer thrive in human-managed landscapes, and their populations have fluctuated with changing human practices. The tendency of deer to live near human settlements stems from their preference for a fine-grained mosaic of fields and forest, which provides an ideal combination of abundant food and ready access to shelter. Today, a variety of constituencies disagree sharply over how to manage growing numbers of deer.

Aboriginal North Americans across the continent considered deer an important resource for their meat, their versatile skins, and in many cases for other body parts that could serve as tools. Many groups, for example the Ojibwe of the Great Lakes region and the Navajo of the Southwest, expressed the importance of this game species through prayers recited upon killing a deer. Native American groups in the northeast and Great Lakes regions understood the deer's ecological preference for patchy landscapes; they burned areas of forest to create an edge habitat and encourage game.

The activities of Europeans upon their arrival in North America in some ways favored deer, but in other ways reduced their numbers. Though the eradication of predators eliminated one ecological control on deer, human hunting pressure increased; in the colonial period both Native Americans and Euro-Americans overexploited deer, particularly for their skins. In the 19th century, venison assumed an important place in the American diet as market hunters kept pressure on deer populations. Also, agriculture and timber extraction left little forest and therefore little edge habitat for deer near human settlements. Increasingly restrictive hunting laws throughout the late 19th and early 20th centuries helped deer populations recover.

Human communities today provide deer with ideal food sources by planting gardens, ornamental trees and shrubs, and agricultural crops. Typical suburban landscapes offer the mix of forest and field that deer prefer, and to a much greater extent than did burning by Native American communities. Deer populations have grown throughout the 20th century, reaching numbers and densities that many see as problematic. State conservation agencies have loosened hunting rules as a management strategy, but to limited effect. Farmers consider deer pests because of the toll that they take on fruit, vegetable, and ornamental crops; deer also damage gardens and landscaping in residential areas. Car crashes with deer cause injury, death, and increasing insurance costs. Deer ticks have increased with deer numbers, and human communities living near these populations have been exposed to Lyme disease, a poorly understood but debilitating illness. High deer populations and population densities are also associated with starvation during winter and chronic wasting disease (CWD). Deer alter vegetation communities through overbrowsing, and this has had cascading effects on other wild species such as songbirds.

In many U.S. regions, however, the cultural and economic significance of deer makes it politically difficult to enact wildlife management policies to reduce their populations. For hunters, deer are the center of important recreational activities as well as cultural identity. Hunters are often suspicious of official estimates of deer numbers, accusing wildlife officials of exaggerating populations; many choose to limit their own takes in order to ensure future abundance of deer. Deer are worth billions of dollars to the communities that bring in out-of-town hunters. Meanwhile, management agencies have also proposed culling campaigns, but concerned citizens and animal rights organizations have protested publicly funded killing of deer. Relocation and sterilization are costly and rarely effective.

Nova Foresta

Deer hunting in England had long been a royal prerogative, and in 1079, William the Conqueror established the New Forest in southern England as a royal forest. Covering the southwest of the county of Hampshire and a small part of the county of Wiltshire, the creation of the New Forest—called *Nova Foresta* in the Domesday Book of 1086—saw the inhabitants of 36 villages dispossessed. This allowed the deer to breed without having to worry about poaching, and the King to hunt freely. William the Conqueror died in 1087 and was succeeded by his son William “Rufus” II.

William Rufus also enjoyed hunting deer in the New Forest, and on one of these hunting expeditions, on August 2, 1100, he was hit by an arrow, allegedly fired in accident. Others have suggested that it was more likely part of an assassination plot organized by William’s younger brother and successor who became Henry I, nd who was, conveniently, in the hunting party. The site of William II’s death is marked by what is known as the Rufus Stone Memorial.

The forest laws ensured that interfering with the King’s deer and its habitat was severely punished, and these rules operated throughout the Middle Ages. Some 90 percent of the New Forest is still owned by the Crown, and is managed by the Forestry Commission. In June 1999 the New Forest was proposed as a UNESCO World Heritage Site, and in 2005 became a National Park. Several different species of deer still live in New Forest, most of them fallow deer, but also roe deer, red deer, and sika deer.

SEE ALSO: Animal Rights; Chronic Wasting Disease; Ecosystems; Edge Effect; First Nations; Fish and Wildlife Service (U.S.); Hunting; Meat; Native Americans; Pests, Agricultural; Wildlife.

BIBLIOGRAPHY. Richard Nelson, *Heart and Blood: Living with Deer in America* (Vintage, 1997); Thomas P. Rooney and Donald Waller, “Direct and Indirect Effects of Deer on Forest Ecosystems,” *Forest Ecology and Management* (v.181, 2003); Wisconsin Department of Natural Resources, “Deer Hunting in Wisconsin,” http://dnr.wi.gov/org/land/wildlife/HUNT/deer (cited April 2006).

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Deforestation

AT LOCAL, REGIONAL, and global scales, deforestation is significantly altering land cover, perhaps at an accelerating pace. According to the Food and Agriculture Organization and the United Nations Environmental Program, tropical forests are disappearing at a rate of 7.6 million hectares per year (as of year 2000): 4.4 million hectares a year in Latin America, 1.8 million hectares a year in Asia, and 1.4 million hectares a year in Africa. Trends suggest that deforestation of tropical forests is occurring at the greatest absolute rate in history. This transformation of the earth's surface is linked to a variety of scientific and policy issues that revolve around the human dimensions of land use/land cover change and the causes and consequences of such changes. As forests are converted to alternate land uses and/or degraded, forests and their ecological services also are profoundly transformed. Further, deforestation changes the nature of population-environment relationships and alters the feedback mechanisms that subsequently influence human decision-making and future trajectories of land use dynamics. On a global basis, forests are essential as a major carbon sink. They regulate climate and mediate greenhouse gases, influence the natural flora and fauna and protect the land and their regenerative properties, as well as impact human behavior and agency in fundamental ways.

PROBLEMS OF DEFINITION

At a fundamental level, deforestation is the transformation, or conversion, of forested areas to non-forested areas. Depending upon the space-time relations, the context of scale, and the particular circumstances of the transformation, the definition and determinants of deforestation are subject to a considerable degree of complexity. The mediating effects of indirect (through perhaps ultimate causes, such as, market forces) and proximate (direct modalities of change, such as access to chainsaws) influences further contextualize the definition, description, and explanation of deforestation.

Forested areas are converted to a variety of alternate land uses, including a change to subsistence or commercial crops; agro-forestry; grasslands for pasture; impoundments of water for lakes, ponds, and reservoirs; human settlements of households and communities; and shifting agriculture. Often, the loss of biodiversity and ecological services are associated with environmental degradation and deforestation. Forests also evolve through secondary forest succession and other mechanisms that influence forests over space and time. *Successional* forests can sequester carbon, possibly at a higher rate than the forests they replace, depending upon species, age structure, and site conditions; but the ecological services that successional forests provide are substantially different than what they replaced. Sustainable forestry offers context to deforestation, as timber management practiced relative to conservation goals, versus development scenarios, yield very different outcomes for population and the environment. Forest habitat fragmentation and the edge-effects of remnant forests also mediate the impacts of forest disturbances, for instance, through logging and fire.

INTEGRATED AND COMPLEX PROCESSES

Deforestation can be viewed, not as a single action or event, but as a set of integrated and complex processes and feedback mechanisms. For instance, deforestation can occur through natural and/or anthropogenic processes that exhibit sets of spatial patterns and time scales. Ecological disturbances, such as insect infestation, wildland fire, wind blow-down, and snow and rock avalanches can shape the composition, age structure, density, and spatial pattern of forests, as well as the timing, type, and degree of ecological services that they provide. Large-scale forest fires, more severe in the tropical regions during El Niño events, have severe implications for forest degradation and the release of carbon through forest fire emissions. Human actions and policies also affect forests and forest resources, through the conversions of forest to agricultural land uses, protection of forests in designated conservation areas, and the maintenance of riparian corridors through laws and regulations.

In addition, the direct and indirect effects of deforestation suggest other confounding issues, at least in the processes as well as the dichotomy of natural vs. anthropogenic factors of forest change. The distinctions between natural versus anthropogenic forest disturbance factors are becoming at times blurred and indistinct, such as in the case of the emerald ash borer that arrived in the Great Lakes region of the United States in wooden pallets from Asia, and are now rapidly decimating the ash tree population. Clearly, human agency has worked inadvertently to initiate a natural (through "exotic") disturbance process. In another instance, anthropogenic fires are significant in newly colonized, frontier areas such as the Amazon Basin, where positive feedback mechanisms between forest fragmentation, forest fires, and selective logging impact the probability of large and severe fires. Exogenous factors such as climate change, air pollution originating locally or over remote regions, environmental policies set by distant groups and organizations, international market prices for local commodities—these factors and others influence the driving forces of deforestation, the space-time lags of the interactions, as well as the scale and spatial context of forest conversions. Endogenous considerations such as land tenure systems, private vs. common property, resource endowments of sites, and culture and context further serve to mediate the description and meaning of forest and deforestation.

TIME

Time is also a central element in the debate over deforestation and in its description. In tropical forests, as well as other biomes of the world, deforestation is occurring at an alarming rate, but land change has commonly and consistently accompanied human developments. In the Amazon Basin, for instance, deforestation is occurring over broad geographic areas and at a staggering rate, driven by the complex interplay of socio-economic, demographic, and geographic factors that are distal and proximate to the basin. Many places around the world have experienced change with a distinct environment and time signature. The deforestation of the U.S. Great Lakes region in the early part of the 20th century is one example of land use/land cover patterns that have shaped today's land use, as is the deforestation in southeast Asia, which is driven by factors such as the expansion of upland field crops—primarily cassava—to meet the demands for high-calorie animal feed in Europe beginning in Thailand in the late 1960s and early 1970s. Other factors include fuelwood consumption, commercial logging, shifting cultivation, and forest degradation through grazing and fire. Within southeast Asia more broadly, population increase—affects the direct and indirect impacts of deforestation. Clearing land for grazing also contributes in important ways to deforestation in this region; for example, by destroying or degrading undergrowth and seedlings that succeed mature trees that are cut for fuelwood.

The grain and extent of deforestation also enters into the understanding of deforestation. *Grain* is the ecological, or *areal* dimension, of the measurement unit (measured at a 10-meter or 1-kilometer cell), whereas the *extent* is the dimension of the geographic context (a farm, province, national park, or a watershed). These concepts help to contextualize gaps in forests that may be caused by an individual tree-fall, or by the transformation of extensive forest tracts leaving only forest remnants.

The relative degree of connection between forest patches or remnants through ecological corridors is often used to describe the spatial organization of forest that has been transformed within a spatial-ecological context. Forest patch dynamics is a useful approach for appraising forests over space and time by considering forest resilience in the face of disturbances. In many definitions of deforestation, plantation forests are excluded, as they suggest a periodicity to the land transformation and the notion of a forest "crop" with an implied cycle of harvest and re-growth. Forest plantations offer very different ecological services than the forests that they may have replaced.

COMPLEX CAUSES

The causes of deforestation are aslo complex and varied. Most of the deforestation caused by anthropogenic actions has been related to the direct and indirect affects of agricultural land conversion, including the cultivation of crops, grazing of cattle, and fire. Land conversion may vary from peasant farmers who generally influence relatively small geographic areas (although their collective effects are substantial) to intensive, highly-mechanized agriculture that affects substantially large geographic areas, and often in a more profound way. Commercial logging is another common process of deforestation. The mode of timber harvest (e.g., selective cutting vs. forest clear-cutting) has severe implications for the environment. An interconnected and competitive global economy can further challenge forest resources, as they are often exploited to meet the demands of national and international markets and a consumptive population. Selling logging concessions, population in-migration into restricted or inaccessible areas, nonsustainable forest practices, mining, and urbanization alter the forested landscape slowly or suddenly and continuously or episodically. Some deforestation is deliberate, such as associated with urbanization, or unintentional, related to uncontrolled grazing of animals. Deforestation also occurs through wildland fire, volcanism, desertification, hurricanes, tornadoes, and other natural catastrophes. Feedbacks between natural and human processes such as air pollution, soil erosion, depletion of ground water, and over-use of forests further affect forests and the processes of change.

Fuelwood consumption, commercial logging, and shifting cultivation into forests all contribute to deforestation.

The influence of direct and indirect effects on forest resources is important. Direct effects include the removal or degradation of forests through fire or logging, whereas indirect effects are seen when forest remnants are overly fragmented, resulting in loss of subsequent forest habitat; reduction in the ability of the forest to provide critical ecological services such as biodiversity; and land degradation, further aggravating hydrological processes and carbon sequestration. Conversely, forest practices that sustain and rehabilitate a forest are important to the health, density, and structure of the forest and its overall resilience. From a social perspective, deforestation can influence human cultures, such as the practice of traditional subsistence agriculture and the hunting and gathering of forest resources by indigenous people.

LAND USE OR LAND COVER

Deforestation is also influenced by whether the forest resource is considered a land use or a land cover. Land use implies a "use" of the land for some sort of activity. An example is the retention of trees to provide shade from the hot tropical sun for farmers and their animals. In this case, the isolated trees of small patches of trees are considered a component of the pasture. Land cover implies a "cover" unrelated to its use, such as a community forest or trees retained near settlements to provide firewood, shade, and related forest resources. Furthermore, if forests are assessed using remote sensing technology, images representing a single "snapshot" in time offer a time-dependent characterization of the landscape, whereas time-series images can be used to examine intra- or inter-annual changes, rates, and patterns of forest change, degree of deforestation and reforestation, the nature of forest succession, and the historical context of deforestation. Comparing vegetation and landscape change patterns across different sensor systems with varying resolutions and design specifications can introduce bias and uncertainties in the forest change reports, so caution is urged.

A number of studies have examined the causes and consequences of deforestation at the local, regional, and global levels. The deforestation of tropical forests has received considerable attention from the science community, as well as government and non-governmental organizations. Case studies have relied upon fine- and coarse-grained sensor systems, country reporting of the forest area, and percent of forest area within political borders and ecological strata, as well as the change in forest conditions over time and space. Studies have also addressed the expected composition of landscapes and the spatial patterns of forests for future time periods using empirical and process models. Spatial simulation models are aslo being used to consider land change scenarios and the integrative effects of people and the environment on deforestation patterns and estimates for subsequent periods and landscape strata.

OTHER FACTORS

In these analyses, no single variable has accounted for the total observed or expected deforestation rates, patterns, and magnitudes. It is widely accepted that deforestation is the product of a host of ecological, socio-economic, demographic, and geographical factors that are linked in diverse ways. Poverty is often an important underlying cause of deforestation, as well as land tenure, plight of landless people, social inequalities, uncontrolled industrialization, globalization and transnational factors, consumptive use patterns, population migration, national debt, consumerism, and environmental policies and institutions.

Other important factors have included colonization and agriculture; infrastructure improvements; more access to markets, capital, and credit; a commercial economy; cattle raising; conversion of mangrove forests to shrimp farms; and oil and gas production. Secondary effects of these factors are important and numerous. For instance, greater participation in the commercial economy as a consequence of oil exploration in a region, and more access to isolated areas on roads built for oil exploration and to lay pipelines, is a story of frontier environments that has been well told.

What is clear is that forests are changing at an alarming rate, and deforestation's causes are social, biophysical, and geographic in origin. Feedback mechanism and nonlinear system dynamics explain many of the compositional and pattern-oriented changes affected by the interactions of people, place, and environment.

A case in point is the land use/land cover change in the northern Ecuadorian Amazon. In this region, evolution, conflict, and adaptation of social and natural systems have spatially-explicit responses and feedbacks that influence land use/land cover patterns and trajectories. Agricultural expansion, urbanization, land use intensification, deforestation, natural resource exploitation, dynamics of protected areas, and indigenous market integration and acculturation are among the most important ongoing processes of deforestation resulting from complex socio-economic, demographic, and biotic interactions between different stakeholders occurring at different scales.

STUDIES IN THE AMAZON

Studies in this region use an assortment of data drawn from theories and practices across the social, natural, and spatial sciences: imagary (to characterize land use/land cover change patterns and trajectories; ecological pattern metrics to describe the spatial structure of land change; a geographic information system to characterize geographic accessibility, resource endowments, and site suitability of land parcels being transformed from forest crops, pasture, secondary forest, and urban uses; longitudinal and cross-sectional, socio-economic and demographic survey data to characterize communities; statistical methods to link distal and proximate causes and consequences of deforestation; and spatial simulation models to examine deforestation, agricultural extensification, secondary forest succession, and urbanization for historical, contemporary, and future periods. Among a great many others, these studies have examined the questions:

What are the rates, patterns, and mechanisms of deforestation, and how do they compare and contrast across space and time scales?

What are the linkages between people, place, and environment on the Ecuadorian Amazon frontier, and what are the feedback mechanisms between population and the environment that influence deforestation patterns?

How are demographic and other aspects of human behavior changing frontier settings? Do properties emerge from local nonlinear feedbacks that constrain the evolving patterns of land use?

While the fundamental causes of deforestation in the humid tropics vary, small farmers are the primary direct agents of forest change in Ecuador. In Ecuador, rapid deforestation has occurred initially as poor farmers clear small areas for annual subsistence crops and to plant perennial cash crops. Then, as they accumulate savings and soil fertility declines, they plant pasture and acquire a few head of cattle. In Ecuador, there has been virtually no abandonment of plots as land degrades; instead, farmers sell off parts of their plots to newcomers, who initiate their own pattern of land clearing. However, their plots are smaller, so they have less land for raising cattle or even to support themselves, and as a consequence, resort more to off-farm employment, often in nearby towns. These towns have been growing very rapidly, so there are close linkages between land use/land cover change and urbanization. It is not only the level of deforestation in the Amazon that is important to understand deforestation, but also changes in the spatial patterns of deforestation and agricultural extensification, and more recently, urbanization that will shape the future trajectories of change.

NATURAL RESOURCE EXPLOITATION

Natural resource exploitation in the region primarily consists of oil prospecting and extraction and, to a lesser degree, African palm plantations. These activities produce large-scale economic impacts and widespread direct and indirect effects on deforestation dynamics. Both activities are mainly controlled by exogenous forces, in the case of the oil, by international and national market forces (oil exportation provides almost half of Ecuador total revenues); and in the case of African palm, by the national market for domestic cooking oil.

These industries directly modify land use/land cover, but their main effect is indirect change. They create demand for employment and services that triggers internal migration to the area and spontaneous agricultural settlement, creating a strong nonlinear relationship between national economic development and local demographic and agricultural processes.

The deforestation that is taking place in the Ecuadorian Amazon is relatively recent. About four decades ago, this landscape was used mainly by indigenous people and very few colonists for subsistence agriculture. The discovery of oil in 1964 triggered infrastructure development and spontaneous agricultural colonization. Rapid land cover changes in the region contributed to Ecuador's rank in 2001 as the country with the highest deforestation rate in Latin America over the last decade. Ecuador's ranking as the country with the third-highest oil reserves in South America and the development of additional oil infrastructure in the region suggests a future of road building, community expansion, and off-farm employment, and as a consequence, more deforestation.

GROWING HUMAN POPULATION

The ultimate driving force of deforestation throughout the world continues to be the growing human population, which is expected to stabilize at around 11–12 billion by the middle of the 21st century. It is not simply the demand human populations create for new agricultural lands that drives forest degradation and clearing. As the economies of the developing world mature and standards of living increase (e.g., China), demand for goods and services linked directly and indirectly to forests increases, usually in a nonlinear fashion (e.g., the U.S. per capita resource consumption trends in the 20th century).

One important growing concern relates to geopolitical circumstances and globalization pressures associated with energy supplies, in particular, fuel oils. Increasing petroleum scarcity due to declining reserves, growing demand, and regional conflict and political instability in areas of production is increasingly driving worldwide growth in alternative energy development.

The African palm is a case in point, as creation of plantations of this species dedicated to the production of biofuels is driving tropical deforestation in Southeast Asia, and is expected to do the same in Africa in the near future. Another example is the link between sugarcane-based ethanol production and deforestation in Brazil, a country that is rapidly decreasing its dependency on foreign crude oil imports through this strategy. Other nations are likely to follow Brazil's path in the coming decades.

Another important complicating factor influencing humanity's ability to understand and manage deforestation processes is global climate change, a phenomenon that is altering environmental gradients and ecotones across space-time scales, leading to greater unpredictability of the response of social and ecological systems to deforestation's affects. Hence, it is imperative that people, from individuals to communities and nations, act proactively to effectively understand, manage, and mitigate the process of deforestation before forest ecosystems are permanently degraded and altered on a global scale.

SEE ALSO: Forest Management; Forest Transition Thesis; Forests; Land Degradation; Reforestation.

BIBLIOGRAPHY. A. Goudie, *The Human Impact on the Natural Environment: Past, Present, and Future* (Blackwell Publishing, 2005); W.B. Meyer and B.L. Turner, eds., *Changes in Land Use and Land Cover: A Global Perspective* (Cambridge University Press, 1994); A.C. Millington, S.J. Walsh and P.E. Osborne, eds., *GIS and Remote Sensing Applications in Biogeography and Ecology* (Kluwer Academic Publishers, 2001); W.K.Y. Pan, S.J. Walsh, R.E. Bilsborrow, B.G. Frizzelle, C.M. Erlien, and F.D. Baquero, "Farm-Level Models of Spatial Patterns of Land Use and Land Cover Dynamics in the Ecuadorian Amazon," *Agriculture, Ecosystems, and Environment* (v.101, 2004); R.R. Rindfuss, B.L.Turner II, B. Entwisle, and S.J. Walsh, "Land Cover/Use and Population," in G. Gutman, ed., *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface* (Kluwer Academic Publishers, 2004); S.J. Walsh and K.A. Crews-Meyer, eds., *Linking People, Place, and Policy: A GIScience Approach* (Kluwer Academic Publishers, 2002); M. Williams, *Deforesting the Earth: From Prehistory to Global Crisis* (University of Chicago Press, 2003).

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Delaney Amendment

THE DELANEY AMENDMENT that was introduced in 1958 to the Federal Food, Drugs, and Cosmetics Act outlawed the use of any food additives that might lead to the causing of cancer, specifically: "the Secretary [of the Food and Drug Administration] shall not approve for use in food any chemical additive found to induce cancer in man, or, after tests, found to induce cancer in animals." This amendment was clearly aimed at protecting consumers from the negligent or malevolent actions of food producers who may include such dangerous elements in their products and make them liable to prosecution if they should do so.

Delaney's argument was that no level of safety in terms of carcinogenic substances could be tolerated. The only safe level, therefore, was zero. Consequently, if in laboratory experimentation conditions test animals could have cancers induced through often large-scale introduction of a particular substance, then that substance was forbidden for use in food of any sort. Rep. James Delaney, D-N.Y., had served on a committee investigating food safety and additives issues that held two years of hearings around 1950. The Delaney Amendment was supplemented by others, notably the 1960 amendment concerning coloring additives, aimed at increasing consumer protection through the same policy of zero inclusion, as was a provision for animal feed.

Clearly, this amendment was considered to be antithetical to the interests of business and to some extent contradictory to existing legislation, which stipulated a legal dose for the inclusion of pesticide residuals, for example. Industry lobbyists spent a great deal of time and effort trying to have the Amendment repealed, and attempted to publish research intended to show that the zero-tolerance policy was inappropriate.

The amendment was repealed in 1997 after years of investigation, led by Monsanto and other corporations and beginning during the Clinton administration, and replaced by a package of legislation aimed at addressing issues that had arisen through scientific research in the intervening years. The concept of tolerable risk replaced the Delaney principle. Clearly, it is impossible to eliminate risk altogether, and technology does provide solutions to problems previously observed. This principle operates with respect to other consumer goods and services, and it would be inconsistent to maintain dual standards.

Further, recent research suggests that changing environmental conditions is leading to changes in allergic response to certain kinds of food, and it would be unfair to hold manufacturers to an unsustainable principle. Even so, it is true that the amendment was ended during a period of politics in which business interests were favored. Continued application and policing of strong regulations remain necessary to protect consumer interests.

SEE ALSO: Allergen; Food; Food and Drug Administration (U.S.).

BIBLIOGRAPHY. Harvey Levenstein, *Paradox of Plenty: A Social History of Eating in Modern America, Revised Edition* (University of California Press, 2003); Richard A. Merrill, "Food Safety Regulation: Reforming the Delaney Clause," *Annual Review of Public Health*, (Vol.18 May, 1997); Kristin Shrader-Frechette, "Technological Risk and Small Probabilities," *Journal of Business Ethics*, (Vol.4, No.6, December 1985); Center of Food Safety and Nutrition/U.S. Food and Drug Administration website, www.cfsan.fda.gov (cited May 2006).

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Democracy

A DEMOCRACY IS a political system in which all adult citizens have the opportunity to participate in decisions affecting their interests. The more significant and comprehensive these opportunities are, the greater the level of democracy: political theorists discuss, in these terms, the "widening" or "deepening" of democratic decision-making. Ultimately, this extension of the democratic principle can lead to the questioning of the "political" category itself and its relationship to social choices determined by a market economy. However, within widely shared conceptions of *liberal democracy,* the economy is not a realm of civic self-determination, while the polity itself comprises decision-making by representatives elected by a form of majority voting among the population. Representative liberal democracy describes the overwhelming majority of political systems in the world today, in which the central institutions of government claim to provide equitable opportunities for citizens to shape the exercise of power, and in which that influence is facilitated by competing political parties.

Environmentalism, for all its organizational and ideological diversity, has presented a number of core challenges to the liberal democracies. Its central charge is that these political systems fail adequately to represent ecological interests, notably those of future generations and nonhuman species. Ecological sustainability is viewed as a critical condition for long-term planetary (including human) survival and well-being, but democratic political procedures are seen as limited in their capacity to deliver this. In the first place, the concerns of citizens, and hence politicians, are routinely centered on short-term material gains; environmental groups must compete for agenda-setting attention with organized interests promoting economic wealth creation regardless of ecological costs. The political and administrative institutions of liberal democracy are claimed to be ill-equipped to master ecological problem solving; there is a clear mismatch between the hierarchical, sector-based structures of policymaking within representative democracies and the dynamic, complex pathways of much ecological harm.

In recent years there has been substantial interest by political theorists in deliberative understandings of democracy, which dwell on the processes of shared communication by which political preferences are shaped. Proponents of *deliberative democracy* find too restrictive the liberal representative view that the essence of democracy is the aggregation of votes, arguing that reasoned discussion and debate on what are publicly justifiable choices is as important. The deliberative perspective has appealed to environmental political theorists for what they judge to be its potential for greening democracy. Given their open decision-making processes, deliberative political institutions are claimed to promote the recognition of environmental protection as a public interest by exposing citizens to other arguments about ecological sustainability. This civic openness is also seen as conducive to solving complex ecological problems inasmuch as deliberative institutions spread the cognitive burden of decision-making among the cooperative efforts of many individuals.

Environmental scholars have identified various institutional forms as promising vehicles for deliberative democracy. At the locus of representative power in parliamentary lawmaking, including its interpretation by the judiciary, the stress is on increased opportunities for articulating and defending ecological interests; for example, constitutional environmental entitlements and legal rights to public participation in project-based and strategic environmental assessment.

At the level of administrative decision making, deliberative designs can expose regulatory actions to citizen scrutiny and environmental values. Institutional designs already realized in practice include deliberative opinion polls, consensus conferences, stakeholder forums, and citizen juries. The appropriateness of a particular design rests on such contextual factors as purpose, issue, and scale; but the intention is always to enhance democratic participation and justification. It should be noted that the academic literature on the environmental credentials of deliberative democracy has focused on North America and Europe: the applicability of this research to younger democratic states remains to be seen.

Proponents of deliberative democracy generally view it as a complement to existing representative institutions, although debate continues about how the two can best be integrated in pursuit of environmental protection. In contrast, advocates of *direct democracy*, such as Murray Bookchin, flatly reject liberal democratic structures in favor of political self-determination by local communities. Inspired by the classical Athenian polis, where sovereignty is exercised directly by (free) citizens, the proposal is for decision-making by face-to-face assemblies, with coordination and administration entrusted to delegated municipal councils. Ultimately, both liberal states and markets would be replaced by communal political and economic structures. While these ideas have found support within radical green activist groups and networks, they remain, not surprisingly, outside mainstream environmental policy discourse.

SEE ALSO: Bookchin, Murray; Green Movement; Political Ecology; Social Ecology.

BIBLIOGRAPHY. Murray Bookchin, *From Urbanization to Cities* (Cassell, 1995); John Dryzek, *Deliberative Democracy and Beyond* (Oxford University Press, 2000); Yoram Levy and Marcel Wissenburg, eds., *Liberal Democracy and Environmentalism* (Routledge, 2004); Michael Mason, *Environmental Democracy* (Earthscan, 1999); Graham Smith, *Deliberative Democracy and the Environment* (Routledge, 2003).

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Demographic Collapse

DEMOGRAPHIC COLLAPSE IS a term used to describe the decline of population or part of a population, especially its size, growth, density, or distribution. The term is connected to and often synonymous with *societal collapse* and is sometimes expressed simply as *collapse*.

Societal collapse is the broad decay or long-term decline of a specific culture and its institutions. Societal collapse frequently describes plagues, sudden and massive loss of human life, and the resulting breakdown of a civilization. The term is frequently attributed to William McNeill's *Plagues and Peoples*.

The 14th-century Black Death of Europe and the death of large numbers of indigenous peoples in the Americas from smallpox, measles, and typhus transmitted by the arriving Europeans are the most commonly cited examples of demographic collapse. Other examples of collapse in North America include the Cahokia and the Anasazi; in Central America, the Maya; in Africa, the Great Zimbabwe; in Asia, the Angkor Wat and the Harappan Indus Valley cities; in South America, the Tiwanaku and Moche societies, and in the Pacific Ocean, Easter Island.

Many societies can have a decline in one or more of their cultural systems, and a collapse is a sustained decline. However, it is sometimes arbitrary to distinguish between a decline and a collapse. Some authors argue against the term *demographic collapse* used as a euphemism for *genocide*. Sometimes, as in the case of Haiti in the 16th century, historians can't agree on the degree of death that resulted from disease and the amount of death that resulted from war, slavery, and forced labor in mines. Some historians say the massive loss of Haitian population was due to natural causes and diseases, and others say the population was intentionally starved and worked to death and thus it was genocide. There are frequently multiple causes in a case of civilization collapse, and it is sometimes difficult to detect primary from secondary.

Authors such as Joseph Tainter maintain that while disease, crop failures, invasions, and environmental degradation may be apparent causes of collapse, the ultimate cause is "diminishing returns on investments in social complexity" and the subsequent abandonment of or failure of the civilization. Jared Diamond follows this multivariable model of describing collapse and accents the environmental variables as being most important. He defines collapse as "a drastic decrease in human population size and/or political/economic/social complexity, over a considerable area, for an extended time."

He maintains that the factors leading to, or more usually, combining to create collapse are usually rising hostile relations with neighboring civilizations, decay of friendly allies and trading partners, climate change, and environmental damage. When cultural systems break down, starvation, war, and disease commonly occur. Collapse frequently occurs slowly, and historians and anthropologists wonder why members of various civilizations seem unable to change the direction of a culture in order to survive. Sometimes, however, collapse happens suddenly and with little warning. The Soviet Union in the 20th century is a good example of sudden collapse.

Beyond plagues and invasions, paleontologists, historians, climatologists, and anthropologists believe environmental problems frequently lead to collapse. Accidental ecological suicide, or *ecocide*, appears to have led several civilizations to collapse. The categories of these environmental problems are often related to overfishing, overhunting, deforestation, soil problems, water depletion, human population growth, and the effects of invasive species. In modern times, besides all of these usual difficulties with the environment, humankind must deal with the large-scale effects of industrialization on the environment: human-caused climate change, nuclear and chemical waste, greenhouse gases, ozone depletion and energy shortages.

Researchers write that our globalized society is perhaps more vulnerable to collapse than civilizations in the past, because a collapse in part of the global system could lead to a collapse of civilization all over the planet. Understanding why civilizations of the past have collapsed promises insights about avoiding a collapse in the future.

SEE ALSO: Black Death; Deforestation; Disease; Easter Island; Epidemic; Global Warming; Globalization; Invasive Species; Overfishing; Ozone and Ozone Depletion; Population; Soil Erosion; Waste, Nuclear.

BIBLIOGRAPHY. Jared Diamond, *Collapse: How Societies Choose to Fall or Succeed* (Viking Adult, 2004); Malcolm Gladwell, *The Tipping Point: How Little Things Can Make a Big Difference* (Back Bay Books, 2002); William McNeill, *Plagues and Peoples,* rev. ed. (Anchor, 1998); William McNeill, *A World History,* 4th ed. (Oxford University Press, 1998); Joseph Tainter, *The Collapse of Complex Societies* (Cambridge University Press, 1990).

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Demographic Transition Model

DEMOGRAPHIC TRANSITION IS a useful, if flawed, framework for understanding how human populations respond over time to particular types of social and economic change. Within this framework, the scale of analysis is typically that of a single country (of any size), and the key elements of population change are birth and death rates, which determine the pace at which a population grows—that is, its rate of natural increase.

Demographic transition models are most often depicted graphically. Birth and death rates are plotted on the y-axis; both are measured as a number per 1,000 population per year. On the x-axis, a unit of time—whether years, decades, or centuries—proxies for a country's level of economic development, or modernization. Four stages are then identified from left to right that correspond to particular ways the population changes as the country modernizes.

TRANSITION MODEL PHASES

In Phase I, pre-industrial, pre-transition populations are characterized by high birth rates and high death rates. Births are high at this stage because the economy is largely agriculture-based, and children's labor is valued. Further, because state social security systems are weak, children represent old age security. Couples may also overshoot their ideal family size because they expect some children to die young. Death rates are high because clean water is scarce and medical care is rudimentary or inaccessible, and death from hunger, infectious and parasitic diseases, and epidemics is common, particularly among children. Because birth and death rates are high, populations in Phase I grow slowly, if at all. These conditions have characterized human populations for most of history.

Phase II is catalyzed by the development of an early industrial economy. Machines replace agricultural workers, and the rural labor force moves to cities in search of jobs. Improvements in technology and national infrastructure enhance food production, storage, and supply; hunger becomes uncommon. Health is also enhanced by basic improvements in clean water provision and hygiene, and by medical treatments (such as vaccines and antibiotics) that reduce the incidence of disease. Death rates therefore drop dramatically. Meanwhile, birth rates remain high. Although children's labor is less needed than before, society is relatively slow to change deeply ingrained notions about the benefits of large families. Because the death rate falls much more quickly than the birth rate, populations undergoing early industrialization typically experience a dramatic population boom (sometimes exceeding three percent per year).

In Phase III, a fertility transition begins. As a new generation grows up in the city and as technological and industrial economies develop and grow, former ideals regarding family size are dropped. More importantly, employment opportunities for women mean that there is an economic cost associated with staying at home to care for children. Educational opportunities also become more widespread; women who stay in school longer typically marry later and are better skilled at ensuring the survival of existing children, as well as availing themselves of contraceptive technologies. For all of these reasons, birth rates begin to decline noticeably in Phase III, and begin to approach the still-declining death rate. Because births continue to outnumber deaths, however, population growth continues, but at a much slower rate (usually well under two percent per year).

Birth and death rates finally align again in Phase IV. By this stage, the economy is no longer dominated by industrial jobs; there is widespread access to good medical care and education, and employment is characterized by service industry jobs. In short, the economy is deemed developed. Small nuclear families of about two children are the culturally celebrated norm. Highly developed medical and sanitation systems mean that fatal infections have all but disappeared, and life expectancies are at an all-time high. Life-threatening conditions are more likely to be heart disease, cancers, and diseases associated with affluence, such as diabetes. Because birth and death rates are low, post-industrial, modernized economies have very low, and even negative, rates of natural growth.

CRITICISMS OF THE MODELS

The basic tenets of the demographic transition model were originally proposed in the late 1920s as a means to model the early-to-modern demographic history of Europe. The model was then elaborated and popularized by demographer Frank Notestein in 1945. He showed how European populations had changed since the early 18th century in response to the Industrial Revolution in ways that were later repeated in North America and other industrialized nations. He also showed how post-war Japan and other populations might be expected to change with increasing economic development.

His model was quickly adopted by demographers as a predictive tool with which to anticipate—even recommend—how a country's population would, or should, change under particular types of social and economic transformation. Its popularity spread as it was found to fit the mid-20th century demographic trajectories of most countries, particularly in the less developed world. In many Latin American and southeast Asian nations, for example, peak growth rates were generally synchronized with massive rural-to-urban migration stimulated by industrialization policies during the 1950s and 1960s (as in Phase II); subsequent entrenchment of the urban labor force led to greater employment and educational opportunities for women, and a correspondingly sharp drop in birth rates was noticeable from the 1970s on (as in Phase III).

By the 1970s, the model was also firmly established as a guide for population policies. Countries whose populations appeared to be lagging behind were prescribed programs to accelerate them to the next stage—usually through family planning programs designed to reduce birth rates. At the same time, academic demographers began to hone the generic model to suit the unique cultural or political contexts of different populations. Post-classic versions of demographic transition therefore incorporated attention to the role of religion, cultural practices, and political–economic arrangements.

But while it was widely recognized that different factors might, in different places, influence the rate and pace of fertility and mortality transitions, for most of the 20th century few scholars or policymakers questioned that the standard sequence of demographic stages through which Europe once passed should hold for all countries. Only recently has this Eurocentric model been seriously challenged. Some point out that Europe's demographic history cannot be a template for countries whose economies have been severely impacted by European colonization. For example, Europe's population would not have changed as it did if millions of rural Europeans had not emigrated to North and South America, thus relieving considerable pressure to absorb this labor force at home. But the demographic transition model, which rests on the problematic assumption that a country's population dynamics can be examined in isolation, does not consider international migration processes.

Other research is also showing that the demographic transition's unilinear, step-wise pattern is not inevitable. In Kenya, for example, researchers have shown that severe economic crises in rural areas—or the absence of economic development—have in fact stimulated a fertility transition. In Sub-Saharan Africa generally, the HIV/AIDS epidemic is also accelerating mortality rates (average national life expectancies below 45 are common) and slowing population growth at a stage of economic development where death rates should be declining. The post-socialist societies of eastern Europe appear to be Stage IV because of their extremely low birth rates, but in fact their economies still incorporate large agrarian elements, and death rates are rising due to economic deprivation and alcoholism.

SEE ALSO: Birth Rate, Death Rate; Demographic Collapse; Life Expectancy.

BIBLIOGRAPHY. Frank W. Notestein, "Population: the Long View," in T.W. Schultz, *Food for the World* (University of Chicago Press, 1954); G.L. Peters and R.P. Larkin, *Population Geography* (Kendall/Hunt, 2002); Population Reference Bureau, www.prb.org (cited October 2006); G.J. Stolnitz, "The Demographic Transition: from High to Low Birth and Death Rates," in G.J. Demko, H.M. Rose, and G.A. Schnell, *Population Geography: A Reader* (McGraw Hill, 1970).

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Dendrochronology

DENDROCHRONOLOGY IS A method of dating through the analysis of tree rings. While it has broad applications for geologists, historical environmentalists, and dendroecologists, dendrochronology has proven especially helpful to archaeologists. Prior to the 1930s, archaeologists could assign only relative dates to their material, using, for example, artifact typologies, an object's position relative to artifacts in other stratigraphy, or the artistic tradition with which the object was ornamented. Relative chronologies, however, are especially problematic for pre-historic sites, which often lack any written corroboration not only of the site in question, but also of the civilization.

Dendrochronology emerged from the American Andrew Ellicott Douglass's master chronology of yellow pine in the 1920s for the dating of prehistoric Indian cultures (such as the Anasazi) in the southwestern United States. Other scientific dating methods (archaeometry) soon followed. Thermoluminescence dating, for example, can be used for nonorganic material (stone and pottery), but it is still in its developmental stage, and radiocarbon dating (C-14), which has a functional dating range to 50,000 B.C.E., only has an accuracy of more or less 200 years. Dendrochronology, therefore, is the only archaeometric process through which it is possible in both theory and practice to date to within a range of one year. One drawback, however, is that dendrochronology can date objects no older than the oldest samples of its regional tree-ring scale. Even with the oldest tree-ring scale in the world (south Germany), therefore, it is only possible to provide dates no older than 10,000 years B.C.E.

Dendrochronology is based on the practice of ring-width pattern matching. Each year, most trees grow a new layer, or ring, of wood. The thickness of the ring (ring-width variability) depends on external environmental factors, including temperature, aridity, and soil types. Trees in temperate zones generally display more ring-width variability than trees growing in semiarid regions. In constructing tree-ring scales, dendrochronologists choose trees indigenous to their region of study because they must compare the patterns of living trees with ancient samples. Core samples are collected from old living trees and compared with ring-growth patterns among several tree cross-sections. Missing years can be supplemented with wood from old buildings (such as medieval churches) or ancient charcoal and preserved wood. By overlapping the cross-sections of a large number of samples, dendrochronologists will arrive at a scale with which scholars can date archaeological contexts with preserved wood.

In addition to the American southwest, master chronologies have been developed for the American Midwest and eastern coastal regions, much of Europe, the Aegean, and the Near East. Chronologies are emerging as well for China and parts of South America. Dendrochronology's contributions to early history are many, including uncovering a climatic regression c.540 C.E. that affected the entire northern hemisphere. Archaeologists excavating waterlogged medieval cities (London, Dublin, Bergen, Stockholm, and Novgorod) in northern Europe use the preserved wooden foundations of buildings to reconstruct precise tree-ring chronologies spanning hundreds of years. And dendrochronologists have dated many of the thousands of painted oak wood panels that artists north of the Alps, especially in the Netherlands, favored during the Renaissance. In addition to the dates, the provenance of many of the panels signed by such artists as Rubens and Rembrandt has been traced to Gdansk (Danzig), Poland, thus shedding significant light on the commercial underpinnings of the Renaissance. The science of measuring tree time, therefore, continues to demonstrate applications extending far beyond the absolute dating of pre-historic sites.

SEE ALSO: Deciduous Forest; Forests; Time.

BIBLIOGRAPHY. M.G.L. Baillie, *Tree-Ring Dating and Archaeology* (Croom Helm, 1982); M.G.L. Baillie, *A Slice Through Time: Dendrochronology and Precision Dating* (B.T. Batsford, 1995); Stephen Edward Nash, *Time, Trees, and Prehistory: Tree-Ring Dating and the Development of North American Archaeology 1914–1950* (The University of Utah Press, 1999).

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Denmark

DENMARK OCCUPIES 16,602 square miles (43,000 square kilometers) and is a flat, highly industrialized country, surrounded by 4,500 miles (7,245 kilometers) of coastline. As of 2003, 61 percent of the Danish land area was cultivated, 19 percent was covered by roads and buildings, 11 percent were forests, and 9 percent was registered as nature.

Some government acts regulating wastewater pollution in Danish cities can be traced back to the 19th century. Furthermore, a comprehensive act on nature conservation was enacted in 1917. It was not until the 1960s and 1970s, however, that the environment became the subject of intense public

Danish energy production is increasing, but importance of oil has been decreasing, from 50 percent to 40 percent.

and political interest, and environmental problems became the object of more coherent public regulation. A Ministry of the Environment was established in 1971 and a comprehensive act on environmental protection was passed in 1973. The act regulated industrial pollution, but the agricultural sector succeeded in avoiding strict regulation.

During the 1980s, interest in environmental matters peaked on the electorate's agenda, and the most important environmental interest organization, the Danish Society for Nature Conservation, achieved an impressive number of members (245,000), representing one in 20 Danes. Several acts regarding environmental matters were passed during these years. One of the most important was the first Plan for the Aquatic Environment (1987), which, in particular, regulated pollution from the agricultural sector. The plan was enacted after Denmark experienced several incidents of severe eutrophication. The target was to reduce total discharge of nitrogen by 50 percent and total discharge of phosphorous by 80 percent. The phosphorous goal was fulfilled in the mid-1990s, the nitrogen goal in 2003. In general, the environmental conditions in watercourses, lakes, and fjords have improved. However, this is still not considered to be enough by the authorities, whose aim is to reduce the pollution further.

The 1980s and 1990s saw the development of new instruments—economic instruments and voluntary agreements. Denmark was among the world's pioneers, when introducing a green tax reform (1993), shifting the tax burden from labor toward natural resources. For instance, Danes now pay carbon dioxide taxes, waste taxes, and a plastic bag tax. Furthermore, these decades saw the development of a new active nature restoration policy.

Internationally, Denmark is under a range of obligations according to European Union (EU) directives and United Nations treaties and conventions.

Today, industry and services are the most important sectors for the Danish economy, while the agricultural, transportation, and energy sectors exercise the largest negative influence on nature and the environment. However, industry still represents a source of environmental problems, for instance, by emitting heavy metals into the air and by using a range of chemical substances that are damaging to human health and the natural environment.

In the agricultural sector, consumption of pesticides has fallen. Overall, consumption of these has decreased by 58 percent since the beginning of the 1980s. However, the sector's emission of ammonia continues to create local problems for sensitive natural areas as well as odor problems for neighbors—especially where emissions stem from large pig farms. Denmark is the world's largest exporter of pigs.

Danish energy production is increasing, but the relative importance of oil has been decreasing, from 50 percent (1985) to 40 percent (2004). On the other hand, natural gas and renewable energy (e.g., from waste and windmills) have increased their share. Sulfur emissions have fallen by 98 percent, and emission of nitrogen oxides by 50 percent, but emission of greenhouse gases in the energy sector has increased. Transportation is growing, but emissions of nitrogen oxides and hydrogen carbons have fallen. On the other hand, traffic is still one of the main sources of noise pollution, and the emission of particles has started rising again in the 21st century due to private diesel cars becoming more popular. The emission of fine particles is having a considerable impact on human health. Furthermore, the emission of greenhouse gases has also increased in the transportation sector.

In general, Denmark has one of the world's highest levels of emissions of greenhouse gases per inhabitant. In the EU's strategy to implement the targets of the Kyoto Protocol, Denmark has committed itself to reducing greenhouse gases by 21 percent in the period from 1990 to 2008–12. Despite the carbon dioxide–reducing policy instruments implemented, Danish emissions were 10 percent above the 1990 level in 2003. Some of the predicted effects of a warmer climate are changes in Danish biodiversity and agricultural crops. Furthermore, a need for better protection of the coastline is likely.

Denmark is well known for effective environmental regulation and the development of cleaner technology. On the other hand, the very high level of consumption in Denmark is having a negative environmental impact. Denmark's National Board of Health has suggested that around 10 percent of all cases of cancer in Denmark are due to negative environmental effects. Denmark's newest strategy for sustainable development (2002) is to decouple economic growth and environmental impact, so the relationship between economic growth and environmental damage can be weakened.

SEE ALSO: Carbon Dioxide; Carcinogens; Greenhouse Gases; Industry; Pesticides; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Hanne Bach et al., *State of the Environment in Denmark 2005—Illustrated Summary* (Ministry of the Environment and the National Environmental Research Institute, 2006); Peter Munk Christiansen, ed., *Governing the Environment: Politics, Policy, and Organization in the Nordic Countries* (Nordic Council of Ministers, 1996).

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The Copenhagen Fire, 1728

The fire in Copenhagen in October 1728 was the largest ever in Denmark's capital, destroying about 28 percent of the city (including just under half of the medieval city), and leaving a fifth of the population homeless.

The cause of the fire, which started in the evening of Wednesday, October 20, 1728, was carelessness by the family of a restaurant manager Peder Rasmussen.

Night watchmen sounded the alarm, but the streets around Rasmussen's house were too narrow for the fire equipment. With a strong wind, the fire spread to nearby buildings with many people working in relays using buckets of water to try to douse the flames. Later that evening, another fire started at a brewery. This caused a diversion of manpower, causing both to consume many houses.

Early on the following morning, the artillery were using cannons to demolish already-burning buildings to create "fire breaks" to try to stop the flames spreading. At about 9 a.m. the bishop Christen Worm, fled his burning residence, only able to save three prayer books. It was not long before the City Hall was destroyed. During the late morning, embers from the other fires ignited new conflagrations, and that evening the Trinitatis Kirke ("Church of the Trinity") was burned down, resulting in the destruction of the University library that was stored there. Some 35,000 books perished, along with the archive of the Zealand Diocese which had been transferred to the library on the previous day.

On Friday with the wind shifting, firefighters made some progress, and on Saturday when the winds died down, the fire was eventually stopped. The Danish king, Christian VI, introduced October 23 as a public holiday but this was abolished in 1770. New fire regulations ensured that the city had wider main streets, and initially that only brick houses could be built along them. However this latter regulation was lifted three years later.

Deoxyribonucleic Acid (DNA)

DEOXYRIBONUCLEIC ACID (DNA) is the complex organic molecular structure that is responsible for encoding information that passes on genetically inherited traits in living creatures. DNA is part of all eukaryotic and prokaryotic cells, in addition to a number of viruses. Although the presence of DNA had been detected in the middle of the 19th century, it was not until 1953 that the Nobel Prize-winning scientists Francis Crick and James Watson determined the characteristic double helix spiral of DNA. DNA strands consist of a chain of nucleotides, which are composed of a sugar molecule (deoxyribose) attached to which are nitrogenous bases known as pyrimidines and purines, as well as a phosphate attachment. The strands are bound to each other covalently and according to a complex, but systematic set of rules. This makes for a stable arrangement in which the DNA can replicate itself by dividing the strands. Portions of each strand contain information known as genes, and these are passed on to the daughters of DNA division as a form of inheritance. The divided DNA consists of one original strand, and one newly created strand, which provides for some variation and evolution within a stable framework that reduces the possibility of entropy.

DNA double strands are combined in proteins within cells intensively, and these form chromosomes of a nature determined by the type of cell. Chromosomes reside within the nuclei of eukaryotic cells and within the cytoplasm of prokaryotic cells, which do not have a nucleus confined within a membrane. DNA also resides in other parts of eukaryotic cells and may also be part of plasmids, which are self-replicating bundles of genetic material found in organisms such as bacteria. The DNA within viruses differs in that it can take either single or double-stranded forms or else may be based on ribonucleic acid (RNA). Since DNA necessarily varies between individuals through carrying genetic material from parents, it is possible to identify unique configurations in people (and animals) and create a database of DNA fingerprints. This would be of considerable assistance in forensics, although it opens up a number of civil liberties issues. Similar technology is also being used to identify people who may be at risk of genetically transmitted diseases and medical conditions.

The number of genes within the DNA chains ranges from 20,000–25,000. Identifying all of these, together with the billions of combinations of chemical base pairs that help to construct them, has been the task of the human genome project that was completed in 2003 and represented a triumph of international scientific research collaboration and organization. Even so, progress toward solving technical issues has outstripped public awareness of and ability to understand the relevance of the work.

There has been considerable research and development aimed at identifying and exploiting the commercial possibilities of DNA and its related technologies. Hundreds of possibilities have been identified, although the complex laboratory techniques and testing processes have ensured that few profitable projects have yet been placed on the market. However, the potential for products that may assist in oncology, for example, provides an enticing prospect that has led to the ongoing availability of investment in science.

There remain a number of ethical issues in terms of manipulating and altering DNA sequences. For a variety of reasons, including religious and political reasons, some people believe that such manipulation is problematic and should not be permitted. The issues are complex and yet to be fully tested in legal systems around the world or in societal discourse. States that seek to inhibit such research will find leading pharmaceutical companies relocating to other regions where their activities are considered legally acceptable.

SEE ALSO: Chromosomes; Genetic Diversity; Genetic Patents; Genetically Modified Organisms (GMOs); Genetics and Genetic Engineering.

BIBLIOGRAPHY. Mark Belsey and Alex K. Pavlou, "The DNA/RNA Market to 2010," *Journal of Commercial Biotechnology* (v.11/3, 2005); Human Genome Project, www.ornl.gov (cited October 2006); James D. Watson and Andrew Berry, *DNA: The Secret of Life* (Knopf, 2004).

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THE UNITED STATES Department of Agriculture (USDA) is an executive department of the government of the United States. It has a multi-pronged mission to maintain an adequate supply of food in the country, promote agricultural research, promote the marketing of American farm products at home and abroad, and seek fair prices for farmers and consumers. The secretary of agriculture, the USDA's chief operating officer, is a member of the president's cabinet, and is appointed by the president and confirmed by the Senate. It has been common in the past for presidents to make appointments to the post of agriculture secretary as a reward for farm interests that supported the president's election; however, the president can ask for the secretary's resignation at any time. The deputy secretary of agriculture is the secretary's assistant. In addition, there are two undersecretaries, seven assistant secretaries, an inspector general, and a general council.

EIGHT MAJOR GROUPS

The UDSA is organized into eight major groups. The undersecretary for small community and rural development directs the Farmers' Home Administration, Federal Crop Insurance Corporation, and the Rural Electrification Administration. The undersecretary for international affairs and community programs directs the Agricultural Stabilization and Conservation Service and the Foreign Agricultural Service. The assistant secretary for marketing and inspection services directs the Agricultural Cooperative Service, Agricultural Marketing Service, Federal Grain Inspection Service, and other agencies. The assistant secretary for natural resources and environment directs the Forest Service and National Resources Conservation Service. The Forest Service manages the cutting of timber on federal lands. The National Resources Conservation Service was formerly known as the Soil Conservation Service. The assistant secretary for food and consumer services heads the Food and Nutrition Service and the Human Nutrition Information Service. The assistant secretary for administration directs the Office of Operations and other offices. The assistant secretary for economics supervises the National Agricultural Statistics Service and the Economic Research Service. The assistant secretary for science and education directs the Agricultural Research Service and other agencies. In addition, there is an assistant secretary for governmental and public affairs.

Because food is a permanent concern of the U.S. government, Congress and President Abraham Lincoln created an agricultural agency in 1862 with a commissioner at its chief operating officer. In the 1860s, about 60 percent of Americans were farmers. They were in constant need of good seed, information, and other help in order to maximize their productivity. In 1889, Congress elevated the original agency to department level with a secretary in charge. From its beginning, the USDA has worked with land-grant colleges, universities, and others with cooperative programs for agricultural research. It has an extension service covering rural areas, with resident farm agents who aid farmers with information. Educational programs for school children ensure there will be future farmers. Other programs aid college educational programs of students studying agriculture at the undergraduate and graduate level. The USDA serves farmers, ranchers, and the public through its programs in a variety of ways that go beyond just farming. As crop yields increased from the use of improved farming methods, the USDA expanded its activities to marketing the growing farm surplus at home and abroad.

The work of the USDA from its beginning has also promoted the adoption of new crops. The USDA encouraged soybean production early on, which has become a very important crop.

The sale of American rice, corn, wheat, soybeans, beef, and other products is promoted by the USDA's open markets program. It also seeks ways to encourage the consumption of all American foodstuffs to the world. The meat, poultry, and egg supplies consumed by Americans are delivered safely because of the USDA's vast inspection programs. It seeks to protect consumers from animal diseases that could affect humans such as foot and mouth disease, mad cow disease, or bird influenza. It also inspects grain supplies to prevent the sale and consumption of grains with diseases that could be harmful to human or animals.

The poor in America are aided by the USDA's participation in federal anti-hunger programs. These programs include Food Stamps, School Lunches, School Breakfasts, and WIC. USDA research also encourages proper nutrition, investing millions into nutrition research. It has developed and continues to modify its nutrition food pyramid. Because rural areas have often been impoverished, the UDSA has promoted rural housing, rural electrification, and supplies of safe drinking water. A number of programs focus on aiding the development of rural infrastructure. The Housing and Community Facilities Programs (HCFP) promote rural development. The Department also plays a very important role in the delivery of food aid to millions of people globally.

The USDA is also a steward of about 200 million acres of national forests and rangelands, providing the opportunity to encourage conservation and promote wildlife. The USDA is also America's largest conservation agency. It promotes environmental projects on vast areas of privately owned lands by encouraging the protection of soil, water supplies, and wildlife.

The research activities of the USDA extend to increase yields using less water and pesticides. It also encourages the development of new strains of seed that are resistant to emerging diseases. Other environmental protection activities of the USDA include dealing with the impact of animal waste, nutrients in water supplies that promote the growth of algae, pesticide runoff onto wetlands, and the development of wildlife habitat. The department's resource economists engage in a wide range of studies that seek answers to the best stewardship techniques for resource management. The laws administered by the USDA cover a wide range of subjects. These include environmental and conservation regulations; food production, safety, and distribution; foods marketing at home and abroad; and responses to natural disasters affecting crops or to terrorist threats to food supplies.

SEE ALSO: Agriculture; Farming Systems; Farmland Conservation.

BIBLIOGRAPHY. Mike Espy, *Reinventing the U.S. Department of Agriculture: 1994 Annual Report of the Secretary of Agriculture* (DIANE Publishing Company, 1998); Albert Gore, *Department of Agriculture: Accompanying Report of the National Performance Review* (United States Government Printing Office, 1993); National Research Council, *Investing in the National Research Initiative: An Update of the Competitive Grants Program in the U.S. Department of Agriculture* (National Academies Press, 1995); W.D. Rasmussen and Gladys L. Baker, *The Department of Agriculture* (Praeger, 1972); Maxine Rosaler, *Department of Agriculture* (Rosen Publishing Group, 2005).

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Department of Energy (U.S.)

THE U.S. DEPARTMENT of Energy (DOE) was created in 1977 under the administration of President Jimmy Carter, following the oil crises of the early 1970s, when the OPEC countries suddenly increased the cost of oil and caused economic difficulties around most parts of the world. However, the DOE traces its history back to at least the Manhattan Project. The DOE was designed to bring under one federal agency (the 12th cabinet level department) a variety of agencies and organizations that separately dealt with nonnuclear and nuclear sources of energy and their regulation.

In common with all governmental agencies, the actions of the DOE are subject to criticism from those who believe government should do less to regulate economic and social activities, and those who believe it should do more. Denial of climate change and the role of human actions in promoting it have intensified this criticism.

The DOE also considers very urgently the threat of terrorism and the possibility that energy institutions will be targeted for attack. As a consequence, the DOE's overarching mission is described as "… to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex."

The DOE has four strategic goals: the Defense Strategic Goal, to protect national security by applying advanced science and nuclear technology to the nation's defense; the Energy Strategic Goal, to protect national and economic security by promoting a diverse supply and delivery of reliable, affordable, and environmentally sound energy; the Science Strategic Goal, to protect national and economic security by providing world-class scientific research capacity and advancing scientific knowledge; the Environment Strategic Goal, to protect the environment by providing a responsible resolution to the environmental legacy of the Cold War and by providing for the permanent disposal of the Nation's high-level radioactive waste.

Consequently, the DOE is involved in sourcing and supplying energy for the nation, subject to the interests of individual states and their rights; dealing with environmental issues arising from the uses of energy; and the provision of and support for science and research and development activities aimed at such subjects as energy conservation, new forms of energy generation, and the recycling of obsolete materials and equipment.

Its success in managing these diverse goals may be seen in that its research and development has won more than any private sector organization and more than twice as many as the total of all other federal agencies. Nevertheless, since elected officials motivate many of its decisions, some of the DOE's policies are subject to criticism on ideological grounds. On February 1st, 2005, Samuel Wright Bodman was sworn in as the 11th secretary of the DOE; his responsibilities include managing a budget in excess of $23 billion and with more than 100,000 employees and contractors. The DOE's activities are likely to become increasingly complex as more data become available on the impact of energy use and, consequently, how it should be regulated, as well as the fraught intersection between international politics and the securing of stable energy sources globally.

SEE ALSO: Carter Administration; Energy Crisis (1973); Organization of Petroleum Exporting Countries (OPEC); Yucca Mountain.

BIBLIOGRAPHY. Edward J. Daniels, et al., "Sustainable End-of-Life Vehicle Recycling: R&D Collaboration between the Industry and the U.S. DOE," *JOM* (v.56/8, 2004); Phillip Margulies, *Department of Energy*, (Rosen Publishing Group, 2005); *Department of Energy, 1977-94, A Summary History* (DOE, 1994).

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Department of the Interior (U.S.)

IN 1789, THE U.S. Congress established three executive departments: Foreign Affairs (later called the State Department), the Treasury, and Department of War, and with them, created the positions of attorney general and postmaster general. Although these three departments were created to accommodate and maintain complicated interior and external affairs, they had to administer most domestic matters as well. The proposal for a department of internal affairs continued for a half-century, supported by many presidents, including Madison and Polk. The Mexican-American War of 1846–48 gave the proposal new support as the responsibilities of the federal government increased. President Polk's treasury secretary, Robert J. Walker, became one of the most vocal advocates for such a department. This idea of forming a separate department to handle domestic issues wasn't realized until March 3, 1849, when a bill was passed that created the Department of the Interior (DOI) to oversee the nation's internal management.

This new department had a wide range of responsibilities, including the management of all public parks, settlement of freed slaves in Haiti, management of hospitals and universities, overseeing all Washington, D.C., jails, and the administration of all patents and pensions. Natural resource management, land use and classification, wildlife conservation, Native American affairs, and territorial affairs remained within the scope of the DOI; however, many of the original domestic concerns for this new department were gradually transferred to other new departments such as the Bureau of Agriculture, which later became the Department of Agriculture. Additional agencies were created, such as the Home Department, which consolidated the General Land

Office into the Department of the Treasury, the Patent Office into the Department of State, the Indian Affairs Office into the War Department, and the military pension offices with the War and Navy Departments. Subsequently, DOI responsibilities expanded to include the census, regulation of territorial governments, exploration of the western wilderness, and management of the D.C. water and sewer system.

In its early days, the Bureau of Education was placed under the DOI, but later transferred to the Department of Health, Education, and Welfare. Since the 1870s, the DOI made important advances that would keep its work crucial to this day. Between 1887–89, the Interstate Commerce Commission (ICC) was established within the DOI, and the Dawes Act authorized property allotments to Native Americans.

Nearly 400 national parks, monuments, seashores, and battlefields are managed via DOI's National Park Service.

In addition, agencies within the DOI were established to oversee most federal lands and issues involving rock and water. Since the department began its geological survey of the American West in 1869, it would ultimately lead Congress to the creation of the U.S. Geological Survey in 1879. In 1910, the Bureau of Mines was established to oversee mine safety and disseminate rock, ore and mineral information, while ten years later, the Mineral Leasing Act would be created to impose mining land rental fees and royalties on oil, gas, rock, ore and mineral production in 1920. In 1977, the Office of Surface Mining Reclamation and Enforcement would be set up to oversee the regulation of federal and state strip coal mining and environmental damage mitigation. In 1982, the Minerals Management Service was established to assist in the collection of ore and mineral revenues and to oversee all offshore sites beyond the near continental shelf areas. Finally, in 1996, all "interior science and technology functions" were consolidated within the U.S. Geological Survey under the DOI.

The department also administers and enforces environmental protection policies for federal lands. Congress established Yellowstone as the first National Park in 1872, but it was President Woodrow Wilson who would sign the Act that created the National Park Service under the National Parks Organic Act in 1916. Currently, national parks and monuments cover more than 83 million acres across 49 States, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands. President Teddy Roosevelt established the first National Wildlife Refuge at Pelican Island, Florida, in 1903.

WILDLIFE, RANGELANDS, AND LIVESTOCK

The protection and management of wildlife, livestock, and rangelands would also become a department focus. From 1902–10, the Bureau of Reclamation was established within the DOI to oversee the construction and management of dams and water systems in the west with the construction of Hoover

Dam completed in 1935. Currently, the Bureau of Reclamation supplies water to about 20 percent of the West—or about nine million acres—with dam-based hydroelectric generation using 56 power plants on-line, generating 35,000 megawatt hours (MWh) of electricity in 1996. In fact, energy projects administered within the DOI on federal lands and offshore areas supply nearly 30 percent of our nation's energy production.

The Taylor Grazing Act would follow in 1934 to regulate the economic use of public lands with a special focus on farmland and range management, mostly due to the disaster of the Great Dust Bowl in the Midwest. During the Great Depression of the 1930s, numerous agencies within the department would utilize thousands of workers employed by the Civilian Conservation Corps (CCC) and Works Progress Administration (WPA) to build and/or improve the infrastructure of over 50 national parks and monuments, wildlife refuges, fish hatcheries, and protected areas.

In 1940, the U.S. Fish and Wildlife Service was created by uniting the Bureau of Fisheries and the Bureau of Biological Survey. The department's General Land Office and the Grazing Service were later merged into the newly organized Bureau of Land Management (BLM) in 1946.

The DOI increasingly implements protection policies for nonmainland lands and territories, but that are still under federal protection or administration. In 1873, all U.S. territories were transferred from the Department of State to the DOI, including Alaska, Hawaii, the Virgin Islands, and Puerto Rico (before their conversion to state status). In 1950, the department assumed jurisdiction over American Samoa, Guam, and the Trust Territories of the Pacific Islands; in 1980, the Alaska National Interest Lands Conservation Act was enacted, which added more than 47 million acres to the National Park System.

In 2006, the DOI managed more than 500 million acres (or 2 million square kilometers) of surface land, or about 20 percent of the United States. It manages nearly 500 dams and 350 reservoirs through the Bureau of Reclamation; nearly 400 national parks, monuments, seashore sites, and battlefields through the National Park Service; and more than 500 national wildlife refuges through the Fish and Wildlife Service.

Subordinate agencies include the National Park Service, Geological Survey, Bureau of Indian Affairs, Fish and Wildlife Service, Bureau of Land Management, Minerals Management Service, Office of Surface Mining, Bureau of Reclamation, and Office of Insular Affairs.

SEE ALSO: Bureau of Land Management; Bureau of Reclamation; Dust Bowl; Fish and Wildlife Service; Hoover Dam; Hydropower; National Parks Service; Roosevelt (Theodore) Administration; Taylor Grazing Act; U.S. Geological Survey.

BIBLIOGRAPHY. J. N. Clarke and D. C. McCool, *Staking Out the Terrain: Power and Performance Among Natural Resource Agencies* (Albany, State University of New York Press, 1996); Johnathan Fairbanks, *Becoming a Nation* (Rizzoli, 2003); U.S. Fish and Wildlife Service website, www.fws.gov (cited February 2007).

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Dependency Theory

DEPENDENCY THEORY IS a school of thought that emerged mainly in Latin America in the 1960s and 1970s to explain sustained patterns of poverty and low growth rates in Latin America, Asia, and Africa after World War II. Dependency theory inverted neoclassical development economics, which assumed that economic growth was eventually beneficial to all, even if the benefits were not equally shared. Neoclassical theorists argued that Latin America, Asia, and Africa were underdeveloped because they had not been sufficiently integrated into a global economy. On the contrary, dependency theorists argued that "developing" countries had been integrated into the world capitalist economy since the beginning of European capitalist expansion starting in the 16th century. Long-term poverty and low growth rates in "underdeveloped" regions were the result of the nature of the interactions between developed and underdeveloped countries, which were characterized by relations of dependency. Underdevelopment was therefore the outcome of a process, rather than being an initial condition from which various stages of "development" ensued.

While all dependency theorists share the view that unequal economic and political relations characterize the interactions between developed and underdeveloped regions, there are many differences between them. Dependency theory can be divided into liberal, neocolonial, and neo-Marxist trends. Raul Prebisch (b.1901), an Argentinean economist, exemplifies the liberal school. He argued that poor countries export primary commodities to the rich countries that manufacture the products that are resold to the poorer countries. This "value added" through manufacturing is captured by the developed countries. He advocated import substitution policies, including tariffs and quotas to protect domestic industry and solve these problems. These policies were followed by many developing countries until neoliberal economic philosophy became dominant in international financial institutions in the 1980s.

The neocolonial approach is identified with Andre Gunder Frank (1929–2005). A refugee from Nazi Germany as a boy, he spent much of his early teaching career in Brazil and Mexico. Gunder Frank's earliest work to deal with dependency was *Sociology of Development and Underdevelopment of Sociology* (1967). There, he not only critiqued most ideas associated with mainstream development theory, but also presented an influential theory of satellite-metropolis relations, which was one of exploitation, as surplus value in the form of profits was appropriated from the satellite regions by the metropolis. Satellite-metropolis relations also existed within developing countries. Urban financial centers functioned as metropoles for the agricultural hinterlands that provided the primary products that were sold by commercial elites to developing countries. His case studies on Brazil (1963), Chile (1964), and Mexico (1965) showed how the most seemingly isolated and impoverished regions of these countries, such as northeast Brazil, had been intricately linked to global capitalism since the 1600s.

Gunder Frank's theory of metropolis-satellite relations was partially criticized by Ernesto Laclau, who argued that the existence of market ties between metropolis and satellite did not mean that the satellites were capitalist. Rather, forms of unfree and servile labor that were characteristic of feudal relations often marked their relations. Hence, dependency theorists should also examine the nature of class relations in the countryside in order to understand the dynamics of underdevelopment. However, Immanuel Wallerstein (1974) ignored this distinction, developing a world systems approach that incorporated many of the ideas of the dependency school. He further added the concepts of core, periphery, and semi-peripheral regions, and differentiated between an economic system and a world empire. The core and periphery regions were similar to Gunder Frank's metropolis and satellite, while the semi-periphery had the function of buttressing the core ideologically and politically.

Dependency theory has a major influence on the field of political ecology, since it helps to show how unequal economic and political relations create poverty, which often produce ecological degradation as a result. So too, economic development programs built around notions of dependency, especially import substitution programs, have environmental impacts since they tend to employ subsidies for industry at the expense of the agricultural sector, with implications for farm product prices, soil exhaustion, and overuse of chemical inputs.

SEE ALSO: Capitalism; Developed ("First") World; Development; Underdeveloped ("Third") World.

BIBLIOGRAPHY. S. Amin, *Accumulation on a World Scale* (Monthly Review Press, 1974); Andre Gunder Frank, *Sociology of Development and Underdevelopment of Sociology* (Pluto 1971); I. Wallerstein, *The Modern World-System* (Academic Press, 1974).

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Deposit-Return Charges

DEPOSIT-RETURN CHARGES ARE fees paid by consumers, typically for containers of liquid or powdered substances. Companies hope to encourage consumers to recycle the containers by repaying the deposit-charge when they are returned to the retailer, who is asked to administer the system of fees on behalf of the manufacturer. The system is particularly useful when the containers are of comparatively high value compared to the contents, as is the case with many carbonated soft drinks in the developing world, when consumers frequently prefer to take away the product in plastic bags for a slightly lower cost and leave the deposit-bearing item in the hands of the retailer, who is thereby able to achieve a modest profit. The system is also important when the containers are environmentally hazardous, and represent a good use of resources if recycling is encouraged, instead of paying the higher costs associated with cleaning the resulting hazard.

In many developed states, the financial incentive is reinforced by information and persuasion, and in some cases, people respond better to such an approach. However, willingness to participate in recycling schemes can decline over time, which can have important implications for industries that rely on recycling for their raw material inputs. Millions of people scavenge for a meager income from rubbish dumps in poorer countries, or scour urban residential and industrial areas for salvageable items. That so many people are able to extract a living this way, no matter how meager, indicates the extent to which so much recyclable waste is needlessly thrown away or consigned to dumps that may then lead to further environmental problems.

The United Nations estimates that some 2,000 million tons per year of waste are generated in Europe alone, which includes 40 million tons per year of hazardous waste. A significant amount of this waste can be eliminated through such measures as encouraging retailers not to distribute free plastic carrier bags, and through greater use of financial incentives to eliminate needless waste. Nevertheless, when the containers are of some economic value, perhaps more than returning them can provide, there is an incentive for retailers to divert them to other purposes. It is estimated, for example, that between 750,000 and 1 million steel beer kegs go missing annually in the United Kingdom at a cost of more than 22 million, because of global demand for steel. Consequently, industry suppliers may levy substantial deposit charges on the items in the future. This is opposed by those retailers who consider themselves innocent of losing or selling the kegs, and resent having to tie up their money in this way. When the waste products involved are hazardous and of little value to the manufacturers, as in the case of mobile (cell) telephone batteries, then government regulation is necessary to ensure that appropriate recycling takes place.

SEE ALSO: Garbage; Recycling; Waste, Solid.

BIBLIOGRAPHY. Subodh K. Das and Margaret Hughes, “Improving Aluminum Can Recycling Rates: A Six Sigma Study in Kentucky,” *JOM* (v.58/8, 2006); Earth911, www.earth911.org (cited October 2006); Tony Halstead, “Pubs Face Keg Deposit Charges,” *Morning Advertiser* (September 21, 2006); United Nations Environment Program, www.unep.fr (cited October 2006).

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Deregulation

DEREGULATION IS THE work that governments do to remove regulations that restrict business, individuals, or other institutions. The regulatory restrictions may be related to economic development, changes in environmental protections, changes in the political philosophy that organizes a nation, or for a number of other reasons. Removing regulations can come for a number of reasons, including changing political philosophies, changing technologies or demographics, or the successes of regulatory policies that render them obsolete.

Until the New Deal’s regulatory legislative program that began in 1932, the United States had historically followed an economic policy of *laissez faire* taken in part from the writings of Adam Smith, author of *The Wealth of Nations* (1776). The goal was to allow free enterprise the maximum amount of room for creating businesses, exploiting the nation’s natural resources, and for providing goods and services to the county. Economically, the country prospered under a policy of *laissez faire,* except that on an almost regular basis, overexpansion of farmland or of other business activities led to economic panics or depressions during the 1800s, and finally in 1929 with the Great Depression.

With the election of Franklin D. Roosevelt in 1932 as President, a major program of regulatory legislation was instituted under the name *New Deal*. This program was really a development of regulatory activities that had begun in the 1800s under the influence of the Progressive Movement, which was opposed to the Robber Barons, as the most successful and aggressive businessmen of the day were known. Antitrust legislation was used to curb the control of John D. Rockefeller's Standard Oil Trust. Soon, legislation was adopted to help the growing conservation movement being encouraged by President Theodore Roosevelt.

However, it was the entry of the United States into World War I that for practical purposes changed the economy from *laissez faire* into a command economy. The end of the war and a "return to normalcy" meant dismantling the regulations used to direct the economy during the war. However, many of the entry and midlevel government bureaucrats in the federal government under Wilson were to become the leaders of the New Deal, including Franklin Roosevelt, who had been Assistant Secretary of the Navy.

During Roosevelt's first term (1933–37), the United States Supreme Court declared many of the laws of the New Deal, such as the National Recovery Act (NRA), unconstitutional. The Four Horsemen—Justices George Sutherland, James Clark McReynolds, Pierce Butler, and Willis Van Devanter—were conservatives who sternly opposed the New Deal legislation. Influenced by Social Darwinism and the Gospel of Wealth, they along with defeated President Herbert Hoover favored a policy of not intervening in the economy, which was supported by Roosevelt. By 1937, the Court began upholding the policies of the Roosevelt administration. The result was that not only was the economy regulated, but so were many new areas of life. The policies of President Lyndon Johnson and others supporting the Environmental Movement after the 1970s promoted a regulatory state.

Regulatory policies aim to protect, promote, or provide, through some form of redistribution, goods and services to the people and even to the environment. Policies, once adopted, do not always last forever. Because of developing technologies, improvements in scientific understanding, changes in lifestyle or any number of reasons, policies may need to be changed or in some cases repealed.

An important deregulation in American history is found in the repeal of the Eighteenth Amendment to the United States Constitution, which sought to impose a public policy to end alcoholism and drunkenness. However, the policy failed to do either and instead fostered criminal empires and lawlessness because of the significant number of people who opposed the policy. The Twenty-First Amendment repealed the policy of federal regulation of all manufacturing and sales of alcoholic beverages and returned regulations to the state. The repeal was a major act of deregulation.

SUCCESSES AND FAILURES

Deregulation may be an indication that a policy has been successful. The prohibition policy was a general failure, but the conservation laws adopted in the 1960s and 1970s have had some notable successes. Among the animals listed in regulations used to administer the act was the American alligator. When the hunting of alligators ceased for a decade or more, their numbers swelled to a level that led to their removal from the endangered species list. However, as their numbers increased to the point that dogs, children, livestock, and sometimes even adults were killed, wounded, or maimed, deregulations were necessary to encourage the hunting of wild alligators. Today there are estimated to be at least one million alligators in the wilds in Florida alone. There are more in other states from Texas to Virginia.

With the return of the alligator in the wild and successful alligator farms, alligator skins are again being used in belts, books, and bags and other products such as alligator meat. Today, alligator farms are an important conservation resource that provides jobs and income to a growing number of people in Florida and other states. The same story of successful recovery can be told about deer herds in the United States as well as other species brought back from the brink of extinction.

In other situations, deregulation has been unsuccessful. In the 1970s, Savings and Loans were financial institutions that had developed into savings banks. They offered similar but different services

Russia's electricity sector and other industries were deregulated after the collapse of communism in 1989.

from traditional banks. Both the banking industry and the savings and loan industry were heavily regulated in response to the many bank and savings institutions failures that had occurred during the Great Depression. However, with inflation and a growing need for amassing huge amounts of capital for big projects, voices were raised to deregulate the savings and loan industry.

For a while, it seemed that deregulation was going to be an enormous success. However, these federally insured institutions, in their rush to make loans, used lending practices that led to very financially insecure loans. Lending competition pressured lending officers into ever less well-secured loans. The appropriate capital resources needed for collateral were weak if not imaginary. By the 1980s, the savings and loan industry collapsed. In response, Congress reregulated the industry.

MODERN DEREGULATION PHILOSOPHY

The philosophy behind much of modern deregulation was developed as an economic philosophy applicable to public policy. Milton Friedman, Alfred E. Kahn, and other economists at the University of Chicago developed the theories of Ludwig von Mises, Friedrich von Havek, and other economists. Among their ideas was the view that government had, in the New Deal and the Cold War, overregulated the economy and society. They taught that businesses were so inhibited by restrictions that markets were rendered inefficient. They also sought to remove the restrictions that hindered competition and that thereby reduced productivity. A major expectation that was offered for adopting deregulation policies was the claim that prices for goods would decrease significantly.

President Jimmy Carter made deregulation an important party of his legislative agenda, seeking the advice of Alfred Khan. Congress passed for Carter's signature three major pieces of legislation deregulating the transportation and shipping industries in the United States. The Hart-Scott-Rodino Antitrust Improvements Act, the Emergency Natural Gas Act, The Airline Deregulation Act, the Staggers Rail Act and the Motor Carrier Act of 1980, and The Depository Institutions and Monetary Control Act were adopted in the last two years of Carter's administration. They have had an enormous impact on the economy since.

Deregulation continued in the administration of President Ronald Reagan. Adopted were the Garn-St. Germain Depository Institutions Act (1982), the Bus Regulatory Reform Act (1982), the Natural Gas Wellhead Decontrol Act (1989), and the National Energy Policy Act of 1992.

Of enormous importance for deregulation during the presidency of Reagan was the breakup of the American Telephone & Telegraph Company (AT&T) by federal court order. The company was split into AT&T and seven "baby bells." The breakup initiated an era of telecommunications growth, as MCI and other companies gained competitive ground. However, new technologies such as cellular phones and fiber optics, along with cable companies competing in the phone business, led to a range of regulations and deregulations that have had a variety of effects.

During Bill Clinton's presidency, more regulatory reforms were adopted. Besides efforts at reducing the size of the federal government, legislation was adopted to deregulate the telecommunications and other industries. The Telecommunications Act of 1996 and the Gramm-Leach-Bliley Act of 1996 had major effects on the future of the United States and the world. The Telecommunication Act provided for enormous competition between the telecommunications manufacturers and communications companies.

However, by the second term of President George W. Bush, a number of actions to deregulate had met with mixed results. An electricity crisis in California, the collapse of energy trading companies such as Enron, and the communications giant MCI all exposed a number of fraudulent practices that required closer scrutiny of the respective industries if investors and the public were not to be cheated by the corrupt few. Other markets deregulated in the United States by 2006 included the media market and the natural gas industry.

Deregulation is not the same as liberalization. Deregulation seeks fewer regulations in order to promote competition, productivity, and market efficiencies. Liberalization allows more competitors into a market. However, it may not necessarily result in fewer regulations. It may be that the market with more competitors is increasingly regulated to protect consumers. It may also be that liberalization leads to the rise of oligopolies or monopolies.

The arguments made by Friedman and others in favor of deregulation were supported by observation of political scientists that the agencies that regulated industries were often subject to "regulatory capture." Theoretically, regulatory bodies are independent and free to regulate according to their mission. However, no matter how independent a regulatory body is when it begins, it is subject to annual budget renewals.

As Congress works on budgets each year, it has members who are more attuned to the interests of industries in their districts than they are to conservation or environmental interests. Eventually, members may be appointed by administrations that are also more sympathetic to industry than to the environment. The regulatory body may be staffed with dedicated people, but unless the agency is constantly in the news as a saving champion of the environment, the agency will be faced with the possibility of budget cuts, appointments of leadership who are opposed to rigorous enforcement of environmental policies, or to the possibility that the agency may be completely eliminated in the budget process. In the end, the politics of the budgetary process and the appointing process facilitate the "capture" of the agency by opponents of rigorous enforcement. Deregulation has promoted at times regulatory capture.

DEREGULATION IN OTHER COUNTRIES

Following the success of some of America's deregulation activities, a number of countries have also attempted deregulation. Some of the deregulation projects have been success and some have been disappointing. In Latin America in 1973, Chile experienced a *coup d'etat,* when the late General Augusto Pinochet overthrew the government of President Salvadore Allende. After the coup, reforms were instituted. These were essential actions to deregulate the economy following the Socialist regulations instituted by the Allende government. In recent years, another Socialist government has been elected; however, it has yet to try to undo the successful economic revolution that deregulation instituted in Chile. To re-regulate the Chilean economy would very likely cause economic collapse and starvation.

Also in Latin America, Argentina was deregulated by the Menem administration during the period between 1989–99. The success of these reforms has been debated. There is no doubt that eventually, massive deindustrialization occurred along with unemployment and severe financial difficulties. Eventually, the United States and some European countries offered aid to Argentina and Brazil.

Other counties that have engaged in deregulations have included Japan and Australia. Japan's economy since its collapse early in the 1990s has been in a period of slow or negative growth. Its tradition of cartels and its huge interaction between government and private industry have made deregulation necessary, but due to Japanese nationalistic ideas, it has been resisted.

In Australia, deregulation has brought mixed results as it also has in New Zealand and in other countries. In southeast Asia, the countries that have gained the most from deregulation have been China and India. Both of these economic giants have experience enormous growth gains after they moved from a Socialist- or Communist-regulated economy to economies that encourage entrepreneurship while lightening the hand of regulation.

For economists, the gains in China and India have been wonderful. However, for environmentalists, the gains have been expensive because of the absence of concern for the environment. Pollution, destruction of habitat, destruction of watersheds and farmlands through dam building projects, and, in the case of India and even quietly in China, significant population growth despite efforts to restrain family sizes to only one or two children.

In Russia and the former Soviet Union, the economic picture has been less favorable than it has been in India and China. The economy of Russia has been weak, primarily due to its legislative failures. In the old Soviet Union, all economic activity was directed by the state and the Communist Party. However, the ecological facts of life in the old Soviet Union were such that the zeal for industrialization and the quest for economic development suppressed concerns for environmental protection.

The case of Chernobyl's nuclear power plant's disastrous meltdown and the resulting pollutions of a vast area were more than matched by destruction of habitats, pollution of the environment, and the ruinous exploitation of many areas under communism. The goal was industrialization and not ecological integrity. The end of Communism has not led to a prosperous period of deregulation. Rather, the absence of organized regulations as well as settled business laws has created uncertainty that stymies development and ecological protection.

One industry to be deregulated in Russia since the collapse of Communism in 1989 was the energy industry. Its electricity sector and other industries were deregulated along with the natural gas sector.

In Great Britain, deregulations have come and gone as the Labor and Conservative governments have waxed and waned. Efforts at deregulation have sought to establish a system that works for the country's economic benefit rather than to placate its political ideologues. Deregulation of environmental laws usually means a return to the destruction of the environment. Human nature is such that the desire for gain usually wins over the zeal to protect the planet.

SEE ALSO: Bush, George W. Administration; Carter, Jimmy Administration; Chernobyl Accident; Clinton, William Administration; Command and Control Legislation; Communism; Conservation; Drilling, Oil and Gas; Johnson, Lyndon Administration; Movements, Environmental; Progressive Party; Reagan, Ronald Administration; Social Darwinism; Socialism.

BIBLIOGRAPHY. Ute Collier, ed., *Deregulation in the European Union* (Taylor & Francis, 1997); Jeffrey A. Eisenach, ed., *Communications Deregulation and FCC Reform: Finishing the Job* (Springer-Verlay, 2001); James M. Griffin and Steven L. Puller, eds., *Electricity Deregulation: Choices and Challenges* (University of Chicago Press, 2005); Peter Z. Grossman and D. H. Cole, *The End of Monopoly: Deregulation and Competition in the Electric Power Industry* (Taylor & Francis, 2003); Paul W. MacAvov, *Natural Gas Market: Sixty Years of Regulation and Deregulation* (Yale University Press, 2001); Sam Peltzman and Clifford Winston, eds., *Deregulation of Network Industries: What's Next?* (Brookings Institution Press, 2000); Dipendra K. Sinha. *Deregulation and Liberalisation of the Airline Industry* (Ashgate Publishing, 2000); Richard H. K. Vietor, *Contrived Competition: Regulation and Deregulation in America* (Harvard University Press, 1994).

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Desert

DESERTS COVER ABOUT 35 percent of the earth's surface and are mainly located between the latitudes of 5–35 degrees north of the equator. They are regions characterized by high aridity, little vegetation cover and large surfaces of bare soil, and highly adaptable plants and animals that can survive long droughts. According to bioecological definitions, the world's deserts represent all ecoregions of the world that harbor desert vegetation, identified by xerophilous life forms and the general desert-adapted physiognomy of the dominant plants.

Among these, aridity is the most prominent indicator, commonly measured by the Aridity Index, an estimator for the ratio between mean annual precipitation and mean annual potential evapotranspiration, which is less than 1.57 inches (–40 millimeters) for arid deserts and –.79 inches (–20 millimeters) for semideserts. Aridity is highest in the Saharan and Chilean-Peruvian deserts, followed by the Arabian, East African, Gobi, Australian, and South African deserts, and lower in the Thar and North American deserts. Desert climate can be hot or cold. Among the hot deserts, there are two that have two rainy seasons—Somora and Karoo. Three have one rainy season: Northern Sahara, Mohave, Middle-Asian. Deserts with summer rains include southern Sahara, inner Namib, and Atacama. Central Australia is a desert characterized with few rains during any season. Coastal deserts that have fog but no rain include the North Chilean Coastal desert and outer Namib. Finally, deserts without any rain or vegetation include the Central Sahara.

PRECIPITATION

Desert climate is characterized by precipitation of less than 9.84 inches (250 millimeters) with high variability, high diurnal variations of temperature, and strong solar radiation. The high aridity as well as typical pulse-type variations in desert environments are caused by global atmospheric and oceanic phenomena, such as the position of the jet streams, the movement of polar-front boundaries, the intensity of the summer monsoon, El Niño southern Oscillation events, and even longer-term ocean cycles, such as the Pacific Decadal Oscillation. Driven by these large-scale forces, the intensity of midlatitude continentality, ocean upwellings, and rain shadows—the major factors modulating the distribution of arid lands—the intensity and frequency of rain pulses on a local scale may vary substantially with time, and in a seemingly unpredictable fashion. This structures desert ecosystems in a way that requires a physical and behavioral adaptation to the patch dynamics of primary production, water, and nutrient cycling in scales of space and time. During pulses of bounty, the fragile seedlings of desert plants can germinate, establish, and prepare for long droughts by burying their roots deep in the desert soils. To a large extent, it is the heterogeneity of pulses that drives the high biodiversity of desert ecosystems.

Among the hot deserts, the Mohave is one of only three deserts that have a rainy season.

Typical desert soils are aridisols, characterized by little weathering of the maternal rocks and low organic matter in the surface layer, formed under the typical influences of desert conditions by strong winds, scattered but torrential rains, and high temperatures. The materials in these soils are often cemented together, forming water-impervious hardpans, sometimes containing salts or gypsum. The low soil cover exposes deserts to much more wind and water erosion than any other environment as a result of steep slopes.

Humans living in deserts undergo considerable dehydration, and therefore have learned to cope with the dry environment for their survival with a panoply of behavioral, cultural and technological adaptations. Traditionally, desert livelihoods were made of three types—hunter-gatherers, pastoralists, and farmers. To adapt to the patchiness of the desert ecosystems, for instance, the movements of pastoralists mimic the variability and unpredictability of the landscape, and range reserves provide saving banks and buffers against periods of scarcity in food, water, and money. Desert agriculture occurs mostly around oases and desert rivers, which often provide silt and nutrients through flooding cycles. These ways of life, however, are changing rapidly, from hunter-gatherers to cattle ranchers, and from nomadism and transhumance to tourist-targeted activities. In recent times, extraction of minerals, use of vast spaces for military facilities, energy-intensive urban developments, and tourism have increasingly changed the ways of life for some desert populations.

However, due to the extremely slow rate of biological activity in deserts, these ecosystems take decades, if not centuries, to recover from even slight damage. Moreover, because traditional livelihoods in deserts require large areas, they are particularly vulnerable to political and environmental changes. Irreversible damages have been caused in previously good agricultural grounds in deserts by large-scale modern developments, such as dam constructions for water and energy supplies. Finally, the specific aesthetic features and atmospheres of deserts, their silence, wideness, beauty, bareness and emptiness, have always created an intimate spiritual relationship between humans and the desert landscape. All three monotheistic religions have roots in desert regions, where they still remain places of spiritual inspiration and meditation.

SEE ALSO: Arid Lands; Sahara Desert; Soils; Gobi Desert.

BIBLIOGRAPHY. S.W. Breckle, *Sustainable Land Use in Deserts* (Berlin Springer, 2001) D. Jasper, *The Sacred Desert: Religion, Literature, Art, and Culture* (Oxford, 2004); A. Monem Balba, *Management of Problem Soils in Arid Ecosystems* (CRC Press, 1995); Maryam Niamir-Fuller, ed., *Managing Mobility in African Rangelands: The Legitimization of Transhumance* (Intermediate Technology Publications Ltd., 1999); J. Skuijns, *Semiarid Lands and Deserts: Soil Resource and Reclamation* (Marcel Dekker, 1991); Walter Whitford, *Ecology of Desert Systems* (Elsevier, 2002); United Nations Environmental Programme: Global Deserts Outlook, Nairobi 2006, www.unep.org (cited December 2006); Arid Lands Newsletter, ag.arizona.edu (cited December 2006).

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Desertification

THE TERM *DESERTIFICATION* was coined in 1949 by A. Aubreville, a French scientist working in West Africa. Aubreville introduced this umbrella term to describe several ecological processes in tropical Africa, in particular the progressive transformation of tropical forests in savanna and drier ecosystems. In advancing this term, Aubreville was attempting to describe the way in which the Sahara Desert was expanding to engulf desert-marginal savanna grasslands. The term was further popularized in the 1970s because of the prolonged Sahelian drought. Since then, *desertification* has aroused intense debate in the scholarly community about the extent, definition, causes, and how to control this phenomenon, which has led to multiple definitions. In 1983, Michael Glantz and Nicolai Orlovsky reported encountering more than one hundred definitions of desertification in related literature, signifying its complexity.

However, what is certain is that desertification is nothing new; it has been with humanity since the beginning of civilization. *The World Atlas of Desertification,* published by the United Nations (UN) Environment Program (UNEP), offers the following definition: “Land degradation in arid, semiarid, and dry subhumid areas resulting from various factors, including climatic variations and human activities.” Land in this context stands for soil, local water resources, land surface, and vegetation, including crops. Degradation is defined as the reduction of resource potential by one or a combination of the processes acting on the land, while arid, semiarid, and dry subhumid climatic zones are collectively referred to as the susceptible dry lands. On the other hand, true deserts (hyperarid zones) are not seen as susceptible to desertification as they are already biologically unproductive.

A more comprehensive definition of desertification was offered by the 1977 UN Nairobi Conference, which served to draw attention to the phenomenon, particularly in terms of its destructive force on people’s livelihoods. This conference defined desertification as:

> ...the diminution or destruction of the biological potential of the land, (which) can lead ultimately to desert-like conditions. It is an aspect of the widespread deterioration of ecosystems, and has diminished or destroyed the biological potential, i.e. plant and animal production, for multiple use purposes at a time when increased productivity is needed to support growing populations

in quest of development. Important factors in contemporary society—the struggle for development and the effort to increase food production, and to adapt and apply modern technologies, set against a background of population growth and demographic changes—interlock in a network of cause and effect.

The UN Nairobi conference attempted to explain the causes desertification. The blame for the deterioration of productive ecosystems was squarely placed on the quest for ever-greater productivity, which has in turn intensified exploitation of fragile environments. Overexploitation was seen to give rise to degradation of vegetation, soil, and water, the three elements that serve as the natural foundation for human existence. The fear was that in exceptionally fragile ecosystems, such as those on the desert margins, the loss of biological productivity through the degradation of plant, animal, soil, and water resources could easily become irreversible, and permanently reduce their capacity to support human life. It was argued that desertification is a self-accelerating process, feeding on itself, and as it advances, rehabilitation costs rise exponentially.

URGING IMMEDIATE ACTION

The Nairobi conference urged immediate action to combat desertification, and a world map of land degradation by desertification and many case studies from all over the world were presented. These case studies clearly illustrated that desertification was not only happening in Africa, but was a worldwide problem. Since then, several other maps of land degradation have been produced, facilitated by improving technologies such as Geographic Information Science and Remote Sensing. These technologies have yielded important data on desertification. It is now estimated that more than 23.6 million square miles (6.1 billion hectares)—47.2 percent of the earth's land surface—is dry land. About 3.9 million square miles (1 billion hetares) of this area are naturally hyperarid (true) deserts, with very low biological productivity. The remaining 19.7 million square miles (5.1 billion hectares) are made up of arid, semiarid, and dry subhumid areas. It is the latter part that has been degraded by human activities and adverse climatic conditions such as prolonged drought. According to UNEP, about one-fifth of the world's population depend on these lands for their livelihood, hence the importance of combating desertification.

Glantz and Orlovsky identify two major factors of desertification: climate and human activities. Climate refers to climate variability, climate change, or drought. Climate variability is defined as the naturally occurring fluctuations in precipitation, temperature, wind speed and direction, evaporation, and so on for a given period of time. Climate change refers to the view that desertification is primarily a result of natural shifts in climate regimes. Prolonged periods of drought are also a major cause of desertification. These three climatic factors often result in the degradation of an ecosystem, thereby affecting the livelihoods of people who depend on it.

The impacts of different types of human activities on the environment form the second set of factors. Activities such as cultivation, livestock herding, and wood gathering have all been cited as major causes of desertification, particularly in fragile environments. Cultivation of marginal climatic environments, poor soils, or the use of inappropriate cultivation techniques such as reduced fallow time, improper tillage, drainage, and water use have all been implicated in the expansion of desertification. Overgrazing is another problem that leads to land degradation, especially in poorly managed rangelands. In many developing countries, people depend on firewood or charcoal for cooking and heating purposes. In some parts of Africa, the production of charcoal to satisfy urban energy needs has resulted in wholesale environmental degradation.

The controversy on defining desertification and attempting to extricate the major factors that lead to this condition has arisen because of disagreements on how it should be considered. Some researchers think of desertification as a process of change, while others view it as the end result of a process of change. For example, World Bank economists have been at the forefront in sounding the alarm about deforestation and environmental degradation in Africa. World Bank economists Kevin M. Cleaver and Gotz A. Schreiber have vehemently argued that Africa is engaged in a downward spiral of population growth leading to environmental degradation and, therefore, poor agricultural performance. They see land degradation as the end result of a process of change with population explosion as the cause. On the other hand, other scholars offer evidence of the opposite, and see land degradation or desertification as a process of change, not the end result. For example, Thomas J. Bassett and Koli Bi Zueli counter the assertions of Cleaver and Schreiber by noting that it is dominant perceptions of environmental change, rather than concrete evidence, that lie behind the widely held belief that Africa is engaged in an "environmental crisis of staggering proportions." These scholars argue that there is only shaky evidence to support the perception of Africa as physically disintegrating due to the destructive practices of its inhabitants. In recent years, a number of books and articles have been written to counter the dominant view that Africa is facing rapid desertification. These include the 1998 work of James Fairhead and Melissa Leach, the 1996 work of Melissa Leach and Robin Mearns, and the 1998 work of Michael Mortimore.

The ways to combat desertification therefore also depend on the understanding of this process. Those who believe it is an end result of several causes such as population growth and overgrazing often suggest population control, reforestation programs, and placing restrictions on pastoralists to make them sedentary and to reduce the numbers of their livestock. On the other hand, those who believe that this is a process in which one species, such as trees, may replace another species, such as grass, do not consider desertification a major problem. However, trees replacing grass may in itself be considered degradation by those who depend on livestock for their livelihood. The case study of northern Cote D'Ivoire, by Bassett and Zueli, clearly points out that the positive perception of afforestation is erroneous. In the Ivorian savanna, the increase in woody species may actually be undermining the health of grasslands, which may, ironically, lead to policy prescriptions that exacerbate grassland degradation, resulting in the loss of an important resource that pastoralists depend on.

SEE ALSO: Climate; Desert; United Nations Environment Programme.

BIBLIOGRAPHY. A. Aubreville, *Climats, Forêêts et Déésertification de l'Afrique Tropicale* (Sociéétéé d'Editions Gééographiques, Maritimes et Coloniales, 1949); Thomas J. Bassett and Koli Bi Zueli, "Environmental Discourses and the Ivorian Savanna," *Annals of the Association of American Geographers* (v.90/1, 2000); Kevin M. Cleaver and Gotz A. Schreiber, *Reversing the Spiral: The Population, Agriculture, and Environment Nexus in Sub-Saharan Africa* (World Bank, 1994); Helmut Geist, *The Causes and Progression of Desertification* (Ashgate Publication, 2005); Michael H. Glantz, *Desertification: Environmental Degradation in and around Arid Lands* (Westview Press, 1977); Michael H. Glantz and Nicolai Orlovsky, "Desertification: A Review of the Concept," *Desertification Control Bulletin* (v.9, 1983); Melissa Leach and Robin Mearns, *The Lie of the Land: Challenging Received Wisdom on the African Environment* (Heinemann, 1996); Arizpe S. Lourdes, Margaret Priscilla Stone, and David C. Major, *Population and Environment: Rethinking the Debate* (Westview Press, 1994); Michael Mortimore, *Adapting to Drought: Farmers, Famines, and Desertification in West Africa* (Cambridge University Press, 1989); Michael Mortimore, *Roots in the African Dust* (Cambridge University Press, 1998); United Nations Environment Programme, *World Atlas of Desertification* (Edward Arnold, 1992); United Nations Secretariat of the Conference on Desertification, "Desertification: An Overview," *Desertification: Its Causes and Consequences* (Pergamon Press, 1977).

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Design (and Ecodesign)

DESIGN IS THE process of planning, initiating and/or laying out a new product, service, piece of equipment, landscape, building, plan, policy or the like, typically in an artistic, technically proficient, or skillful fashion. It is a future-oriented act of envisioning and creative problem-solving.

Typically, design involves sketching, drafting, computer-assisted manipulation of three-dimensional spaces, and artistically or accurately representing and arranging forms and materials for new functions and purposes. Design by its very nature embraces ideas about utility, aesthetics, convenience, efficiency, and practicality. In architecture, for example, design ideals can be traced to Vitruvius, who espoused durability, convenience, and beauty as the tenets of design. Design involves the manipulation of technologies, from simple instruments such as drafting pens and paper to sophisticated technologies such as Computer Assisted Design (CAD) and Geographic Information Systems (GIS). Design practitioners include architects, planners, landscape architects, instrument-makers, interior designers, artists, engineers, environmental scientists, computer scientists, and chemists, among others. Much design literature is underpinned by environmental determinism (the notion that the environment directly affects human behaviors and actions) and encompasses a set of values whereby humans are seen to legitimately manipulate the environment to produce outcomes that benefit our species over others.

DESIGN IN HISTORY

Throughout history, various civilizations have practiced elements of design. Stonehenge in England, for example, is a Neolithic design innovation, presumably allowing for the accurate forecasting of crop sowing and harvest times. Some commentators have argued that the ability to design is a unique property of our species, enabling humans to produce environmental modifications and transformations from stone tools to metropolises like Chicago. Feminist historian of science Donna Haraway has even asserted that in many ways humans have become cyborgs—biomechanical entities that are dependent upon, and have merged with, our technologies.

Western society in particular has inherited a fractured system of thinking centred upon the instrumental value (use value) of nature. Since the Industrial Revolution, modern design practices have resulted in the large-scale metabolization of nature into canals, bridges, buildings, automobiles, and the like. The perception that humans are outside of nature has led to environmental impacts seldom being factored into design processes (e.g., the production of toxic substances such as dioxins or radioactive waste). More recent design applications, including the use of nano-technology in the design and assembly of tools at a molecular level, and genetic engineering (the manipulation of an organism's DNA to produce new features within that organism or even new organisms), perpetuate dualistic thinking about nature–society relations and the concomitant risk of adverse environmental impacts.

ECODESIGN

Ecodesign entails "designing with nature" for the benefit of the wider environment. Contemporary applications of ecodesign include the development of new technologies as a transition to ecological sustainability—what Slessor characterizes as a movement from "high tech" to "eco tech." Water-sensitive urban design, nature's services approaches, ecological restoration, permaculture, green buildings, biotechnology, wind farms, and hybrid cars are all examples of ecodesign. Ecodesign combines environmentally benign philosophies, technologies, materials and legal standards to meet current needs in ways that create lower levels of environmental impact while preserving biodiversity (natural capital).

Ecodesign advocates strategies that will result in a net environmental gain, both social and ecological. The underlying premise is to emulate biophysical and ecological processes—recognizing interdependencies, and in so doing, improve the ecological sustainability of products and services. Ecodesign seeks to overcome the "utopian ideals" inherent in traditional design practices, such as order and beauty, which inevitably produce "sterile environments," replacing them with sensibilities grounded in the chaotic "messiness" of biological systems. Industrial ecology, for example, seeks to mimic ecosystem processes by metabolizing waste. The waste outputs of industries are used as the raw material inputs for other industries—thus closing material and energy loops.

From an environmental planning perspective, perhaps the most influential work on ecodesign was Ian McHarg's *Design with Nature* (1967). In this book, McHarg sketched out a new way of designing human settlements working with, rather than against, natural processes and recognizing natural limits. Possibly the ultimate expression of ecodesign can be found in Jennifer Wolch's 1998 "Zoöpolis,"a new kind of socially and ecologically inclusive city built around environmental processes and acknowledging plants and animals as legitimate urban residents.

SEE ALSO: Alternative Energy; Green Consumerism; Wind Power.

BIBLIOGRAPHY. P. Calthorpe, *The Next American Metropolis: Ecology, Community and the American Dream*. (Princeton Architectural Press, 1993); W. Cronon, *Nature's Metropolis: Chicago and the Great West* (W.W. Norton and Company); R.A. Frosch, “Industrial Ecology: Adapting Technology for a Sustainable World,” *Environment,* (37, 16-37, 1995); M. Gandy, *Concrete and Clay: Reworking Nature in New York City* (The MIT Press, 2003); D.P. Grant, “The Nature of Design and Planning, in *Design Professionals and the Built Environment* (John Wiley & Sons, 2000); D. Haraway, *Modest_Witness@Second_Millennium. FemaleMan©_Meets_Oncomouse™* (Routledge, 1997); M. Hough and R.H. Platt, R.A. Rowntree and P.C. Muick, eds., *The Ecological City: Preserving and Restoring Urban Biodiversity* (The University of Massachusetts Press); I. McHarg, *Design with Nature* (John Wiley & Sons, 1967); R. Paden, “Values and Planning: The Argument from Renaissance Utopianism,” *Ethics, Place and Environment,* (4(1), 5-30, 2001); R.H. Platt, R.A. Rowntree, and P.C. Muick, eds., *The Ecological City: Preserving and Restoring Urban Biodiversity* (The University of Massachusetts Press, 1994); V. Plumwood, *Feminism, and the Mastery of Nature* (Routledge, 1993); C. Slessor, *Sustainable Architecture and High Technology: Eco-Tech* (Thames and Hudson, 2001); A.W. Spirn, *The Granite Garden: Urban Nature and Human Design* (Basic Books, 1984); S. van der Ryn and S. Cowan, *Ecological Design* (Island Press, 1995); J. Wolch, *Animal Geographies: Place, Politics and Identity in the Nature-Culture Borderlands* (Verso, J. 1998).

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Developed “First” World

THE FIRST WORLD, now known as the *developed, industrialized,* or *Western world*, are terms used to describe countries that have collectively attained a good standard of living, a high per capita gross national product and a strongly diversified technology base. The United Nations (UN) state that “developed countries tend to have high gross domestic products, high literacy rates, minimal spread of poverty, and are technologically advanced.”

Standard of living describes the quality and quantity of goods and services available to people in any given country. It is generally measured by real (i.e., inflation adjusted) income per person, and the Gross Domestic Product (GDP) of a country is defined as the total value of final goods and services produced within a country's borders in a year, regardless of ownership. Neither standard of living nor GDP are the same as “quality of life,” which takes into account a variety of other factors that determine social well being such as recreation, safety, cultural diversity, social life, mental health, and environmental quality issues. The UN Human Development Index (HDI), identifies countries with an HDI measurement of over .8 as falling within the developed world category. Categories within the HDI include life expectancy, poverty, literacy, and healthcare.

According to the UN, Economic Division countries—including Japan, Canada, the United States, Australia and most countries in the European Union—are First World countries. While statistical analyses can be useful in differentiating between the social and economic status and welfare of nations, the term *First World*—like *Third World*—is essentially a political term that has many other connotations attached to its use.

The term was first used after the end of World War II, when the parties to the North Atlantic Treaty Organization and the Warsaw Pacts became known as the western and eastern blocs. Many countries did not fit into either category, with the remaining often referred to as belonging to the Third World. The countries belonging to the First and Third Worlds have changed with the political times, and today, the terms *developing* or *First World* are often derided for being too Western and paternalistic in focus, presuming superiority by one group of nations over others.

This does not hide the fact that inhabitants of First World countries do enjoy a substantially higher standard of living than do those living in the Third World. The socio-economic advantage that the First World has gained over the Third World has come at a significant environmental cost. Raven notes that “there is an important linkage between such factors as human population density, rate of growth, consumption and the choice of particular technologies on the one hand, and the state of the environment on the other."

Approximately 25 percent of the world's people reside within developed countries, yet consume 80 percent of the world's nonfuel minerals. The United States, while comprising only five percent of the world's population, consumes up to 30 percent of the worlds resources. Environmental impacts from the consumption of resources by the First World is having a major impact on the world's environment and climate with most of the largest emitters of greenhouse gases being those countries in the developed world. Australia, for example, has the highest emissions of climate changing gases by any country on a per capita basis, and they are equal to six times more than those emitted by China. For context, Australia's population is 20 million, whereas China's is 1.3 billion.

The impact of high consumption of the Earth's resources by the developed world is being felt more acutely in the environments of the developing world. Consumer demand in Japan for timber has resulted in the deforestation of parts of southeast Asia, while in East Africa, forests have been cleared to grow tea, coffee and other cash crops for export to Europe. In South America, the pampas grasslands have been cleared in favor of serving the market for meat in Europe and North America.

High consumerism levels in the First World have created a major non-organic waste problem compared to that of the Third World. *The Atlas for Population and the Environment* notes that more than 500 million tons of waste is generated each year in the First World, of which some 30 percent are mineral wastes, 20 percent industrial, 40 percent agricultural and 5 percent municipal. By contrast, research has identified that throughout the developing regions of the world, such as Indonesia or India, 73–96 percent of local waste consists of food and biodegradable material. The importance of the link between affluence and waste is further highlighted by the fact that a 40 percent increase in GDP of countries belonging to the Organization for Economic Cooperation and Development has been accompanied by a similar increase in waste generation.

Given the global nature of our economy and the global reach of environmental issues such as climate change, significant equity challenges exist for the rights of developing countries to also provide for their citizens a similar lifestyle to that enjoyed by people in developed nations. The challenge is how to support these rights, while minimizing the major environmental impact this will cause. Estimates show that if all of the world's people attained the standard of living comparable to that in the United States, three more planets—comparable to earth—would be needed to support them. This is clearly not an option.

The impact of globalization has meant that now, more than ever, we live in an interdependent world connected by mutual need for natural resources, through the relations of a global economy and the movement of people across countries. This need has been partially recognized in meetings such as the Earth Summit in Rio in 1992, the development of the Millennium Goals, and the formation of many international institutions that attempt to address the conjuncture of population, technology and environment in both the developed and developing worlds. Such institutions include the World Bank, the International Monetary Fund, the World Business Council for Sustainable Development, the UN Development Program, Consultative Group on International Agricultural Research (CGIAR) and formation of international environment groups such as World Wildlife Fund or Friends of the Earth, who focus on the equitable relationship between people and the environment.

SEE ALSO: Consumption; Underdeveloped ("Third") World; World Systems Theory.

BIBLIOGRAPHY. K. Baumert and J. Pershing, "Climate Data Insights and Observations," (Pew Centre, 2004); P. Harrison and F. Pearce, *Atlas of Population and the Environment*, (American Association for the Advancement of Science 2001); T. Panayotou, "Globalization and the Environment," *Environment and Development Paper No.1* (Harvard University, 2000); World Resources Institute, *World Resources 1998-99* (Oxford University Press, 1998).

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Development

THERE ARE FEW ideas more contested than development, which involves a complex history of competing understandings of terms as varied as *progress, geopolitics, gender, culture,* and *environment*. There is general consensus that the development era began at the end of World War II and was tied to European Reconstruction and shifting geopolitics. Colonialism had been the central organizing practice prior to this period and was gradually receding with the increasing independence of former colonial outposts. Colonialism involved the political, economic and spatial control of various regions for the benefit of colonial empires. The colonies were established for the removal of raw materials and human labor, while being promoted as part of a larger imperial mission. In an example of this sentiment, writer Rudyard Kipling argued that the development of other regions was part of the "white man's burden," which spoke to a paternalistic responsibility that came with being supposedly more advanced. In addition to the decline of colonialism, a speech by President Harry Truman in 1949 helped usher in the development era by arguing that colonialism would be replaced by "a program of development based on the concepts of democratic fair dealing." Rather than colonial empires and colonies, the globe would be divided into independent nation-states that would set the terms for political and economic engagement. Also important at this time was the establishment of new international institutions to facilitate the rebuilding of Europe and global exchange. A series of meetings at Bretton Woods, New Hampshire, in 1944 resulted in agreements on the rules for commercial and financial systems between the world's major industrial states. These meetings are also remembered for establishing the International Monetary Fund (IMF) and the World Bank, which have become two of the leading institutions in promoting international development.

Development has always involved politics as much as economics. This can be seen by the labeling of countries under the development lexicon. Durign the rising tensions between the United States and the Soviet Union, developing countries were viewed as strategic pawns. The United States and its allies were classified as members of the First World, the Soviet Union and its allies were the Second World, and all the other countries became the Third World. Although there are tremendous variations between countries labeled Third World, this became a commonly used classification. Third World or developing countries tend to rate low on development indicators that assess their socio-economic characteristics. Commonly used indicators include Gross Domestic Product (GDP) and Human Development Index (HDI). GDP is a measure of all the goods and services produced within one year. HDI assesses life expectancy, education measured as adult literacy and average years of schooling, and purchasing power. Development indicators can be problematic, however, since they often overlook differences within specific countries and regions. GDP, for example, is helpful in understanding the overall economic output for a particular country, but does not show income inequalities or variations between urban and rural areas. Critics have also argued that GDP increases positively with some negative environmental conditions such as the clean-up of an oil spill. Indicators such as these provide only a limited picture and can also contradict each other. Several countries rate fairly high according to their GDP but much lower based upon their HDI because of socio-economic inequality. As such, the classification of countries for the purposes of development should be treated carefully.

MODERNIZATION THEORY

The focus of much early development thinking was the diffusion of Western characteristics to facilitate the perceived necessary evolution of countries in the Third World. This was known as modernization theory. The best example of this was Walt Rostow's "Stages of Economic Growth," which positioned each country in a particular stage that required technical and cultural transformation to facilitate its development. The five stages were traditional society, preconditions for take-off, take-off, drive to maturity, and high mass consumption. These stages were an ideal path, involving a linear evolution realized through increased manufacturing and industrial organization, infrastructure development, and the emergence of a social elite. Rostow argued that countries could move along the trajectory once they acquired certain economic, political, and cultural characteristics that resembled the developed world. Modernization was firmly linked with the goal of Soviet containment, as the United States and its allies believed economic development would resist the spread of communism throughout the Third World. As such, development aid was often directed toward countries with strategic benefits to lending countries.

THE ROLE OF THE STATE

Another important element of early development thinking was theorizing the role of the state. Supported by influential economist John Maynard Keynes, the state was believed to play a large role in facilitating economic growth for developing countries. An example of this applied in practice was import-substitution industrialization (ISI). ISI was an approach adopted by a number of Latin American countries in the 1950s and involved strong state intervention to encourage domestic production for domestic markets. ISI utilized the state and market manipulation to facilitate its goals. Import tariffs were instituted to make foreign products more expensive and were eliminated on needed inputs for domestic production.

ISI was generally unsuccessful for a number of reasons. It had little impact in reducing imports, and in some cases increased them since more inputs were needed to support local industries. There was little diversification of the sectors supported by ISI beyond the industries producing sophisticated goods. In responding to market indicators about which products to create, ISI tended to reproduce economic inequality by manufacturing goods that were unaffordable to the majority of the population. The failure of ISI helped propel arguments that economic growth was best achieved through the utilization of the market, which would reach ascendancy in the 1980s with neoliberal theory. Other perspectives about international development emerged as well, including the dependency school, which argued that global integration and trade worsened—rather than improved—economic conditions in the developing world. To the dependency theorists, ISI was evidence that the global system was primarily designed to benefit wealthier countries.

The 1970s were a volatile period for geopolitics, global finance, and development. The Organization of the Petroleum Exporting Countries (OPEC) instituted an oil embargo that dramatically increased the price of gasoline. This produced an energy crisis that had ripple effects throughout the world. Poorer countries found it more difficult to manufacture basic commodities and were forced to pay more as imported goods increased in price. Revenues from high gasoline prices—or "petrodollars"—were funneled into the Third World by private banks. The result was that developing countries took out more loans to stay afloat.

The debt crisis was further exacerbated by U.S. policies in the late 1970s to strengthen the value of the dollar, which resulted in increased interest rates. Finance markets were tied to changes in international markets and as the prices of primary commodities declined in the early 1980s, the income generated by developing countries was reduced. Between 1973–83, the outstanding debt owed by developing countries increased fivefold, to $810 billion. This resulted in a number of countries, beginning with Mexico, announcing that they would be unable to service their debt. In order to halt a potential global financial crisis, the IMF and World Bank stepped in as brokers, thereby expanding their influence within the developing world.

ASIAN TIGERS

During this time, development began to experience shifts in regards to economic theorizations of the role of the state and the market. Neoliberalism became more pronounced and asserted that the state was a hindrance to effective economic growth. One of the mechanisms for advancing neoliberalism was structural adjustment, which attached specific conditions upon loans to developing countries. Structural adjustment goals included the reduction or elimination of a balance of payments deficit, the resumption of higher rates of economic growth, and the achievement of structural changes that would prevent future payments and stabilization problems. State-owned businesses were sold and budgets were often directed away from supporting environmental and social services. The legacy of structural adjustment, and lending conditionality more generally, remains one of the most contested issues in development policy today.

Neoliberalism gained further prominence in the 1980s with the seeming explosive economic growth of several Asian countries. Labeled the *Asian Tigers,* these newly industrializing countries (NICs) demonstrated success in establishing a viable manufacturing sector through export processing. As opposed to ISI, export processing involved the establishment of manufacturing not for domestic production but for foreign export. Countries such as South Korea, Taiwan, and Singapore were able to attract foreign capital to establish manufacturing bases within their borders. Utilizing a number of incentives such as reduced tax rates and low labor costs, export processing became frequently cited as a model for successful economic growth. It is worth noting that critics of this strategy argue that export processing results in significant social and environmental costs as foreign firms show little concern for local conditions. Additionally, it has been argued more recently that, rather than relying exclusively on the market to achieve economic growth, the national governments of the NICs were quite aggressive in suppressing labor costs and unions.

CONCERNS ABOUT ENVIRONMENT

A shift in development accompanied increasing concerns in the 1970s about environmental problems including deforestation, desertification, population and famine. Neomalthusian ideas of population growth surfaced, which asserted that famine and other environmental issues were the product of a rapidly increasing global population living beyond its means. Influential scholars such as Paul Ehrlich argued that human population was increasing exponentially while the ability to sustain the population through environmental resource consumption was more limited. In *The Population Bomb*, Ehrlich argued that human population growth would result in the deaths of hundreds of millions of people. Also in the 1970s, the Club of Rome published a report entitled *The Limits to Growth* that asserted that major changes in geopolitical relations would be needed to stem an environmental catastrophe and population collapse. These events pushed environmental concerns onto the forefront of development debates and contributed in a wave of interest in merging environment and development. This popularized the idea of *sustainable development,* which generally attempts to combine economic development with concerns for environmental sustainability.

Sustainable development has been influenced by a series of key meetings and reports that helped frame its central tenets. One event was the United Nations (UN) Conference on the Human Environment, which was held in 1972 in Stockholm, Sweden. This was the first major summit on environment and development and was attended by representatives from 113 nations. Conference attendees agreed to a number of principles, including the idea that development and environmental protection were not mutually exclusive and could actually support each other. This seemingly upended the idea that environmental protection would always come at the expense of economic growth. The Stockholm Conference was followed by the World Conservation Strategy (WCS) of 1980, which attempted to integrate development goals with conservation planning. The three central objectives of the WCS were maintaining essential ecological processes, preserving genetic diversity, and ensuring sustainable utilization of species and ecosystems.

A watershed moment for sustainable development was the World Commission on Environment and Development (WCED) *Our Common Future* report of 1987. The WCED defined sustainable development as "[meeting] the needs of the present without compromising the ability of future generations to meet their own needs." The WCED Report identified a number of critical areas for sustainable development, including reviving growth, changing the quality of growth, meeting essential needs, ensuring a sustainable population level, conserving and enhancing the resource base, reorienting technology and managing risk, and merging environment and economic in decision making. Most important was its continuation of earlier statements that sustainable development could reconcile economic growth and environmental sustainability.

Subsequent international gatherings attempted to build upon these developmental principles. Foremost among them was the UN Conference on Environment and Development, which was held in Rio de Janeiro, Brazil, in June 1992. The Rio Summit received significant international publicity and produced *Agenda 21*, a lengthy document that outlined 27 principles for sustainable development. The World Summit on Sustainable Development was held in Johannesburg, South Africa, in 2002 and attempted to further expand upon some of the goals established in Rio. Specifically, the WSSD resulted in an *Action Plan* that included halving the proportion of people without access to sanitation and drinking water, deal with climate change, and stop biodiversity loss by 2010. As a result of these meetings and reports, sustainable development has become a buzzword that has sparked a significant amount of attention in professional and academic circles while becoming a paradigm for institutions as diverse as the World Bank, corporations, and nongovernmental organizations (NGOs) throughout the developing world.

ISSUES IN DEVELOPMENT

Development has continued to expand to involve a number of concerns. One of these is development and gender, which assists in understanding the impacts of development processes upon men and women. Informed by feminist theory, scholars have shown that development differentially impacts women who are often overlooked by development agencies. Women have been shown to contribute differently to the public and private spheres, and possess different knowledge about local conditions. The UN established the Women in Development decade to focus attention upon the relationships between gender and development and various institutions have worked to include women as full stakeholders in development planning.

A second issue has been the localization of development and interests in participation. Participatory rural appraisal (PRA) involves a number of techniques to include local communities as participants in development. PRA and participatory development represent a critique of large-scale development that is blueprint-oriented and ignores the nuances of local context that often shape the effectiveness of development. A wave of interest in NGOs and social capital suggest an intention to direct attention toward local processes, communities, and actors. The growth of microenterprise lending, which provides small loans to poor groups, also fits within this trend. Microenterprise lending began when the Grameen Bank in Bangladesh began giving out small loans, called microcredit, in the 1970s. The high repayment rates, coupled with the ability to assist the very poor, have generated a great deal of interest in microenterprise lending.

The belief that we are increasingly living in a globalized world has focused attention upon global finance, flows of exchange, global environmental processes, and cultural change. Countries continue to position themselves within regional trading blocks to access new markets and protect themselves from foreign competition. The North American Free Trade Agreement (NAFTA) connected Canada, Mexico and the United States, while the expansion of the European Union (EU) links countries from eastern and Western Europe. There has been continued movement toward other regional associations, as represented by the Free Trade Area of the Americas (FTAA) and the rebirth of the African Union (AU).

Development remains a hotly contested and challenging set of ideas and goals. This is evidenced by recent assessments of the state of international development. The UN has proposed its own Millennium Development Goals that challenge the global community to meet the following by 2015: eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality; improve maternal health; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; and develop a global partnership for development. Unfortunately, recent evidence indicates that for many countries, particularly in sub-Saharan Africa, these goals will not be achieved. Even while economic and political relationships expand at the international scale, development is increasingly the site of protests and resistance within various locations. Protests have accompanied the World Trade Organization (WTO) meetings from outside, and from within as a bloc of developing countries, derailed recent agreements because of their concern for agricultural subsidies in the United States and Europe. Reactions to neoliberal economic theory have appeared particularly in Latin America as countries such as Bolivia nationalize certain industries. These events suggest that development will continue to be challenged and reworked in the 21st century.

SEE ALSO: Colonialism; Gross Domestic Product (GDP); Human Development Index (HDI); Import-Substitution; International Monetary Fund (IMF); Modernization Theory; Neoliberalism; North American Free Trade Agreement (NAFTA); Organization of the Petroleum Exporting Countries (OPEC); United Nations Conference on Environment and Development; World Bank.

BIBLIOGRAPHY. William M. Adams, *Green Development: Environment and Sustainability in the Third World* (Routledge, 2001, 2nd ed.; Robert Chambers, *Rural Development: Putting the Last First* (Pearson-Prentice Hall, 1983); Stuart Corbridge, ed., *Development Studies: A Reader* (Edward Arnold, 1985); Philip W. Porter and Eric S. Sheppard, *A World of Difference: Society, Nature, Development* (Guilford, 1998); Walt W. Rostow, *The Stages of Economic Growth: A Non-Communist Manifesto* (Cambridge University Press, 1960); Jeffrey Sachs, *The End of Poverty: Economic Possibilities for Our Time* (Penguin Press, 2005); Amartya Sen, *Development as Freedom* (Alfred A. Knopf, 1999); Joseph E. Stiglitz, *Globalization and Its Discontents* (W.W. Norton, 2002); World Commission on Environment and Development, *Our Common Future: Report of the World Commission on Environment and Development* (Oxford University Press, 1987).

Development indicators can be problematic, since they often overlook differences within countries and regions.

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Diamond, Jared

JARED DIAMOND IS Professor of Physiology and Geography at the University of California, Los Angeles. He is an important academic, both in his own right and as a lightening rod for renewed debate over the merits and dangers of what is most commonly called environmental determinism. Jared Diamond was trained as a physiologist, but is well known for his ecological investigation of avian evolution in Papua-New Guinea and more recently for his work as an environmental scientist, historian, and geographer. He is probably most popularly known for his 1997 book, *Guns, Germs, and Steel,* which won a Pulitzer Prize in 1998. Both the arguments in the book and its success make it important for an understanding of contemporary environment–society relations.

The argument is simple: Diamond attributes the enormous differences worldwide in income, welfare, and stability to a single ultimate cause: environmental conditions. He argues that "[three] factors—time of onset of food production, barriers to diffusion, and human population size—led straightforwardly to the observed intercontinental differences in the development of technology."

Diamond positions his argument as a denial of genetic or cultural explanations for the differences between contemporary societies. Instead, the societies with greatest access to cultivable food supplies and domesticable animals were able to develop powerful military tools (namely, steel tools, weapons, and deadly germs) that enabled them to conquer the world. Diamond called the transition from hunting and gathering to settled agriculture the greatest mistake human society ever made.

There have been many critiques of Diamond's work, but the best is by geographer Jim Blaut, who argues that Diamond's science is inaccurate and marshaled selectively, particularly with regard to Asia. In addition to critiques of his science, Blaut (and others) challenge Diamond's understanding of the relationship between history, culture, and the environment. The environment is clearly an important historical actor, but it works in conjunction with economic relations, politics, cultural beliefs, and even historical contingency. Within geography, the most severe critiques of environmental determinism (generally pre-dating Diamond) are to be found in the subfield of political ecology.

ENVIRONMENTAL DETERMINISM

Aside from the specifics of Diamond's science, the success of *Guns, Germs, and Steel* is important in the context of a revived environmental determinism. Several prominent academics such as Jeffrey Sachs, David Landes (1998), and Ricardo Hausmann (2001) have criticized geography for casting aside explanatory models that causally link the environment and economic development. They have articulated a sort of "politically correct" environmental determinism in which poverty is not a product of history, culture, or politics—it's a case of "bad latitude."

There are several factors that facilitate the revival of this determinism: first, the failure of development economics to deal with inequalities between human societies has transformed the optimism of the early post-war period into a certain fatalism; second, the possibility of multiple superpowers has gradually been replaced by the military and economic dominance of a small handful of countries—primarily those European countries blessed with the most "favorable" environment; third, there is a new awareness of—and respect for—the ability of the environment to effect not only localized conditions, but the well-being of human life on this planet.

SEE ALSO: Deep Ecology; Environmental Determinism; Environmentalism.

BIBLIOGRAPHY. Piers Blaikie and Harold Brookfield, *Land Degradation and Society* (Methuen, 1985); Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (W.W. Norton & Company, 1997); J.L. Gallup, J.D. Sachs, and A.D. Mellinge, "Geography and Economic Development," *International Regional Science Review* (22(2), 1999); Ricardo Hausmann, "Prisoners of Bad Geography," *Foreign Policy* (122, 2001); David Landes, *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor* (W.W. Norton & Company, 1998); Paul Robbins, *Political Ecology: A Critical Introduction* (Blackwell, 2003).

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Diffusionism

DIFFUSIONISM IN THE social sciences of anthropology and cultural geography is a theory about the spread of ideas, technologies, and practices from one culture to another. Human beings invent things or behaviors. It has been long noted that some cultures use similar tools, art techniques, or cultural practices. The question has naturally arisen whether these similarities are due to the spread (diffusion) of ideas, or whether they arose spontaneously as independent inventions in different locations. In diffusionism, features of one culture spread to another culture over geographic distances because of mutual contact. An example of cultural diffusionism is the use of the hammock. For centuries, European sailors slept on the decks, piles of ropes, or on whatever could be tolerated in the ships they sailed. Christopher Columbus's first voyage to the New World brought his sailors into contact with the use of the hammock. The idea spread to other

European sailing nations and soon was a standard way to sleep.

Social scientists from the Heliolithic and culture-history schools of thought represent the most extremes advocates of the theory of diffusionism. Functionalists like Bronislaw Malionowski opposed their theories. In England, G. Elliott Smith was a leading English diffusionist. In Germany and Austria, the Kulturkreis School was an advocate of diffusionism among pre-Bronze Age humans. Cultures diffuse geographically as they spread things such as foodstuffs, music styles, items of clothing, and technological developments. Diffusion can also include the spread of religion. It is well known, for instance, that religions in India have spread along the Grand Trunk Road that runs from Calcutta along the Ganges River, through the Punjab to the Khyber Pass. Those who have spread their religions on this road include warriors, merchants and prisoners, as well as innumerable monks, priests, preachers, and other religious teachers.

Diffusionism is often described using biological models. The model of the spread of a disease can be used to describe the contacts needed to spread tools, technologies, and theories. For example, the spread of syphilis began with the return of Columbus from his First Voyage. Among the six Indians and sailors who returned, several carried the disease. Contact with prostitutes in Spain and then their contacts with a unit of French soldiers gave rise to the name *French Pox*. Tracing the vectors of many diseases is an exercise in medical detective work. Anthropologists conduct the same detective work to trace the spread of ideas from one culture to another. Types of diffusion include: relocation, expansion, hierarchical, contagious, and stimulus.

Relocation diffusion occurs when the same individuals or groups move from place to place spreading their culture. The Puritans of New England moved to spread their religion to a new land. Expansion diffusion describes the spread of a newly adopted cultural feature into an ever-growing population. The result is a dramatic increase in the number of people who have accepted the new cultural feature. Hierarchical diffusion occurs when cultural ideas leapfrog from elites in one central area to others in another city by passing rural or poorer areas. The spread of eating sushi in the United States has followed this pattern. Contagious diffusion spread like diseases. In fact, this is descriptive of the spread of diseases in cultures. The spread of HIV/AIDS has exhibited this pattern. Stimulus diffusion occurs when one culture applies the general idea(s) of one culture in a new way in their own environment. The adoption of reindeer by Siberian peoples is an example of stimulus diffusion. Diffusion can be slowed, delayed, or blocked by a number of factors. Time and distance have, until the advent of modern travel, often muted the spread of cultural factors. In some cases, cultures may outlaw the adoption of cultural changes in an attempt to prevent their spread.

SEE ALSO: Culture; Ideology; Religion.

BIBLIOGRAPHY. James Morris Blaut, *Diffusionism: History Inside Out* (Guilford Press, 1992); Marvin Harris, *The Rise of Anthropological Theory: A History of Theories of Culture* (Crowell, 1968); Kristian Kristiansen and Thomas B. Larrson, *Rise of Bronze Age Society: Travels, Transmissions, and Transformations* (Cambridge University Press, 2006).

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Dioxins

DIOXINS ARE A class of 75 chlorinated aromatic hydrocarbons that vary widely in their toxicity to humans. Dioxin toxicity is measured by Toxic Equivalent Factor (TEF) for which the standard of 1.0 is TCDD, or *tetrachlorodibenzo–p–dioxin*, one of the most toxic substances known. Dioxins are chemically and toxicologically related to chemicals known as furans, and some of the polychlorinated biphenols, or PCBs. Dioxins have no commercial application and can be produced as byproducts of manufacturing processes involving chlorine or fire in the presence of chlorine and complex carbon molecules.

Dioxins are more soluble in fat than water, meaning they bind to organic matter and bioaccumulate. Human exposure to dioxin is generally through consuming animal-based foods like meat, dairy, and eggs, making exposures widespread. Dioxins are very persistent in the environment and do not migrate easily through groundwater or vaporize into the air. Much is unknown about the causes and effects of dioxin toxicity, but it appears it influences endocrine function affecting fetal development, the reproductive system and the liver, and is associated with some cancers. Dioxin is believed to act through binding to a receptor protein that enters the cell nucleus and affects gene expression. In acute doses, dioxin can cause a skin condition known as chloracne, and its hormonal effects can be evident in extremely tiny doses of parts per trillion.

The sources of dioxin are almost entirely anthropogenic. The EPA estimate conducted in 2003 found that the vast majority of releases in the United States were into the air, and about half of those from medical and municipal waste incinerators. Most of the remainder came from backyard burning of trash, cement kilns, and fuel combustion.

SCIENCE AND POLITICS OF DIOXIN

The science and politics of dioxin have been marked by a series of controversies related to where dioxin comes from, what it does to people, and what constitutes an acceptable level of risk, punctuated by periodic environmental justice flashpoints centering on dioxin exposure. Industrial accidents involving dioxin provided contested evidence of dioxin's dangers. The involved corporations found no link between dioxin exposure and illness in the studies they paid for and conducted, while independent studies found significant increases in cancer in exposed people.

A series of broad-scale dioxin exposures that occurred in the 1960s and 1970s made dioxin a major environmental justice issue. From 1962–71, the U.S. Air Force sprayed large areas of South Vietnam with *Agent Orange,* a mix of herbicides including 2,4,5–T and 2,4–D, organochlorine chemicals that contained substantial amounts of dioxin byproducts. American veterans' health problems from Agent Orange led to a series of studies that found many veterans' health conditions were due to their exposure to dioxin.

Love Canal was a site where tens of thousands of tons of chemical waste containing dioxin was dumped and subsequently leached into groundwater, mobilizing the dioxin that readily diffuses through oily solvents. The health problems faced by Love Canal residents made public in the late 1970s accelerated attention from the environmental justice movement, government, and corporations on dioxin. Other dioxin hotspots were the Alsea river valley in Oregon where 2,4,5–T was sprayed, causing widespread birth defects; and Times Beach, Missouri, where dioxin-polluted oil was sprayed to keep down dust on roads and subsequently contaminated the town.

Around this time Dow Chemical Company, a manufacturer of many products linked to dioxin, came out with a paper entitled "Trace Chemistries of Fire" that contended dioxin came not from human activity, but was produced naturally from forest fires. This theory was quickly refuted, but the role of natural combustion in global dioxin production continues to be promoted by spokespeople for industries tied to dioxin pollution.

The EPA made its first assessment of dioxin's public health implications in 1985, and has issued three reassessments since: in 1988, 1994, and 2003. The magnitude of exposure and its consequences remains much disputed. Although EPA reported in 2003 that dioxin emissions fell about 75 percent since 1987 (mostly due to reductions in incinerator emissions) and dioxin concentrations in food have declined considerably since 1970, the EPA admits that the cancer risk from dioxin to the general U.S. public may exceed 1 in 1,000. This level is three magnitudes greater than the generally accepted one in a million acceptable risk. The average body burden of dioxin in the U.S. public approaches the minimum level at which harm may result.

SEE ALSO: Agent Orange; Love Canal; Superfund Sites.

BIBLIOGRAPHY. T. Colborn et al., *Our Stolen Future* (Plume, 1997); L. Gibbs and Citizens Clearinghouse for Hazardous Waste, *Dying From Dioxin: A Citizen's Guide to Reclaiming our Health and Rebuilding Democracy*. (South End Press, 1995); S. Steingraber, *Living Downstream* (Vintage, 1998).

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Disasters

A DISASTER IS a serious disruption of society that causes human suffering, and damage to built and natural environments so extensive that the affected communities cannot recover through the use of their own resources. Disasters have traditionally been divided into two groups: natural and man-made. They can also be classified according to their speed of onset, as either sudden or slow.

Man-made disasters are the direct consequence of human action and involve some aspect of human intention, negligence, or error. Technological disasters include transport, industrial, and structural accidents. Two of the greatest man-made industrial disasters occurred in the 20th century: the Bhopal gas tragedy in 1984 and the Chernobyl nuclear disaster in 1986. Man-made disasters may also include ecological disasters in which human actions damage ecosystems, often in a way that threatens human communities, and disasters caused by wars and civil conflict.

Natural disasters occur when a vulnerable community suffers casualties or damages from a natural hazard. These are normally–occurring events in the environment which have the potential to harm human communities. They can be divided into meteorological and hydrological hazards (cold waves and heat waves, extreme storms, hurricanes, tornadoes, drought, flood), geological hazards (earthquakes, tsunamis, landslides, volcanoes) and biological hazards (epidemics and infestations).

NATURAL OR MAN-MADE?

The distinction between natural and man-made disasters has become increasingly blurred as it is recognized that there is a strong human component in all disasters. Some hazards are clearly "natural," such as earthquakes, tsunamis, or volcanic eruptions. Their negative impact on communities, however, can be aggravated by human actions. An earthquake can trigger a disaster only if communities are built in seismic zones and if building construction is not adapted to earthquake activity. The loss of lives and property and the social dislocation caused by Hurricane Katrina in August 2005 was exacerbated by a range of human actions. The primary aggravating factor in the losses suffered in New Orleans, for example, was the historical development of large sections of a city in an area two meters below sea level.

Other disasters can be the indirect consequence of human action. Flooding can be caused or intensified by deforestation and the destruction of wetlands. Droughts and the famines that follow them are caused by global variations in climate but also by deforestation, overgrazing, and the excessive use of rivers and aquifers for irrigation.

Disasters have social and environmental consequences. The direct economic costs of a disaster are generally measured in the number of casualties and the expense of re-establishing property and infrastructure. The intangible social costs include the disruption of societies caused by the exodus of evacuees from a disaster zone or intensified competition for limited resources.

The poor and disenfranchised in a community are more likely to suffer the adverse effects of disasters because they lack the resources to effectively prepare for them or recover from them. Similarly, wealthier countries have more resources with which to respond to disasters within their borders than do developing countries. Disaster impact comparisons based on insured losses can be misleading, as poorer nations have less infrastructure and capital exposure. Slow-onset disasters, such as drought or famine, sometimes do not appear in such analyses at all.

The ecological losses that can result from disasters, such as the destruction of habitats or the loss of wildlife, are not easy to quantify and are seldom factored into impact studies of disaster events. *Disturbance ecology* teaches that floods, fires and other natural disruptions are essential to the dynamics of ecosystems. Naturally occurring fires are part of the life cycle of forests and maintain a vigorous biodiversity. River ecosystems require periodic flooding to remain healthy. The natural capacity of ecosystems to withstand or even thrive after such natural disruptions can be severely diminished by human actions. Degraded forests are more prone to fire and insect infestation. Removing wetlands, dunes, and mangroves from coastal areas increases the damage caused by ocean storms and tsunamis. Eroded hillsides are more vulnerable to flooding.

One of the prime reasons why statisticians show an increase in the number of disasters in recent decades is the massive increase in human populations living in hazard areas. Global warming may also increase the frequency and intensity of extreme weather events and cause increased flooding and ocean storm surges, as well as fatal heat waves. Recent research suggests a possible correlation between sea surface temperature in the key areas of cyclone birth in the North Atlantic and the annual intensity of cyclones.

SEE ALSO: Blizzards; Fire; Floods and Flood Control; Hazards; Hurricanes.

BIBLIOGRAPHY. Janet N. Abramovitz, *Unnatural Disasters* (Worldwatch Institute, 2001); Mark Pelling, ed., *Natural Disasters and Development in a Globalizing World* (Routledge, 2003); Ted Steinberg, *Acts of God: The Unnatural History of Natural Disaster in America* (Oxford University Press, 2000).

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Discount Rate

THERE IS AN ongoing discussion in environment-related fields about the practice of discounting in economic analysis. The need for discounting arises when economists seek to compare the costs and benefits of a project or policy that occurs over a number of years. Economists do not treat future costs and benefits the same as current ones, because the value of a dollar tomorrow is less than the value of a dollar today. This argument is theoretically related to two factors. First, this money can be invested, and interest earned, between now and the future. If the dollar is not received until the future, than such an investment opportunity is foregone. In practice, this foregone rate of return is often calculated at the prevailing interest rate (or the average productivity of capital) in a particular context. Second, economists argue for a positive rate of time preference for at least two reasons. First, the underlying level of impatience assumption suggests that people have a time-bound conception of their own self-interest that leads them to favor consumption in the present over that in the future. It generally has been assumed that poor households have a higher rate of time preference than wealthier ones as satisfying basic needs in the present is paramount. Second, a positive rate of time preference is suggested based on the belief that future generations will be better off than those in the present. According to this argument, current generations may reasonably weight a unit of consumption in the present more heavily than the same unit in the future, where it is assumed to be a proportionately smaller piece of an ever-expanding pie.

Projects in the private sector often rely on the opportunity costs of capital (or the interest rate) to establish a discount rate. It is disputed whether the discount rate for public sector projects should be based on the opportunity cost of capital or a social discount rate that is more closely associated with the rate of time preference. In the past, the World Bank has recommended that the standard opportunity cost of capital be used as the discount rate. Development economists typically have suggested a discount rate of 10 percent for projects in developing countries based on this opportunity cost criterion. Others argue that it is better to go with the social rate of time preference, as government and individuals are different than corporations in that they must consider a wider range of issues than just profit.

In practical terms, the discount rate enters project calculus when it is used to determine the net present value of all future benefits and costs. When all such costs and benefits are expressed in present terms, analysts may undertake a cost benefit analysis to determine if it is worthwhile undertaking a project. The formula for calculating net present value is (B minus C) divided by (1 plus r)$^{\text{year}}$, where "B" equals benefits, "C" equals costs, "r" equals the discount rate, and "year" refers to the number of years into the future from the present.

The choice of an appropriate discount rate for the cost-benefit analysis of public sector projects is highly controversial. First, some assert that the use of a high discount rate, or any discount rate at all, leads to short-sighted assessment of costs and benefits, especially longer-term environmental costs and benefits. The higher the discount rate, the more significantly future costs and benefits will be progressively reduced each year in relation to current costs and benefits. Projects that affect environmental quality over the longer term, such as soil conservation efforts that will not yield results for ten years, do not appear to be remunerative investments when future benefits are highly discounted. Second, many have suggested that high discount rates have negative implications for inter-generational equity because this practice dissuades public entities from investing in projects that only generate significant benefits for future generations. Finally, there is an emerging body of scholarship that suggests poor people do not necessarily have higher rates of time preference than their wealthier counterparts. For example, recent empirical research in Zimbabwe found that poor subsistence farmers often demonstrate future bias in their decision making. The behavior of poor households under famine conditions in others parts of Africa also suggests a very low rate of time preference. The implications of this for discounting practice in the public sector are potentially significant. If one accepts that the rate of time preference may be a more appropriate determinant of discount rates for use in the cost-benefit analysis of development projects in the poorest countries, then it would seem reasonable to re-examine standard discount rates given that time preference rates for the poor may not be as high as previously thought.

SEE ALSO: Consumers, Economic; Economics.

BIBLIOGRAPHY. S. Hellweg, T.B. Hofstetter, and K. Hungerbuhler, "Discounting and the Environment—Should Current Impacts Be Weighted Differently than Impacts Harming Future Generations?" *International Journal of Life Cycle Assessment* (v8, 2003); R. Hueting, "The Use of the Discount Rate in Cost-Benefit Analysis for Different Uses of Humid Tropical Forest Area," *Ecological Economics* (v.3, 1991); S. Lumley, "The Environment and the Ethics of Discounting: An Empirical Analysis," *Ecological Economics*, (v.20, 1997); W.G. Moseley, "African Evidence on the Relation of Poverty, Time Preference and the Environment," *Ecological Economics* (v.38, 2001).

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Discourse

DISCOURSE IS A term used by social scientists and theorists to refer institutionalized habits of thinking, talking, and narrating, which both reflect, reproduce, and impose understandings of the world. The most prominent theorist influencing nature–society studies that incorporate or adopt the idea of discourse is Michel Foucault, whose social theory directs attention at normal ways of speaking about and categorizing the world; the degree to which they are inherited, imposed, and enforced socially; and the limits and bounds they place on seeing nature and society. As Norman Fairclough explains, for Foucault,

> the objects of discourse are constituted and transformed according to the rules of some particular discursive formation, rather than existing independently and simply being referred to or talked about in a particular discourse.

Discursive practices, in other words, guide what can and cannot be said in particular places and times. In modernity, the "rules" of discourse are increasingly tied to institutions such as governments, schools, hospitals, and prisons. These institutions, by design, are in the business of producing normative proposals for (individual and collective) social conduct. Accordingly, Foucauldian analyses tend to be highly anti-institutional and particularly skeptical of the norms that arise within discourse.

FOUCAULTIAN DISCOURSE

Methodologically, Foucaultian discourse analysis tends to focus on the textual aspects of discourse, rather than the institutions themselves. From various texts, the "rules" of discourse can be extracted, and the silences and displacements inferred. Discourse analysis offers the opportunity to "rewrite" the discourse, laying bare that which was previously disallowed or disavowed. Discourse analysis is thus an openly political maneuver, designed to "destabilize" primary or authoritative texts.

As many "discourses of nature" (biodiversity conservation) are associated with large-scale institutions and also tend to proffer normalizing programs, nature-discourses have come under increased scrutiny from poststructuralists. As Noel Castree explains, "'Deconstructing' [discourses of nature] entails 'denaturalizing' them: that is, showing them to be social products arising in particular contexts and serving specific social or ecological ends that ought to be questioned."

There is an assertively normative component to discourse analysis as well: discourses of nature "ought" to be deconstructed. This is representative of a radical "nature-skepticism." The task at hand is not just to call into question the naturalized discourses, but also to effectively denaturalize them, and so make them harder to take for granted, and easier to unseat. As so much environmental discourse relies to a great degree on the efficacy of statements regarding nature or "the natural," an effectively denaturalized text is stripped of much of its authority.

Bruce Braun and Joel Wainwright hail this approach as "a departure from existing work in the field which assumes nature to be an unproblematic category, in the sense that it is a thing that is self-present to knowledge." They argue instead that the object of environmental studies and politics, nature is an effect of power. To make sense of this last statement, it is necessary to examine Foucault's theorization of *power*.

For Foucault, *power* is not something which the state or a dominant group has or possesses. Rather, it is diffuse and omnipresent: people (through discourse) are always operating within a "field of power." This concept of power was at least partially formulated in an attempt to replace the unrealizable utopian goal of revolution (the overthrow of a singular, oppressive, sovereign power) with one of resistance, where individuals and groups regain a positive political presence within (rather than against) oppression through everyday acts of destabilizing authoritative discourses (as texts, rules, ways of acting). Specifically in terms of knowledge, Foucault argues that there can be no knowledge outside of power, so the concept of *knowledge* is replaced by *power/knowledge*.

Conceptualizing nature as a discourse and an "effect of power," then, is to make a claim that the what we take for granted as "nature" is historically produced, enforced and made to appear normal through power relations. In such a formulation, some ecological advocates, among others, understand nature as unproblematic and unconstructed, even while statements about nature are always inherently political. Such advocates, however well-meaning, fail to recognize the political character and effects of their discourses, assuming them instead to be "natural" or given.

Braun's writing on the temperate rainforests of British Columbia is representative of this sort of discourse analysis at work in nature-society studies. In his analysis, he reveals that struggles between the forestry industry and environmentalists, though they appear dramatically opposed to one another, actually adopt common frameworks by inheriting discourses that hold the forests of the region to be natural (and therefore nonhuman). All the while, their tacit discursive consensus render indigenous people, and their claims to the forests of the region, essentially invisible, disallowing their voice in the debates over the use and protection of the forests. This marks an important intervention into the debates over these forests. More generally, the post-structuralist intervention signals important lessons for any critical or reflexive analysis of environmental problems and politics.

SEE ALSO: Biodiversity; Deforestation; Forests.

BIBLIOGRAPHY. Bruce Braun, "Buried Epistemologies: The Politics of Nature in (Post)colonial British Columbia," *Annals of the Association of American Geographers* (v.87, 1997); Bruce Braun and Joel Wainwright, "Nature, Poststructuralism, and Politics," in Noel Castree and Bruce Braun, eds., *Social Nature: Theory, Practice, and Politics* (Blackwell, 2001); Noel Castree, "Socializing Nature: Theory, Practice, and Politics," in Noel Castree and Bruce Braun eds., *Social Nature: Theory, Practice, and Politics* (Blackwell, 2001); Éric Darier, "Foucault Against Environmental Ethics," in Éric Darier, ed., *Discourses of the Environment* (Blackwell, 1999); David Demeritt, "What Is the 'Social Construction of Nature'? A Typology and Sympathetic Critique," *Progress in Human Geography* (v.26, 2002); Norman Fairclough, *Discourse and Social Change* (Polity, 1992); Kate Soper, *What is Nature?* (Blackwell, 1995).

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Disease

WHILE THE CONCEPT of disease might appear to be straightforward, it is actually highly complex. Its definition varies across geographic and temporal context and it must be considered in relation to how health and illness are also defined. In its simplest form, disease is a condition that has been diagnosed by a medical practitioner. In the West, biomedical practitioners, also called allopathic physicians, generally determine how a particular disease is defined. A disease, then, is something that can be operationalized biomedically, where the link between a cause and effect might be known. Illnesses, on the other hand, may manifest themselves without any clear cause or disease etiology. It is common to have a cold without the presence of a disease. Disease is often contrasted to health, which is even more difficult to define or measure. There is no ideal time when someone is in a total state of health. So, social and physical scientists tend to focus extensively on disease causation, effects, distributions, and diffusions.

EPIDEMIOLOGY

The study of diseases in human communities is called *epidemiology*. Epidemiologists investigate the biological, social, historical, or geographical relationships between a disease and its consequences. In any epidemiological study, the focus is on mortality (death) and morbidity (disease and/or illness) and the causal links between the two. The goal of epidemiology is twofold: to understand why morbidity or mortality rates may rise or fall; and to try to understand how and why a disease may wane and how to control future spread. The factors leading to increased morbidity and mortality rates may be biophysical, social, or environmental. Epidemiologists examine different diseases in their biological, social, or environmental contexts to determine how to reduce the spread and effects of particular diseases. Moreover, epidemiologists seek to identify new illnesses and place them into disease categories.

Many diseases fit into two broad categories: chronic or acute. Chronic diseases (or illnesses) are long-term conditions that may or may not require medical intervention, such as heart disease or high cholesterol. Acute diseases (or illnesses) are intense, short-term conditions, such as influenza or strep throat. Some chronic diseases are differentially intense, causing periods of decreased mobility or feelings of ill health. Depending on the person and their current state of health and the broader circumstances, both chronic and acute diseases can be the cause of mortality. Some diseases are also considered infectious, spreading from one person or animal to another person or animal, or even through one animal or insect to another animal or insect, and then to a human. Often, epidemiologists are interested in understanding the vector of an infectious disease, the subject through whom a disease passes as it spreads. Some infectious diseases can be carried from an insect to a human (such as malaria), while others are purely human-to-human (such as HIV).

When studying the spread of diseases, it is important to examine a multitude of factors, including the overall population that is impacted by a particular disease, the environmental context (broadly conceived) in which that disease is spreading, and the individual or community-based behaviors or practices that might intensify or mitigate the diffusion of a particular disease. It is impossible to partition one of these areas out from the rest, and so social scientists must consider the interrelationships among the multitude of factors that intensify certain disease distributions and limit others. Moreover, it is critical that those studying diseases take into consideration the broader socio-cultural and political-economic contexts that play a crucial role in determining how certain diseases spread and why others may be stopped. As an example, malaria eradication programs have been very effective in a number of highly industrialized economies, while this particular disease, spread via mosquitoes, remains a leading killer of people in many parts of the developing world. There is thus a geography that underlies any disease distribution or pattern, a geography based in the context of human–environmental and social relationships.

Often misunderstood by the general public, therefore, are the social power dynamics that impact disease distributions. This is because biomedicine often constructs diseases as spread through germs (or other microbes), focusing our attention on the microbiology of disease dynamics. While the biological is always important, the political and economic context may play an even more significant role in the daily lives of those at risk for disease. Some social scientists have thus turned to the subdiscipline of political ecology as a framework for explaining the complex intersections between humans and their environments and the emergence of diseases. A political ecology of disease suggests that scientists must examine the environmental as well as the human factors of diseases in tandem, since there is no way to divest disease causation from its broader human context.

POLITICAL ECOLOGY

In taking a political ecology approach, the distribution and diffusion of diseases as emerging out of the dynamic environment can be investigated, much of which is based in human-induced change. As an example, recent studies have shown that the use of certain pesticides in agriculture found throughout many areas of Latin America might cause long-term neurological, gastrointestinal, or physiological diseases (or illnesses). Over time, extensive exposure can lead to long-term problems, including the onset of certain cancers.

As another example, shrimp farming can produce, in areas with endemic malaria or dengue hemorrhagic fever, such as Vietnam or Eritrea, new, large sites of standing water ideal for the breeding of mosquitoes. These mosquitoes have the potential to further spread malaria or dengue fever. Recent studies have also shown that schistosomiasis, a parasitic infectious disease that develops in water-based snails and spreads to humans, has become endemic in new flood areas around dams. The most recent example is that of the Three Gorges Dam area in China, where the expansion of water on the land has been linked to the potential for this disease to spread to multiple communities. This is similar to what happened along Lake Volta in Ghana, a human-created lake that was linked to an increase in cases of schistosomiasis.

Susceptibility to these diseases, based in changes to the environment, are not without socio-cultural and political–economic links. It is often the case that extended exposure to pesticides, malarial exposure via shrimp farming, or contact with the parasites that cause shistosomiasis are more common among the working poor. In fact, in all three cases, the root of transmission is as much a product of the political–economic context as it is the biological one. For example, in industrialized agricultural economies, regulations have been put in place to mitigate the use of certain toxic pesticides. Such regulation is less likely in developing economies. The daily operation of industrialized shrimp farms is often left to the working poor, who are more likely to see day-to-day exposure to the mosquitoes breeding in these farms. And, those who must use water from rivers or man-made lakes that might contain high levels of parasites because they have no running water, are much more likely to encounter schistosomiasis.

INTENSIFIED URBANIZATION

There are other ways, however, that shifts in the ecology of certain places might lend themselves to the expansion of diseases. For example, intensified urbanization. Proximity to freeways, ports, or industrial parks might increase the likelihood of having asthma. Diseases of the skin and regular rashes are also common among those living close to these hazards. Crowded urban areas, particularly in poorer neighborhoods, can intensify the rate of tuberculosis or whooping cough infections, which are spread via the human respiratory system. The outbreak of SARS (severe acute respiratory syndrome) was concentrated in major metropolitan areas, such as Hong Kong and Singapore, and was linked to wind flow patterns in certain high-rise complexes in Hong Kong, in particular.

As an airborne disease, SARS spread quickly and was quite dangerous to the most vulnerable, particularly children and the elderly. The close proximity of urban living and the built environment of the high rise partially accounted for the rapid spread of this particular disease. This means, as well, particularly in countries such as the United States, that certain ethnic and racial communities are more susceptible to certain diseases. The rates of respiratory infection are particularly high among poor African Americans in heavily polluted urban areas in proximate location to factories and freeway systems, for example.

Throughout history, diseases have also spread from one population to the next via the ever-increasing interconnections present in the economy.

In historical context, the Silk Road was not only a vehicle of dynamic economic exchange and socio-cultural diffusion between the Mediterranean and East Asia; it was also a vehicle for the transportation of diseases from one place to the next. Smallpox, measles, and the bubonic plague spread throughout the regions of the Silk Road. These diseases spread to areas where people lacked any immune experience to deal with their spread, and this held dire consequences for those who came into contact with these diseases. On occasion, diseases have been used intentionally as weapons, thus also facilitating their global spread. Syphilis also traveled via an expanded global network of trade. The intensified sexual and drug-using networks made available by modern-day air transportation, which linked cities such as New York and Port-au-Prince in the 1980s, facilitated the spread of diseases such as HIV. SARS was identified as having moved from Asia to Canada via the air transportation system, which led the World Health Organization to briefly recommend the quarantine of the Toronto area and its airport.

The distribution of diseases and the fear attached to them often has dire political–economic consequences. Take, for example, Bovine Spongiform Encephalopathy (BSE) or "mad cow disease." This disease, which can spread from a cow to a human who ingests that cow, significantly impacted the British beef market. Travelers from the United Kingdom are asked to report if they have been in a rural area when entering the United States as a way to mitigate the spread of BSE in the United States. Despite these efforts, there have been a few cases of BSE reported in the United States, prompting the Japanese government to stop the import of U.S. beef into their country. This debate over the link between an economic import and the spread of a deadly disease has led to an intense economic struggle between these two trading partners. In another case, Haiti in the 1980s was identified as a key site for the spread of HIV, leading to the decimation of their tourist economy. Fear of SARS and Avian Bird Flu has similarly hurt the tourism economies of Hong Kong and Thailand.

Ironically, there are also potential consequences when the biological environment is intentionally modified to reduce certain diseases. The recent controversy over the link between heavy metals (particularly mercury or thimesoral) in vaccines and autism among young children is an example. Despite protestations from the pharmaceutical and medical communities, thimesoral has been removed from many vaccines in the last five years because of the intense scrutiny it has received. Mercury has been replaced with aluminum, which is sometimes linked to Alzheimer's and dementia, although no link has been made about the long-term effects of aluminum-based vaccines. So vaccines, despite their widespread use and high rates of success for stemming the diffusion of certain diseases, are not without controversy or concern. The hope that penicillin and other medicines more generally would put an end to infectious diseases in the 1970s, for example, has not come to fruition. Scientists underestimated the mutability of diseases.

Some of the most significant problems today stem from the fact that new forms of old diseases

Ryan White

There is a high degree of social stigma attached to the people and places thought to be diseased. Examples of this can be found throughout history with the development of leprosy colonies and asylums meant to house those who were thought to have mental diseases. Seen as unproductive economic citizens, the plan was to quarantine these populations to minimize their impact on the larger society. Stigma is also often fueled by misconceptions of how certain diseases are spread in the first place, leading many to conflate the causes of one disease with the spread of another.

Such confusion may have significant social implications, as people are made marginal because of misunderstanding. This is most classically seen in the case of Ryan White, a young boy who contracted HIV in the United States from a blood transfusion while treating his blood disorder known as hemophilia. Ryan White fought the stigma and isolation and became an important representation of how HIV was and was not transmitted.

are emerging that are resistant to the prophylactics meant to stem their spread. Newly developed malarial medications have not been able to keep pace with the mutation of malaria. It is quite possible to contract a strain of malaria that is drug resistant. Antibiotics, once seen as a panacea for all diseases, have been given in such large quantities for viral infections (where they are ineffective because antibiotics fight bacterial infections) that they are becoming ineffective against bacterial infections as well. In some cases, antibiotics have also destroyed the good bacteria in the body, giving rise to a new regime of medications called probiotics, designed to promote bacterial growth in the body; for example, in digestion. More generally, vaccine and other pharmaceutical developments are also controversial because they often pit individual rights (the right to vaccinate or not) against the larger public good (the right to be protected from various diseases).

Disease is not simply the absence of health, because a person can live a perfectly healthy (and long) life with a chronic illness. But, diseases are processes that lessen how a person might live. It is thus valuable to consider how diseases manifest themselves, how and why they might spread, where they spread, and how they might be contained. At the same time, diseases are not simply the responsibility of individuals; they are often tied to the dynamic changes taking place in socio-cultural, political–economic, and environmental contexts. Moreover, diseases are not isolated from one another. In fact, co-infections or co-factors are common and can exacerbate the consequences of having certain diseases. Malnutrition diminishes the body's capacity to fight off com-

Susceptibility to diseases is not without socio-cultural and political–economic links. For example, the daily operation of industrialized shrimp farms is often left to the working poor, who are more likely to be exposed to mosquitoes.

mon infections, which other, healthier bodies might be able to handle. Immune-suppressing diseases such as HIV, or autoimmune diseases such as lupus, which attack their own host's cells, make individuals susceptible to diseases that can eventually kill them. No one, in fact, dies from HIV disease (often called AIDS); they die from tuberculosis or malaria or even a common cold because their immune system is unable to produce antibodies to fight off the infection.

Despite the optimism that biomedical advances would be able to rid the world of most diseases, doctors are seeing a resurgence of older diseases and the emergence of new diseases. In this context, protecting biodiversity becomes even more important as people struggle to find ways to cope with both chronic and acute illnesses. In places where biomedical treatments are rarely available, common property resources form essential places for the development of nonbiomedical treatments and medications to minimize the severe symptoms associated with many diseases. The intricate link between disease, health, society, and environment is thus more complex when the invaluable significance of biodiverse ecoregions and their potential to provide short- and long-term mitigations against current and future diseases is considered. This includes biomedical interventions, which continue to also rely on both naturally and synthetically based medications that may help people cope with the day-to-day realities of trying to live healthy lives.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDs); Antibiotics; Black Death; Bovine Spongiform Encephalopathy; BT Toxoid; Cancer Alley; Carcinogens; Center for Disease Control; Chronic Wasting Disease; Drugs; Epidemic; Epidemiology; Fecal Coliform Bacteria; Health; Influenza; Syphilis; Typhus; Vaccination; West Nile Virus; Yellow Fever.

BIBLIOGRAPHY. Andrew Cliff, Peter Haggett, and Matthew Smallman-Raynor, *World Atlas of Epidemic Diseases* (Oxford University Press, 2004); Susan Craddock, *City of Plagues: Disease, Poverty, and Deviance in San Francisco* (University of Minnesota Press, 2000); Sarah Curtis, *Health and Inequalities: Geographical Perspectives* (Sage, 2004); Paul Farmer, *AIDS and Accusation: Haiti and the Geography of Blame* (University of California Press, 1992); Anthony Gatrell, *Geographies of Health: An Introduction* (Blackwell, 2002); Jonathan Mayer, "The Political Ecology of Disease as One New Focus for Medical Geography," *Progress in Human Geography* (v.20, 1996); Jonathan Mayer, "Geography, Ecology, and Emerging Infectious Diseases," *Social Science and Medicine* (v.50, 2000); Melinda Meade and Robert Erickson, *Medical Geography* (The Guilford Press, 2000).

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Disequilibrium

DISEQUILIBRIUM, AS USED in ecology, is a term used to describe systems that do not tend toward a stable, homeostatic balance. Whereas an ecological system in equilibrium tends toward stability both in terms of species composition and cycling of abiotic nutrients and energy, a system in disequilibrium exhibits no stable end point, has species composition in flux, and exchanges nutrients, energy, and organisms with surrounding systems.

Disequilibrium systems can be either dynamic or static. With dynamic disequilibrium, disturbances to environments occur too frequently for a stable equilibrium to be reached, and species turnover, the rate at which become locally extinct from a given location and are replaced by new species, is driven by the interaction between frequency of disturbances relative to the mortality and reproductive rates of constituent species. Disequilibrium in ecology thus relies on autecological explanations by examining the response of individual species to various environmental stimuli. In contrast, equilibrium approaches focus on the formation of stable assemblages, and tends to be concerned about the responses of entire communities to environmental stimuli (*synecology*).

Static disequilibrium occurs when species composition in a given area remains stable over short to medium time-scales (hence it is static), but changes when viewed over long time-scales. Disturbance is more prominently featured within disequilibrium ecologies as well. Within equilibrium ecology, disturbance is a viewed as an aberration that interrupts the natural development of stable ecosystems. Disequilibrium ecology views disturbance as a vital and natural component of proper ecosystem functioning, depending on the frequency and spatial scale of disturbances.

DISEQUILIBRIUM APPROACH

The intermediate disturbance hypothesis is an example of a disequilibrium approach to ecology. Following disturbance, rapidly reproducing and dispersing pioneer species (r-species) with short life spans tend to dominate the area of disturbance, and then gradually give way to slower growing, long-lived species characteristic of later successional stages (k-species). The intermediate disturbance hypothesis states that where disturbance is too frequent, species composition becomes skewed toward the pioneer species; whereas if disturbance becomes too infrequent, species composition becomes skewed toward late-successional species. This hypothesis states that the greatest biodiversity occurs with intermediate rates of disturbance, such that viable populations of both r-species and k-species will be maintained. This contrasts with equilibrium approaches, which assert that greatest biodiversity occurs strictly within the stable assemblage of species that develop when disturbance is minimized.

The subject of disequilibrium, especially in contrast to equilibrium, is critical to the philosophy and practice of conservation. Equilibrium approaches to ecology have played a crucial role in the establishment of nature reserves, with a generalized strategy of setting aside large portions of habitat and minimizing disturbance and human involvement. Disequilibrium approaches have been regarded with some suspicion by some conservationists, out of concern that an allowance for disturbance within nature would be used to justify extractive activities and further loss of habitat, despite growing acceptance of disequilibrium ecology's explanatory power. Other ecologists point out that equilibrium approaches can be detrimental to conservation, in that the Balance of Nature ontology suggests that nature will maintain itself, and obscures the necessary role that people must play in actively maintaining biodiversity, especially in the context of global climate change.

Disequilibrium ecology intersects concerns over environmental conservation and social justice as well. Conservation areas designed under equilibrium perspectives emphasize the importance of increased area to promote higher biodiversity, and tend to grow in size as buffers and connective corridors are acquired. With this expansion, land use conflicts often arise. Additionally, the establishment and maintenance of parks in the developing countries often conflicted with the presence of human populations, often indigenous groups or migrants.

MINIMIZING DISTURBANCE

Equilibrium design advocates minimization of disturbance and the exclusion of people from conservation areas, and have resulted in local groups being removed from the landscape. Disequilibrium approaches accept some level of disturbance as being necessary and natural to the maintenance of biodiversity and proper functioning of ecosystems. Some level of human use of landscapes can therefore be tolerated by environments, such as fuel gathering or the collection of nontimber forest products. Some reserves in the developing world have been designed to include people living within the its boundaries. The term *conservation with development* is applied to this application of disequilibrium ecology, allowing a balance of human use with biodiversity conservation.

SEE ALSO: Conservation; Disturbances; Ecosystem; Equilibrium; Nutrients; Species.

BIBLIOGRAPHY: Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Michael E. Soulé and Gary Lease, eds., *Reinventing Nature? Responses to Postmodern Deconstruction* (Island Press, 1995); Robert J. Whittaker, *Island Biogeography: Ecology, Evolution, and Conservation* (Oxford University Press, 1998); Karl S. Zimmerer, "The Reworking of Conservation Geographies," *Annals of the Association of American Geographers* (v. 90, 2000); Karl S. Zimmerer and Kenneth R. Young, eds., *Nature's Geography: New Lessons for Conservation in Developing Countries* (The University of Wisconsin Press, 1998).

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Disturbances

A DISTURBANCE EVENT perturbs ecosystems, driving ecological patterns and processes outside their normal range of variability. Disturbances may alter species richness, population structure, net primary production, and nutrient flows. These changes may be temporary or long term, depending on both disturbance type and ecosystem characteristics. Determining whether ecological changes fall within normal ecosystem variability requires a judgment call. When is drought severe enough to be a disturbance? When does insect herbivory grade into insect outbreak?

Anthropogenic disturbances are caused by people, and include fire, oil spills, livestock grazing, pollution, logging, and fishing. Natural disturbances are caused by climatic, geologic or biological change. Examples of climatic disturbances are drought, hurricanes, and windstorms. Geologic events include earthquakes, volcanic eruptions, and landslides. Pest or pathogen outbreaks, mass marine mortality, and algal blooms are all biological disturbances. Disturbance impacts also interrelate. A forest suffering from drought is more susceptible to insect outbreak. Oysters in Chesapeake Bay declined due to a combination of storms, overharvest, pollution, and disease. Determining whether a disturbance is anthropogenic or natural is complicated. Evidence that humans have for millennia influenced ecosystems from African savannahs to Amazonian rainforests draws into question any strict divide between human and "natural" drivers of disturbance. The potential for anthropogenic climate change gives disturbances such as glacial movement and hurricanes ambiguous origins.

Ecologists further differentiate endogenous from exogenous disturbances. Endogenous disturbances are caused by internal ecological changes, such as treefalls that open up gaps and alter light, temperature, and moisture regimes. Treefalls immediately impact understory growth, litter decomposition, and ecosystem productivity. They have long-term impacts on microtopography, soil organic matter, and forest structure. Exogenous disturbances are those events that originate outside an ecosystem.

Disturbances are characterized by their intensity, severity, frequency, timing, and geography. Intensity is the energy a disturbance releases per unit time and area. Hurricanes are more intense than mild breezes. Disturbance intensity depends on ecosystem conditions and external forces. For example, fire intensity depends on fuel mass as well as wind speed. Severity is the magnitude of ecological change a disturbance causes. A flood that forever alters a river channel is a severe disturbance.

Frequency is how often a disturbance reoccurs, and is often inversely proportional to intensity. Low-intensity boreal forest fires occur frequently, whereas high-intensity tropical forest fires occur infrequently. Disturbance timing is important. A severe frost during plant budbreak or wildlife birth season will have a greater impact on survival than at other times. Disturbance geography includes its size, shape, and adjacent ecosystems. Whereas a single treefall may impact less than 2.5 acres (about one hectare) of forest, the hurricane of 1938 flattened forests throughout southern New England. The shape of an area impacted depends on site elevation, aspect, and species composition. Proximity and connectivity to an undisturbed area affect species repopulation.

ASSUMPTIONS AND REALITY

Historically, ecologists believed that ecosystems possessed a natural equilibrium, and that variations from this equilibrium reflect an imbalance of nature. This perspective originated with Frederick Clements's theory of ecological succession, which posits that vegetation composition changes through time until reaching a climax community. Ecologists predicted that stable, unchanging conditions were necessary to develop biodiverse ecosystems such as Amazonian rain forests. Disturbances were thought to throw ecosystems off their trajectory toward climax equilibrium and reduce biodiversity potential. Natural resource management incorporated this assumption. U.S. national parks had policies to suppress both natural and anthropogenic fire, which backfired. Fire suppression contributed to fuel buildup and conflagrations such as that in Yellowstone National Park in 1988.

In recent decades, ecologists recognize that disturbances are integral to a healthy ecosystem. Disturbances alter ecosystem structure and rearrange nutrients and energy sources and sinks. Joseph Connell's intermediate disturbance hypothesis proposes that a medium level of disturbances actually increases biodiversity. Coral reefs were once thought to be uniform ecosystems that required a steady environmental state to develop their diversity. Instead, coral reefs are a mosaic of patches that reflect different disturbance events and recovery stages across the landscape.

Analyzing how disturbances impact ecosystem health involves measuring not variations from an equilibrium, but rather ecosystem resistance and resilience. Resistance refers to the relative capacity of a system to return quickly to previous or original conditions after a disturbance. The thick bark of Douglas fir increases its resistance to fire. Debris dams increases a stream's resistance to floods. Resilience is the ability to quickly return to normal conditions after a disturbance. Mountain ash resprouts quickly after fires. The rapid life cycles of stream invertebrates promote population resilience. Postdisturbance recovery may be along a different successional pathway, yet still within normal ecosystem parameters.

Disturbances can push an ecosystem past a threshold to a new state from which it is difficult to return. Once shifts in temperature, nutrients, and consumer species allow algae to dominate coral reefs, corals have a hard time regaining a foothold. Cheatgrass (*Bromus tectorum*) is an exotic that now holds a near monoculture in western U.S. ecosystems because it has outcompeted native vegetation for moisture and altered fire frequency. Native plants are not likely to grow back without significant human intervention.

Ecosystems have disturbance regimes, namely the spatial and temporal scales of disturbance and recovery. Species adapt to disturbance regimes over evolutionary time. Some species even depend on disturbances. Many pines require fire to open up cones and release seeds. Today, resource managers try to manage within disturbance regimes, rather than fighting them. Techniques such as controlled burns mimic natural fire regimes. This approach is part of ecosystem management, which manages for ecosystem health rather than an idealized balance of nature.

SEE ALSO: Biodiversity; Clements, Frederick; Climax Communities; Coral Reefs; Disequilibrium; Drought; Ecosystems; Equilibrium; Fires; Hurricanes; Succession.

BIBLIOGRAPHY. R.M.M.M. Crawford, ed., *Disturbance and Recovery in Arctic Lands* (Sprīger-Verlag, 2002); Carl F. Jordan, *Amazonian Rain Forests: Ecosystem Disturbance and Recovery* (Sprīger-Verlag, 1986); Lawrence R. Walker and Roger del Moral, *Primary Succession and Ecosystem Rehabilitation* (Cambridge University Press, 2003).

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Dodo Bird

IN LOUIS CARROLL'S *Alice in Wonderland*, a fictional Dodo bird leads a "caucus race" in which everybody wins a prize. The real Dodo, first discovered on the then-uninhabited island of Mauritius in the 1500s by Dutch and Portuguese sailors, was a loser in the race of survival. Flightless, large, and never exposed to human hunters, the Dodo bird would often haplessly approach European hunters. Because the meat of the Dodo was allegedly distasteful, the Dutch called the bird *Walgvogel,* meaning "bad tasting bird," and the birds were quickly hunted to extinction. The last reliable sighting of the bird was in 1663. A stuffed Dodo bird was sent to Oxford University's Ashmolean museum, but was partially destroyed by a fire in 1755. A discovery in 2005 of Dodo bird bones has added new information about the shape and DNA of the bird.

The Dodo is a symbol of extinction and the uneasy interaction between humanity and the environment. The fact that Mauritius was pristine wilderness, untouched by any human contact, made the animals of Mauritius particularly susceptible to human hunting, and to the nonnative animals that were inevitably introduced by human visitors. The volcanic island of Mauritius is located far off the eastern shore of Madagascar, far from most shipping lanes and—before the 16th century—hundreds of kilometers away from human habitation. There is some evidence that Arab traders could have known about the island, but it was in every sense a separate natural world. This small island, a beautiful emerald in the clear waters of the Indian Ocean, has recently become a tourist paradise and is now home to some two million diverse human inhabitants. Although the Dodo is gone, rare and fragile populations of island birds like the famous pink pigeon maintain a precarious hold in cramped aviaries and on the remotest mountaintops of Mauritius. Although Dodo in Portuguese means "dumb," perhaps the label is best reserved for those who fail to appreciate the lesson of its extinction.

SEE ALSO: Extinction of Species; Hunting; Madagascar.

BIBLIOGRAPHY. Peter Bennett, *Evolutionary Ecology of Birds: Life Histories, Mating Systems and Extinctions* (Oxford University Press, 2002); Sir Richard Owen, *Memoirs of the Extinct Wingless Birds* (John van Voorst, 1879); Steven Stanley, *Extinction*, (Scientific American Library, 1987).

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Dogs

DOGS HAVE BEEN human companions at least since the Mesolithic era, some 20,000 years ago. Oddly, whenever they are successfully trained by humans to comply with their specific duties, dogs are rewarded and considered as "intelligent" or "smart" by their masters. Therefore, the term *socialization* used in the case of dogs implicitly refers to the relationships between dogs and humans, and not among dogs.

Nowadays, no one would be too much alarmed to see an adult person having a discussion with a dog, even though we are aware that the animal can not really "understand" the nuance of words. Incidentally, a Canadian professor of psychology, Stanley Coren, has conducted years of research and has published six books about the possible ways of communicating with dogs and understanding the "dog language."

Among their many social uses, dogs can help hunters and shepherds; serve as house guardians; assist the blind; or be used by the police to search for suspects, rescue lost persons, or for security purposes in airports. In Italy and France, the "truffle dogs" are trained in digging up high-value truffles in forests. In the Arctic, Huskies are not only a vital element for transportation, even in 21st century, but are also a true tradition going back thousands of years. Many charity organizations related to dogs have been created. In Canada, the "Fondation MIRA" (and founder Éric St-Pierre) have given a guide dog for free to the blind teenagers in Québec since 1990.

Dogs have contributed to social life in many countries, for instance with dog exhibitions and clubs, one of the first being the Birmingham Dog Show Society founded in 1859. Cities have created bylaws and regulations specially made for dogs. In several parks in New York City, there are special sections for pets, and sometimes separate sections for "big dogs" and "small dogs," to avoid conflicts between animals and owners. On the sidewalks of Paris, dog owners must clean up after their pets; otherwise, a severe regulation imposes a penalty of more than $200.

Dogs are often seen as "man's best friend," but their relationships with people can sometimes be hazardous. In her book titled *Fatal Dog Attacks: The Stories Behind the Statistics* (2002), veterinarian Karen Delise from the National Canine Research Council states that there were "over 540 fatal dog attacks in the United States" from 1965 to 2002. According to the U.S. Department of Health and Human Services, only for 1994, "an estimated 4.7 million dog bites occurred in the United States, and approximately 799,700 persons required medical care."

A DOG IN THE KITCHEN

Dogs are a part of many cultures, but their relationship with humans are set in many different ways and traditions. For instance, in many of France's restaurants, dogs are allowed in kitchens; but in Canada, a restaurant could be closed if an inspector found a pet anywhere in a restaurant. Oddly, one of the world's finest restaurants, founded in 1740 in Paris, is called *Au Chien Qui Fume* ("The smoking dog").

There seem to exist an almost universal taboo against eating dog meat in most cultures, with the exception of China, Mexico, and a few societies in the Pacific Islands. This aversion for the idea of eating dog meat is cultural and probably comes from

Dogs are a part of many cultures, but their relationship with humans are set in many different traditions.

the fact that dogs are seen as puppies, as "a part of the family." In Western countries, most people would accept to eat a common hot dog because they know sausages are in fact made with pork or beef. However, according to Kathleen E. McLaughlin, a correspondent with *The Christian Science Monitor*, the Animals Asia Foundation (AAF), an animal-welfare charity based in Hong Kong, "estimates that up to 8 million dogs are eaten every year in China. Most large restaurants offer a dog dish or two, and nationwide, dog meat is as easy to find in any big restaurant as a hamburger is in the United States."

DOGS IN POPULAR CULTURE

Dogs are present in art and popular culture. Countless popular songs refer to dogs. In 1948, bluesman Lightnin' Hopkins sang "Let Me Play With Your Poodle." Blues singer Big Mama Thornton recorded "Hound Dog" in 1953, which was later sung by Elvis Presley in 1955. Paul McCartney referred to his dog in his song "Martha My Dear" (1968), and included "Three Legs" on his *Ram* album (1971). David Bowie composed a song titled *Diamond Dogs* (1974), looking like a dog on the album's cover. The group Pink Floyd also created a piece titled "Dogs" on the album *Animals* (1977). However, singer Iggy Pop was the canine champion with two provocative songs he wrote: "I Wanna Be Your Dog" (1969) and "Dog Food" (1980).

Director Jacques Godbout made a documentary film about the love for dogs in North America and France, titled *Aimez-vous Les Chiens?* (1975), that linked "De Luxe" dogs with our excessive, consumer's society. The director argues that we treat dogs as we do for ourselves. The film explores hairdressers and restaurants for dogs. But before that odd film essay, dogs became heroes in many Hollywood movies and TV series: the first Rin-Tin-Tin (1916–32) appeared during the silent era, in *The Man From Hell's River* (directed by Irving Cummings, in 1922). From 1943, the MGM also had its own dog star, Lassie. The first of a series of melodramas shot in color, Fred Wilcox's *Lassie Come Home* (1943) told the story of a poor child who tried to find his beloved dog, sold by his parents to an aristocrat. Walt Disney and Ken Petterson issued many versions of *One Hundred and One Dalmatians* (1961).

In cases of anthropomorphism, many dog stars created for younger audiences often have human qualities. As Charles Schultz created Snoopy in his comics strips *Peanuts*, dogs were also very popular in French comic books: in Belgium, Tintin has his dog companion named Milou; in France, Astérix and Obélix have Idéfix, the little white dog. Apart from achieving many exploits, all these imagery dogs heroes could easily talk with their masters.

In ancient Egypt and Greece, artists used to make sculptures of dogs. In their book about the representation of dogs in Western art, Peter Peters Bowron, Robert Rosenblum, William Secord, and Carolyn Rose Rebbert acknowledge that the most important painters have included dogs in some of their works, from Gustave Courbet to Edouard Manet and Salvador Dalí.

An old Arab proverb says "The Dogs Bark But the Caravan Moves On," which can take many different meanings: "No matter what people say, I carry on," or "Those who are against us are worthless," or "The dogs give us the signal so we can go on safely."

SEE ALSO: Animals; Children; Environmental Education; Parks; Pets; Smokey Bear; United States; Urban Planning.

BIBLIOGRAPHY. American Veterinary Medical Association, *U.S. Pet Ownership & Demographics Sourcebook, 2002 Edition,* www.avma.org (cited May 2006); Peter Peters Bowron, Robert Rosenblum, William Secord, and Carolyn Rose Rebbert, *Best in Show: The Dog in Art from the Renaissance to Today* (Yale University Press, 2006); Stanley Coren, *How to Speak Dog: Mastering the Art of Dog-Human Communication* (The Free Press, 2001); Karen Delise, *Fatal Dog Attacks: The Stories Behind the Statistics* (Anubis Publishing, 2002); Jacques Godbout, *Aimez-vous les chiens?* (Montréal: National Film Board of Canada, 1975); Fondation MIRA website, www.mira.ca (cited May 2006); Kathleen E. McLaughlin, "With Woofs and Wet noses, Dogs Help Heal in China," *The Christian Science Monitor* (June 1, 2005); U.S. Department of Health and Human Services Centers for Disease Control and Prevention, "Nonfatal Dog Bite–Related Injuries Treated in Hospital Emergency Departments, United States, 2001," *Morbidity and Mortality Weekly Report*, www.cdc.gov (cited July 2003).

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Dolphins

DOLPHINS HAVE FIGURED prominently in society for ages. To the Minoans, as far back as 2000 B.C.E., dolphins were symbols of joy and music. Centuries later, the ancient Greeks and Romans featured dolphins in their mythology, art, and literature. The four extreme points of the Australian continent continue as sacred "dolphin dreaming" sites for aboriginal tribes. In fact, all over the world—Australia, Oceania, China, India, Egypt, and Africa—dolphins often appear in stories of human creation and civilization. In contemporary society, dolphins are likewise ubiquitous in popular media and culture. However, the quantity and quality of society's encounters with dolphins today are very different from those of the past. Unfortunately, as greater numbers of people inhabit the world's coastal areas and society intensifies its use of coastal and ocean spaces, dolphins and their habitats are threatened like no time before in history.

Dolphins are aquatic mammals, belonging to the order Cetacea, which is made up of whales, dolphins, and porpoises. Many people are familiar with bottlenose dolphins *(Tursiops truncatus)*, those most often on display at marine parks and aquariums, and the species of dolphin that starred in the *Flipper* television shows and movies. Actually, there are more than 30 different species of dolphins worldwide. Like humans, all dolphins are highly social and most live in groups, sometimes called "fission/fusion" societies, which range from a few members to thousands. With large brains and a substantial cerebral cortex, it is widely accepted in the scientific community that dolphins have considerable cognitive abilities. They communicate with one another using a complex system of whistles, body language, and touching. Dolphin researchers also agree that dolphins have a rich emotional life, including a sense of humor and distinct personalities, as well as a keen sense of self-awareness.

Thus, dolphins apparently share a suite of attributes with people (many of which were once believed unique to humans), such as intelligence, emotions, and self-awareness. However, dolphins also have inner and outer worlds that are completely foreign to humans. Along with physical attributes that make dolphins marvelously suited for their watery environment, dolphins navigate their world primarily through the use of a sophisticated system of echolocation—a system by which dolphins project sonic "clicks" that return echoes to portray a three-dimensional image of the world around them. As sound passes through living tissues, dolphins routinely "see through" each other and every other living organism. It is perhaps a combination of their familiarity and their exotic other-worldliness that has attracted humans and dolphins to one another throughout the ages.

Most people encounter dolphins today by visiting a zoo or aquarium. In the United States, more than 50 million people are estimated to have visited captive dolphin facilities in 2003, where they spent more than $1 billion. Still, the maintenance of dolphins for public display is among the most controversial of issues relating to dolphins in society today. Depending upon the views and values that people attach to aquariums and the dolphins they hold, people might think of aquariums as amusement parks, public education centers, scientific research sites, conservation centers, or simply as prisons. Essentially, these various ways of thinking about dolphins in society fuel the different arguments that either justify or condemn the practice of keeping dolphins in human care.

Such arguments extend also to various interaction opportunities offered at aquariums today (allowing customers to feed or touch dolphins, for example) as well as swim-with-the-dolphins programs, which began in the late 1980s. Commercial swim-with-the-dolphins programs and related activities also take place with free-ranging dolphins in open waters. While many believe that such activities can be beneficial to both humans and dolphins, others strongly oppose any interaction with wild, free-ranging dolphins and suggest that dolphin viewing from a safe distance is the only appropriate form of dolphin interaction in the wild. Other controversial dolphin-society issues include scientific research involving dolphins, the military's use of dolphins, dolphin-assisted therapy, rescue and rehabilitation efforts for stranded dolphins, and human interactions with lone sociable dolphins.

Despite the controversy surrounding many human–dolphin interaction issues, society's affection for dolphins certaintly added steam to the burgeoning environmental protection movement of the 1970s, especially as relates to the plight of whales around the world and the public outcry related to dying dolphins in the eastern tropical Pacific Ocean purse-seine fisheries. Indeed, the Marine Mammal Protection Act of 1972—the primary legal vehicle for regulating dolphins and their habitats in the United States—was enacted largely in response to the urgent call by environmental organizations, humane groups, independent scientists, and others to protect whales and dolphins.

SEE ALSO: Animal Rights; Aquariums; Marine Science.

BIBLIOGRAPHY. Toni Frohoff and Brenda Peterson, eds., *Between Species: Celebrating the Dolphin–Human Bond* (Sierra Club Books, 2003); Donald R. Griffin, *Animal Minds: Beyond Cognition to Consciousness* (University of Chicago Press, 2001); Richard Harrison and Michael Bryden, eds., *Whales, Dolphins and Porpoises* (Facts on File, 1994); Karen Pryor and Ken Norris, eds., *Dolphin Societies: Discoveries and Puzzles* (University of California Press, 1991); John E. Reynolds III, Randall S. Wells, and Samantha D. Eide, *The Bottlenose Dolphin: Biology and Conservation* (University Press of Florida, 2000).

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Domestication

DOMESTICATION IS THE taming of animals and the cultivation of plants for human use. Some plants and animals have been domesticated for food; others for their utility as work animals or products such as sources of leather, and others for their aesthetic or entertainment value. The process of domestication began with Paleolithic humans, who domesticated the dog for guarding, hunting, working, and for food. Other animals domesticated early on were pigs, sheep, goats, and cattle. Archeological evidence from grave goods, paleoglyphs, or other evidence shows that even beekeeping had been domesticated before the Bronze Age.

By 2,000 years ago, wild horses, donkeys, cattle, oxen, and camels had been tamed and were being used for human needs. Domestication included not only the taming of wild animals, but development of animal husbandry. The breeding of small wild horses eventually led to the selective breeding of larger horses that could be used to pull chariots, and further advances produced horses large enough to be ridden by heavily armored and armed men.

Animal husbandry meant that animals were selectively bred for even more specialized human uses. Horses were bred as warhorses, as farm draft horses, and as wagon horses. The invention of the horse collar enabled greater "horse power." The breeding of horses or other livestock added immensely to the wealth of nomads, noblemen, and farmers. It also increased the range of foods available for human and animal consumption immensely over what could be gained in hunting and gathering cultures. Christopher Columbus's discovery of the New World opened the way for many new species of plants and animals to be spread around the world, and for many species to be introduced into the Americas. These exchanges were not always wholesome. The introduction of rabbits and the prickly pear cactus to Australia was disastrous. Scholars have debated fiercely about the process of domestication. Some claim that domestication was due to fortuitous mutations in species that made them useful to humans. Others argue that selective breeding is the source of the enormous "favoritism of the species" that human domestication has achieved.

For example, corn (maize) in the New World and wheat in the Old World are two immensely important food stocks for humans. They both came from wild grasses, but were cultivated and dispersed globally in different ways. Wild wheat seeds fall off when the wheat is ripe; however, domesticated wheat heads remain on the wheat stem, allowing them to be harvested more efficiently. The question is whether or not the wheat's current genetic characteristic that causes it to retain the wheat on the wheat stalk is a mutation, or a characteristic what was selectively bred into wheat over the centuries. Some scholars believe that it is both.

Some animals and plants have resisted domestication. For an animal to become domesticated for use by humans, it needs to have a temperament that can be settled and not prone to panic or fear.

Some have argued that in the domestication of dogs, the most ferocious dogs often ended up in the stew pot because they were too dangerous. Those that were friendly got some of the stew. Dogs have been used for work such as herding sheep, pulling traverses and sleds, for war, fighting in sporting matches, and for hunting. The characteristics desired have been selectively bred to produce breeds that are famous for certain skills. The Saint Bernard was bred for rescue in deep mountain snows. Another characteristic needed for domestication is a diet that can be easily met. General diets are more easily provided than are specialized diets. The koala bear and the panda bear have very specialized diets that would, along with other factors, make them difficult to domesticate. Camels can feed on very poor grasses or shrubs, and are to go without water for long periods, making them desirable for transportation in the desert. There is also the question of growth rate and of the ability to breed in captivity. Research is constantly conducted so that humans can better care for domestic and wild animals. A final characteristic of animals is how social they are. If a species of animal such as cattle have a natural herd, pack, or leader established by dominance; it is possible for a human to become the "alpha male" of the group.

By 2,000 years ago, wild horses, donkeys, cattle, oxen, and camels had been tamed for human needs.

The domestication of plants made agriculture possible. Without it, very few humans would survive.

Farming began in the Fertile Crescent about 12,000 years ago, probably with wheat production in ancient Iraq. The dry summers of Mesopotamia and Egypt allowed for the production of cereal grains, vegetables, and fruits. In the Americas, especially Meso-America, the domestication of beans, squash, and maize were revolutionary, and made large civilizations possible. In the Orient, the cultivation of rice was central to the development of civilization. The development of agriculture reduced the areas of the world that were open to hunting and gathering, while the search for plants and animals to domesticate continues. Every species that is tame becomes a plant or animal that is serviceable to humans, but also increases human knowledge and appreciation of nature. For example, the development of aquariums has led to whole industries focused on the entertainment and knowledge of keeping fish. Scholars have sought to understand the domestication process since the beginning of human history with numerous plant and animals, including sea mammals.

SEE ALSO: Agriculture; Animals; Aquariums; Dogs; Livestock.

BIBLIOGRAPHY. Stephen Budiansky, *Covenant of the Wild: Why Animals Chose Domestication* (Yale University Press, 1999); Juliet Clutton-Brock, *Natural History of Domesticated Mammals* (Cambridge University Press, 1999); Helmut Hemmer, ed., *Domestication: The Decline of Environmental Appreciation* (Cambridge University Press, 2005); Edward O. Price, *Animal Domestication and Behaviour* (CAB International, 2003); Melinda A. Zeder, et al., eds., *Documenting Domestication: New Genetic and Archeological Paradigms* (University of California Press, 2006).

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Domination of Nature

THE CONCEPT OF the domination of nature can be traced to the 17th-century Scientific Revolution and the subsequent period of the Enlightenment, which was the 18th-century philosophical and social movement that transformed visions of society, science, and nature. Previously, nature and the material world were commonly believed to be a living organism comprised of earth, air, fire, water, and "ether" that formed the stars and planets. Spiritual and religious frameworks that regarded nature as a living being independent of human will provided cultural and moral constraints to the overexploitation of nature.

Seventeenth-century thinkers developed a philosophical commitment to rational science, logical thinking, and mathematical reasoning that allowed nature to be known, managed, mastered, and dominated. According to Francis Bacon (1571–1626), the key conceptual author of the mastery of nature thesis, "nature must be 'bound into service' and made a 'slave', put 'in constraint' and 'molded' by the mechanical arts." Bacon rationalized this mastery using a religious frame of reference, arguing "only let the human race recover that right over nature which belongs to it by divine bequest, and let power be given it; the exercise thereof will be governed by sound reason and true religion." Enlightenment thinkers subsequently developed a mechanical view of nature, viewing reality as a machine comprised of discreet and individual parts whose actions could be known, possessed, and mastered for the benefit of humans. No longer part of nature, humans came to depend on the continued development of science and technology to meet human needs and advance social progress.

The domination of nature thesis has been taken up by various social theorists since the period of the Enlightenment. Max Horkheimer and Theodor Adorno, German philosophers and founding members of the Frankfurt School of Critical Theory, critiqued the real results of the Enlightenment as leading to the disenchantment and alienation of humans from nature, arguing, "on the road to modern science, men renounce any claim to meaning." This alienation is extended to the relationships between humans and even to the self, leading to the objectification and destruction of all human–human and human–nature relationships.

In 1972, philosopher, political scientist, and sociologist William Leiss published the influential work *The Domination of Nature*. His ideas caught the public interest at a time of increased awareness of environmental degradation. In addition, the effects of environmental pollution on human health—during an era of rapid technological changes—began a response to environmental problems. Leiss suggested that theoretical treatments of the domination or mastery of nature can be divided into two categories: those concerning how the "attitude or concept of mastery over nature arose and developed, and those that deal with the practical outcomes of this 'attitude' (what damage has been done in its name, and what we must do to repair it)."

HUMAN ENTITLEMENT

Through the development of an exegesis of the Baconian idea of the domination or mastery of nature, Leiss demonstrates "humanity's entitlement to mastery over nature is a subterranean theme that runs throughout the collective consciousness of the modern era … framed above all by a thoroughly secular natural science." Leiss underscored two important points in his exegesis. First, he argued that any attempt to separate humans from nature as analytical categories is misleading. Second, he explored the process by which the domination of nature came to be identified with scientific and technological progress as a broad social task that developed in response to the formation of human needs. He argued that the human urge for self-preservation spurs ongoing efforts to intensively exploit the earth's resources. But the ongoing creation of new societal wants and needs and the existence of social conflict stimulate the "seemingly endless productive applications of technological innovations" and preclude the setting of limits.

Technology, for Leiss, is the link between the mastery of nature through knowledge and the use of that knowledge to acquire and use more of physical nature in daily life. Leiss demonstrates the contradiction, however, in the growing ability of humanity to produce technological progress and innovation (what he deems *operational powers*), while failing to control the detrimental effects of this technology for both humans and nature. Leiss then proposes a socialist "counter-ideology" of the liberation of nature through the rational use of technology to eliminate wasteful production and environmental destruction. He draws parallels with other historical propositions for social change that involve both living in harmony with nature and using technology to advance the human condition. He also admonishes against using the notion of the liberation of nature as a mere slogan against the continued advances of modern technology. Instead, he argues that "the idea of the mastery of nature must be reinterpreted in such a way that its principal focus is *ethical or moral development* rather than scientific or technological innovation…a task that primarily involves the reconstruction of social institutions."

In 1980, environmental historian and ecofeminist Carolyn Merchant published another important work addressing the historical implications of the Enlightenment's transition toward a science-based view of nature. In *The Death of Nature: Women, Ecology, and the Scientific Revolution,* Merchant argues that when pre-Enlightenment visions of nature as feminine were replaced by a mechanistic worldview as part of the scientific revolution of the 16th and 17th centuries, a hierarchical and patriarchal social order emerged that linked the domination of nature to the domination of women.

Merchant demonstrates the way in which notions of ecology, science, and gender were socially and historically constructed to provide the foundations for the social and economic transition to capitalism, and connects the feminization of nature to the capitalist justification of overexploitation of nature's resources. As a foundational text within eco-feminist thinking, *The Death of Nature* argues for the re-integration of an organic and feminine worldview into modern scientific and technological treatments of nature and society.

The domination of nature thesis underlies many other discussions of the relationship between society and nature in various disciplines, including critical theory, environmental sociology, ecological philosophy, environmental ethics, ecofeminism, social ecology, and ecological Marxism. Most of these fields seek critical ways of understanding how to overturn the domination of nature within contemporary society. They do this by examining the transformation of individual and collective interpretations and implications of this domination and the potential for alternatives. Murray Bookchin, in *The Philosophy of Social Ecology* for example, proposes a theory of social ecology that links the domination of nature to class domination and social hierarchy. But he also argues "at no time can we surrender to the 'inevitability' of domination in certainty that latent liberatory possibilities do not exist." More recently, sociologist Damian Finbar White, in his article, "Hierarchy, Domination, Nature," has followed geographer Henri Lefebvre's distinction between the domination and appropriation of nature and space. He argues "all human societies have been involved in the dynamic appropriation of their natures (that is, in bringing their relations with nature into conscious rational control to survive)," rather than being destined to dominate nature. These notions of the possibility of exiting the domination-of-nature paradigm provide a foundation for contemporary theories of sustainable development, ecofeminism, and bioregionalism, all of which advocate the development of creative ways of sustainable appropriation of nature that allow the survival of all species and the domination of none.

SEE ALSO: Bioregionalism; Domination of Nature.; Ecofeminism; Social Ecology.

BIBLIOGRAPHY. Murray Bookchin, *The Philosophy of Social Ecology* (Black Rose Books, 1995); Max Horkheimer and Theodor Adorno, *The Dialectic of Enlightenment* (Herder and Herder, 1972 [1944]); William Leiss, *The Domination of Nature* (George Braziller, 1972); Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (Harper Collins, 1980); Carolyn Merchant, *Radical Ecology* (Taylor and Francis, 2005); Damian Finbar White, "Hierarchy, Domination, Nature" *Organization and Environment* (March 2003).

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Dominican Republic

THE DOMINICAN REPUBLIC (DR) and Haiti share the island of Hispaniola (also called Quisqueya) in the Caribbean. The island was partitioned formally in 1777 by the Aranjuez Treaty signed between the Spanish and the French colonial powers. The DR is located on the eastern two-thirds of the island and has just over nine million inhabitants, as well as a large undocumented Haitian- and Dominican-born Haitian population (between 300,000 to 1,000,000). Contrary to the experience of many other nations in the Caribbean, and especially neighboring Haiti, the DR was primarily a subsistence agriculture and ranching economy in the late colonial period with some tobacco and cocoa production. Due to the general abandonment of the colony by the Spanish, few settlers could afford to buy or maintain slaves. Relations of production were characterized by generalized impoverishment, low-intensity land use and a relatively small, largely mixed race population. The difference in colonial production with respect to the plantation society across the border has been defining in constructions of race and class on the island. A doctrine of anti-Haitianism was promoted throughout the 20th century and most intensely expressed in the state-supported massacre of 30,000 Haitians in the DR in 1937.

The proliferation of large-scale sugar plantations beginning in the 1870s, the construction of railways, and rising timber exports led to accelerated deforestation by the turn of the century. By 1980, 25 percent of cultivated land was planted with sugar. Most of the hardwood forests—including mahogany—were clear-cut or selectively cleared between 1880 and 1930. The first municipal regulation against logging and river contamination was passed in 1901, but early legislation was not enforced. The first natural reserve was established in 1927 to protect the watershed of the country's second largest river, the Yaque. Following U.S. occupation (1916–24), Rafael Trujillo took over the country for 31 years (1930–61). Trujillo directly appropriated forest and farmland for his or his cronies' private commercial use, while establishing some national parks to protect watersheds. Forest cover in agrarian landscapes was at times considered not under "productive use" and expropriated by the government or local elites.

Almost a decade of political instability followed the assassination of Trujillo, fueling resource extraction by powerful elites and efforts by farmers to resettle areas captured by Trujillo. Joaquin Balaguer, who had served under Trujillo, was elected in 1966 and dominated Dominican politics and environmental policy for the next 30 years. In 1967, in line with Cold War policies throughout the region designed to extend military control to rural areas, the government passed Law 206, placing forests under the protection of the state. Logging was criminalized and the forest service was incorporated into the armed forces. That same year, 12 loggers were killed by the military during a raid on a clandestine logging camp. Militarized campaigns to conserve forests continued, involving forced removals, jail terms, and violence directed toward squatters, subsistence farmers, and charcoal makers. The largest of these evictions took place in 1992, when 70,000 forest farmers were expelled from Los Haitises national park. Following Balaguer's rule, the forest service reverted to civilian administration.

Balaguer's environmental policy yielded a comprehensive natural reserve system reportedly consisting of 74 parks and marine reserves and officially encompassing 32 percent of national territory. Yet, prospects for conservation and effective environmental management of resources are highly uncertain and will depend on trends in foreign investment, the growing tourist industry, export production, and state regulatory effectiveness.

SEE ALSO: Caribbean Sea; Haiti; Sugar.

BIBLIOGRAPHY. Roberto Cassá, *Historia Social y Económica de la República Dominicana* (Alfa y Omega, 1998 and 2001); Dianne Rocheleau and Laurie Ross, "Trees as Tools, Trees as Text: Struggles Over Resources in Zambrana—Chacuey, Dominican Republic" *Antipode* (v.27, 1995); Sylvio Torres-Saillant, "Creoleness of Blackness: A Dominican Dilemma" *Plantation Society in the Americas* (Spring, 1998); Richard L. Turits, *Peasants, the Trujillo Regime, and Modernity in Dominican History* (Stanford University Press, 2002).

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Downing, Andrew Jackson (1815–52)

AN AMERICAN LANDSCAPE designer and author, Andrew Jackson Downing (1815–52) promoted the Gothic Revival style in gardens throughout the United States, writing a number of books and editing *The Horticulturalist*, a magazine published from 1846 until 1852.

Andrew Downing was born on October 30, 1815, at Newburgh, New York. His father was Samuel Downing, a nurseryman. He was named after Andrew Jackson, the American victor at the Battle of New Orleans in January 1815, and later the 7th president of the United States. He left school at the age of 16 and started work in his father's nursery, becoming interested in landscape gardening and architecture. As a result, he started writing about garden landscapes and botany. His first book, *A Treatise on the Theory and Practice of Landscape Gardening, Adapted to North America*, published in Boston, New York, and London in 1841, was widely acclaimed.

This led to work with Alexander Jackson Davis on another book, entitled *Cottage Residences*, which was published in the following year. It included many designs of houses and architectural styles, drawing heavily on an idealistic view of English country housing. In 1845, Downing collaborated with his brother Charles on *Fruits and Fruit Trees of America* (1845), which became recognized as the standard work on the topic. In the following year he started editing and published the journal *The Horticulturalist, and Journal of Rural Art and Rural Taste* which continued until his death. Another book, *The Architecture of Country Houses* (1850), followed, again showing many designs of houses.

Late in 1850, Downing went to Europe, where he saw an exhibition of watercolors by Calvert Vaux, whom he persuaded to move to the United States and work with him as partner in his company. This collaboration on a number of major projects included landscaping some of the gardens of the White House, and also the Smithsonian Institute in Washington, D.C.

Just as business was going well, Andrew Jackson Downing was killed on July 28, 1852, during a fire that followed a boiler exploding on a steamboat. His remains were buried at Cedar Hill Cemetery, in Newburgh. Vaux continued the architectural practice for many years, and in 1858 was one of the men involved in the design of Central park, New York. There is a memorial to him near the Smithsonian.

SEE ALSO: Central Park; Community Gardens; Gardens; Urban Gardening and Agriculture.

BIBLIOGRAPHY. Judith K. Major, *To Live in the New World: A.J. Downing and American Landscape Gardening* (Massachusetts Institute of Technology, 1997); David Schuyler, *Apostle of Taste: Andrew Jackson Downing 1815-1852* (Johns Hopkins University Press, 1996).

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Drilling (Oil and Gas)

DRILLING IS THE method by which earth is penetrated for the purpose of exploration or production of oil and gas. Exploration wells are intended to gather information about the sedimentary formations that exist beneath the surface, and their structural configuration. Production wells are intended to hit a specific target, or pool, in a place where the production of oil and or gas can be maximized. Drilling is not used exclusively for oil and gas, but is a common method of subsurface exploration and production of groundwater, or even solid mineral resources.

Oil and gas are fluid hydrocarbons that commonly occur in the pore spaces of sedimentary rocks. These hydrocarbons form as the result of organic material, commonly derived from marine plankton, transformed into hydrocarbons. This transformation requires burial, pressure, temperature and time. The pressure and temperature is commonly the result of deep burial beneath successive layers of accumulating sediments. Thicker sediments and deeper burial usually results from longer history of sedimentation and/or higher sedimentation rates in areas that commonly become sedimentary basins. Common sedimentary basins include the Appalachian, Illinois, Michigan, Williston and Gulf Coast basins, to name a few. These basins, and others like them, contain many of the oil and gas fields of the petroleum provinces of the United States.

Once hydrocarbons form, they may migrate from the stratum in which they form (source rock), through or into other strata. The higher the permeability (connected pore space) of a stratum, the more likely hydrocarbons will migrate into or through that stratum. Migration is driven by density. The strata in which hydrocarbons are generated, or through which they migrate, also contain water. Oil and gas are immiscible with water and with each other. Water has a higher density than hydrocarbons, and the hydrocarbons therefore migrate upward relative to water.

An oil or gas pool is formed where the upward-migrating oil and/or gas is trapped by some type of barrier. Barriers are usually impermeable layers that have a geometry that can trap the upward-migrating fluids. There are several possible trap configurations. In an anticline or dome, strata occur in a convex-upward shape, and oil and gas is trapped in a permeable stratum (reservoir rock) that is overlain by an impermeable stratum (cap rock). Oil and gas can be trapped by a fault that superimposes an impermeable stratum against a permeable one. Oil or gas can be trapped by the pinchout or termination of a tilted permeable layer that is underlain and overlain by impermeable strata. Oil or gas can be trapped by the lateral (facies) change within a stratum from permeable to impermeable conditions, and if the stratum is overlain by an impermeable stratum. If a trapping mechanism occurs, and water, oil, and gas are present in a subsurface pool, the gas generally occurs on top (the oil below that) and the water on the bottom. Because the pools have a very specific geometry and location, drill holes must be carefully placed to maximize extraction of the oil and gas.

The environmental effects of drilling can be numerous and varied. Drilling on land requires that an area be cleared of trees and vegetation to allow the transportation and setup of the drill rig. The drilling process itself produces the spillage of drilling mud over the ground surface. Some oil usually leaks out of the hole, but this is usually kept to a minimum. Some of the worst environmental hazards are the result of oil or gas well fires. These are like huge natural torches that are difficult to extinguish. A well fire releases large amounts of carbon dioxide into the atmosphere.

Offshore drilling is usually accomplished from a ship (usually for exploration) or a drilling platform (for production wells). Many consider drilling platforms unsightly. The main environmental concern, however, is seepage or leakage of oil from the drill rig or the producing well.

Despite its adverse effects, drilling is necessary as long as society is dependent on oil and gas as an energy source.

SEE ALSO: Fossil Fuels; Oil Spills; Petroleum.

BIBLIOGRAPHY. William D. McCain, *The Properties of Petroleum Fluids* (PennWell Books, 1989); William Leffler and Martin S. Raymond, *Oil & Gas Production in Nontechnical Language* (PennWell Books, 1995); A. I. Levorsen, *Geology of Petroleum* (Freeman, 1967); Armando Navarro, *Environmentally Safe Drilling Practices* (PennWell Books, 1995).

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Drinking Water

OF ALL THE uses of water, drinking water is the most fundamental, since the lack of safe and sustained water to drink is life-threatening. Yet, according to the United Nations (UN), as of 2002, nearly 20 percent of the world's population still lacked regular access to clean drinking water. Of these 1.1 billion people, 65 percent were in Asia, 27 percent in Africa, 2 percent in Europe and 6 percent in Latin America and the Caribbean.

In most countries, the state is responsible for the provision of drinking water. Any drinking water supply system consists of three major elements: source (surface water sources such as lakes, rivers, and reservoirs, as well as groundwater sources such as wells), treatment (e.g., adding disinfectants such as chlorine), and distribution to users (including pricing). Drinking water supply systems have had a long history; for instance, the ancient Greeks and Romans were among the first to introduce long-distance water pipelines. However, in recent times, the question of provision of drinking water has become even more critical and complex, particularly with the growth of large cities that are situated at a considerable distance from adequate and reliable sources of water.

How much water people need for drinking varies according to diet, climate and the work they do. The minimum amount of water needed for drinking ranges from about 2 liters in temperate climates to about 5 liters per day for people in hot climates who have to carry out manual work. Pregnant and breastfeeding women need more water. Water for basic needs goes beyond water needed for survival; it includes water for cooking and to maintain a standard of personal and domestic hygiene that is sufficient to maintain health.

Apart from the quantity requirement, drinking water also needs to meet certain minimal quality requirements. Drinking water can be contaminated by a range of chemicals (lead, arsenic, benzene),

For drinking water to be secure and useable, everyone must have safe and easy access to water facilities.

microbes (bacteria, viruses, parasites), and physical hazards (glass chips, metal fragments) that can pose risks to health if present at high levels. Consuming such contaminated water can lead to waterborne diseases like diarrhea, cholera, typhoid and dysentery, and is one of the leading causes of illness and death in the developing world. The World Health Organization has put in place norms on water quality, which form the basis for regulation and standard-setting in many national, regional and local laws. However, standards for drinking water quality continue to be either ill-defined or poorly implemented in many countries.

The question of quality of water is also closely related to the question of sanitation. This is because one of the primary causes of contamination of water is the inadequate or improper disposal of human (and animal) excreta. Meeting adequate levels of sanitation is critical in order to ensure that drinking (and other) water meets certain quality standards.

ACCESS TO WATER

Apart from quantity and quality requirements, in order for drinking water to be secure and useable, everyone must also have safe and easy access to water facilities. For instance, in households using only a remote and unprotected source, health can be jeopardized by water contamination. Further, collecting water from distant sources could also mean that a lot of time is spent on the task, with the result that women and children (who are the ones who bear the burden of collecting water in many cultures) are unable to undertake other productive activities (like going to school).

In addition, there is also the risk of injury while carrying heavy loads. Global coverage figures from 2002 indicate that out of every ten people, roughly five have a connection to a piped water supply at home (in their dwelling, plot, or yard); three make use of some other sort of improved water supply, such as a protected well or public standpipe; and two are unserved, with no choice but to rely on potentially unsafe water from rivers, ponds, unprotected wells, or water vendors.

Drinking water also needs to be affordable. The World Health Organization recommends that no more than 3 to 5 percent of an individual's income should be spent on water. However, the poor often pay far higher amounts for water that is neither safe in terms of quality nor reliable in terms of timing.

FOUR DIMENSIONS OF DRINKING WATER

The four dimensions of drinking water—quantity, quality, accessibility, and affordability—are currently facing high degrees of pressure.

The supply of water in the world has always been finite. Only 3 percent of the world's water is fresh water, most of which is locked in the icecaps of Antarctica and Greenland or in deep underground aquifers, which remain technologically or economically beyond our reach; further, only 0.3 percent of the world's total freshwater reserves is found in the reserves and lakes that constitute the bulk of our usable supply. However, the current shortages in safe and drinking water are also a result of wasteful and unsustainable consumption of water, along with competing (and often more powerful) demands of industry and agriculture. Newer options, such as reusing wastewater, are beginning to be considered.

Similarly, the question of quality has acquired great importance in recent years in the light of growing groundwater pollution as well as contamination of surface water bodies. For instance, in the late 1990s, groundwater in Bangladesh in south Asia was discovered to be contaminated with high levels of arsenic. The deterioration in quality in many places is in large measure due to chemical fertilizers and pesticides used in agriculture as well as dumping of household and industrial waste without treatment. The question of affordability of drinking water has also come to the forefront in recent times (in parts of Africa and Latin America, for instance) due to attempts in many parts of the world to meet costs of public drinking water systems by raising tariffs, and/or privatizing existing water supply systems.

In spite of the high importance of water, it is important to note that a human right to safe and adequate drinking water has still not been fully defined by existing international law or practice, although it is supported by many human rights instruments as well as other international laws, declarations and state practice. To date, the most explicit formulation on the right to water at the international level is the General Comment 15 adopted by the UN Covenant on Economic, Social and Cultural Rights in November 2002. The 145 countries that have ratified the covenant are bound to ensure that everyone has access to safe and secure drinking water, equitably and without discrimination.

SEE ALSO: Clean Water Act; Disease; Safe Drinking Water Act.

BIBLIOGRAPHY. Peter Gleick, *Water in Crisis: A Guide to the World's Fresh Water Resources* (Oxford University Press, 1993); UNESCO—WWAP, *The United Nations World Water Development Report* (UNESCO and Berghahn Books, 2003); World Health Organization, *Right to Water* (WHO, 2003).

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Drought

A DROUGHT IS commonly understood as a prolonged and abnormally extreme dry spell in a region's climate in which there is an extended absence of rains. In this vein, meteorologists define drought in terms of the extent and severity of rainfall deficiencies. Agriculturalists define drought in terms of its impact on agricultural production, while hydrologists compare ground water levels, and sociologists define it on social expectations and perceptions. The three main types of drought are: meteorological drought, which is brought about when there is a prolonged period with less than average rainfall; agricultural drought, which is defined as a condition when there is insufficient moisture for the raising of sufficient livestock or crops due either to soil conditions or the agricultural techniques under use, in spite of the fact that there may be adequate precipitation; and hydrological drought, which is brought about when the water reserves available in sources such as aquifers, lakes, and reservoirs falls below the statistical average because of overuse.

Several meteorological processes are responsible for causing drought conditions. Among these are periodic flaring of the sun known as *sunspots*, increases in atmospheric dust, the warming of the planet through increased carbon dioxide (CO_2) and fluorocarbon emissions resulting in the greenhouse effect or global warming, and the effects of the El Niño-southern Oscillation (ENSO). Scientists have argued that in some areas of the world, there is a fairly regular 22-year rain/drought pattern. These scientists believe that this 22-year cycle is linked to sunspot patterns. Sunspots are huge magnetic storms on the sun's surface. They have life spans of only a few days, yet, it is believed that they somehow affect the weather on earth by changing pressure and temperature conditions at the equator, which then results in droughts in certain parts of the world. It is known that sunspot activity reaches a maximum every 11 years. That 11-year pattern is thought to relate to the 22-year weather cycle on earth.

ATMOSPHERIC DUST

Another climatic phenomenon that is believed to result in drought is increased atmospheric dust. Winds at the desert margins spur vast amounts of dust into the air. The fine material is propelled into the atmosphere and transported long distances by the easterly winds as a long dust cloud. Such dust clouds have been observed off the coast of West Africa from satellites and space shuttles, extending far out into the Atlantic Ocean. Some of this dust can be blown all the way across the Atlantic into the Caribbean Islands. The dust layer high up in the atmosphere can hinder cumulus cloud formation because of the warm temperatures emanated by the dust layer as the sun heats it. Because of atmospheric dust, drought conditions might be experienced in regions where rain would usually have fallen.

The massive amounts of greenhouse gases (such as carbon dioxide, methane, nitrous oxide, chlorofluorocarbons, and ozone) that are being spewed into the atmosphere due to recent increased human activity, and intercontinental pollution of the atmosphere with aerosols, can result in more frequent droughts. For example, there has been increased variability of the monsoon weather over the Indian subcontinent in recent decades. This is blamed on polluted "atmospheric brown clouds" traveling from one continent to another, which interact with oceanic warming, resulting in an increased frequency of drought conditions.

Scientists are currently generating large-scale models of the atmosphere called *General Circulation Models* (GCMs), which are composed of mathematical equations and relationships designed to simulate global atmospheric conditions and make projections of the future climate. These models indicate that, as a result of increasing greenhouse gas concentrations, the average global temperature will increase 1.4–5.8 degrees C (2.52–10.44 degrees F) by 2100. With the projected global temperature increase, some scientists think that the global hydrological cycle will also intensify. Thus, the combined impacts of increased temperature, precipitation, and evapotranspiration will be increased snowmelt, runoff, and soil moisture conditions. These models further indicate that rainfall will increase at high latitudes and decrease at low and mid-latitudes where it is normally high. This will result in severe drought conditions in mid-continent regions.

EL NIÑO

One other climatic feature that has been blamed for causing drought conditions, particularly in Africa and Australia, is the El Niño-Southern Oscillation (ENSO) event. ENSO events are major disturbances in the air pressure and surface water temperatures in the Pacific Ocean. El Niño-Southern Oscillation is the result of a cyclic warming and cooling of the surface ocean of the central and eastern Pacific. This region of the ocean is normally colder than its equatorial location would suggest, mainly due to the influence of northeasterly trade winds, a cold ocean current flowing up the coast of Chile, and to the upwelling of cold deep water off the coast of Peru. Periodically, the tropical sun warms these cold waters, causing the surface of the eastern and central Pacific to warm up in an El Niño event. This results in heavy rainfall in South America, but also in severe droughts in the Indian Ocean and the western Pacific, extending as far south as the eastern coast of Australia and as far north as the Horn of Africa. The more intense the El Niño, the more intense and extensive the droughts in Africa and Australia become. The reverse phenomenon, the cooling of the eastern Pacific waters, is known as La Niña. The possible interrelationship between El Niño and global weather patterns, especially the simultaneous droughts in Russia, Africa, Australia, and Central America, was first realized in 1972–73.

On average, ENSO events take place every five years. The largest was recorded in 1982–83, and coincided with the major drought in Ethiopia and the Horn of Africa. The event in 1998, which resulted in massive droughts in southern Africa between 1998 and 2002, is believed to have also affected global weather patterns. In 1998, the southern portion of the United States experienced droughts. There were warm winters in the northeastern United States; at the same time, Alaska and British Columbia experienced unprecedented warm waters. However, it was unclear whether these events were related to the fading 1998 El Niño. Since the late 1950s, there have been several major El Niño events: 1957–58, 1965, 1968–69, 1972–73, 1976–77, 1982–83, 1986–87, 1991–92, 1994–95, and 1998–2001.

The 1982–83 El Niño was the strongest event during the 20th century, causing well over $8 billion dollars in damages worldwide. Australia experienced devastating drought and brush fires. There were massive crop failures in Indonesia and the Philippines followed by starvation. southern and eastern Africa experienced prolonged droughts resulting in disease, malnutrition, and untold deaths of livestock and people. Shortages of fresh water in India and Sri Lanka were commonplace due to drought. Across the Pacific, coral reefs died. Other parts of the world experienced devastating deluges. Tahiti experienced six cyclones. There were massive floods and mud/landslides in the Colorado River basin, Peru, and Ecuador. Downpours in the Gulf States caused extensive death and property damage. The fishingf industry in South America was devastated due to the decrease in nutrients off Peru, which meant fewer anchovy.

In some regions of the world, such as Africa, the American West, and Australia, drought is a recurring feature of the climate, with devastating consequences for human livelihoods. Drought can have social, environmental, and economic consequences. From an economic standpoint, water is crucial to the production of goods and services. In times of drought, national economic growth can be lost, resulting in the slowing of economic development. The quality of crops is often damaged with less food produced, less income for farmers, and increased prices for food. These economic hardships are often followed by high unemployment rates and refugee migrations.

Environmental consequences of drought can include reduced rangeland and forest productivity, reduced water levels, increased fire hazard, increased livestock and wildlife death rates, and damage to wildlife and fish habitat. Although many of the consequences of drought are short term, environmental impacts might have long-term repercussions for the affected area. For example, species of animals can become extinct due to loss of important habitats such as wetlands, lakes, and vegetation. Social impacts include compromised health conditions, conflicts between water users, and reduced quality of life. During droughts, many people in less-developed parts of the world die of starvation and malnutrition. Many others migrate to areas outside the drought-affected location as refugees.

MAJOR DROUGHTS

Several major droughts have been recorded during the 20th century. In 1900, India experienced a major drought in which 250,000 to 3.25 million are estimated to have died due to starvation and disease. The former Soviet Union is said to have lost 250,000 to five million people from starvation during the 1921–22 drought that hit the Ukraine and Volga regions. Another major drought 1932–34 in the Ukraine, Kuban, and North Caucasus regions of the former Soviet Union killed an estimated five to 10 million people. In 1928–30, northwest China lost three million people due to a drought caused famine. Six years later, in 1936, another region of China (Sichuan Province) experienced the worst drought, which killed five million people and displaced over 34 million farmers. Between 1930 and 1937, the United States experienced three waves of drought referred to as the *Dust Bowl*. This series of droughts coincided with the Great Depression with severe consequences, resulting in entire districts of the American Great Plains being depopulated as people were forced to leave.

Millions of people and livestock have perished due to drought on the continent of Africa, particularly in drought-prone areas along the southern rim of the Sahara Desert known as the Sahel and in southern Africa. The 20th century has seen three major famines in northeastern Africa; in 1913–14, 1968–74, and 1982–84. In Australia, recurring drought has meant billions of dollars in losses due to livestock deaths. In 2000–05, a major drought struck large parts of Australia, and for the first time water scarcity began to affect the urban population with heavy restrictions on water usage. Some towns were forced to import water. Other cities along the coast began building desalination plants, and others contemplated using water recycled from sewage.

While drought cannot be reliably predicted, this climatic condition should not always lead to famine and starvation. Certain precautions and infrastructure can be put in place to minimize the impacts of drought, especially in drought-prone areas. Such infrastructure might include the construction of reservoirs for emergency water supplies, putting limits on settlement in drought-prone areas, and education about the dangers of overcropping and overgrazing. The U.S. Agency for International Development (USAID) has established a Famine Early Warning System for much of Africa, a system that collects meteorological and other data to monitor people's access to food and to provide timely notice when a food crisis threatens the region. The International Weather and Climate Monitoring Project at the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce has extended the earlier USAID Famine Early Warning System to other parts of the world, which encompasses all of Africa, Afghanistan, Central America and the Caribbean, the Mekong River Basin, and much of southern Asia. The goal of the program is to provide weather and climate-related information to users within USAID, as well as organizations involved in providing humanitarian assistance.

SEE ALSO: Climate Modeling; Climate, Arid and Semi-Arid; Climatology; Desert; Desertification; Dust; Dust Bowl, U.S.

BIBLIOGRAPHY. W.M. Adams, A.S. Goudie, and A.R. Orme, *The Physical Geography of Africa* (Oxford University Press, 1996); Millard Burr and R.O. Collins, *Requiem for the Sudan: War, Drought, and Disaster Relief on the Nile* (Westview Press, 1995); M.L. Cooper, *Dust* *to Eat: Drought and Depression in the 1930s* (Clarion Books, 2004); E.F. Dolan, *Drought: The Past, Present, and Future Enemy* (F. Watts, 1990); E.M. Fratkin, *Surviving Drought and Development: Ariaal Pastoralists of northern Kenya* (Westview Press, 1991). M.H. Glantz, *Drought and Hunger in Africa: Denying Famine a Future* (Cambridge University Press, 1987); M.H. Glantz, "Drought in Africa," *Scientific American* (v.256, 1987); M.H. Glantz, *Drought Follows the Plow: Cultivating Marginal Areas* (Cambridge University Press, 1994); A.T. Grove, *The Changing Geography of Africa* (Oxford University Press, 1994); L. Olsson, "On the Causes of Famine: Drought, Desertification and Market Failure in the Sudan," *Ambio* (v.22/6, 1993); S.D. Schubert, et al., "Causes of Long-Term Drought in the U.S. Great Plains," *Journal of Climate* (v.17/3, 2004); D.R. Ward, *Water Wars: Drought, Flood, Folly, and the Politics of Thirst* (Riverhead Books, 2002).

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Drugs

DRUGS ARE CHEMICALS that have a dramatic effect upon a living organism by altering one or more body organs. They can be used to alter or block the processes of diseases. They can also be misused or abused. Drugs are commonly placed into a dozen categories. Those used to treat humans are classified according to the way they affect the human body. They can also be classified by their chemical makeup, the disease they fight, the affect they have on the heart or blood vessels, or their affect on the nervous system. Manufactured drugs have three names: a scientific chemical name, a manufacturer approved generic name, and the brand name of its manufacturer. Since ancient times, drugs have been produced from many different plants, animals, and minerals. Penicillin, an antibiotic, is probably the most famous of the infection fighting drugs. Others antibiotics include the sulfa drugs (sulfonamides).

Vaccines, antiserums, and immunoglobulins are infectious disease-preventing drugs. These drugs work by stimulating the body to create antibodies to fight potential diseases such as measles, smallpox, and polio. When the antibodies combine with the antigens on the bacteria or virus, they render them harmless. Antiserums and immunoglobulins also neutralize the antigens of the infectious disease, such as diphtheria, tetanus, hepatitis, or rabies. The cardiovascular drugs affect the heart or blood vessels by normalizing irregular heartbeats, stimulating the heart beat so that more blood is pumped, and enlarge small blood vessels; or, in the case of hypertensive drugs, treat high blood pressure. Drugs such as analgesics, anesthetics, hallucinogens, stimulants, and depressants affect the nervous system. The analgesic drugs relieve pain, but because some of them contain a narcotic, they are subject to abuse. Narcotics (analgesia plus a sedative) include codeine, heroin, and morphine. Aspirin is a nonnarcotic analgesic.

The general anesthetics are drugs that produce a state of sedation that blocks sensations. Ether halothane and thiopental have been used in surgery. Hallucinogens or psychedelic drugs such as LSD (lysergic acid diethylmide), marijuana, and mescaline produce hallucinations. Hallucinogenic mushrooms and other plants are often grown illegally, and are known to cause drug addiction. The stimulant drugs affect the nervous system. They can reduce fatigue, stimulate the kidneys, or produce other affects. Caffeine, cocaine, and amphetamines are drugs in this category, which are also subject to abuse. Depressants cause the nervous system to become relaxed so that tension and worry are diminished. Tranquilizers (anti-anxiety agents), alcohol, and sedative-hypnotics are depressants. Other depressants include benzodiazepines and barbiturates (Phenobarbital, pentobarbital and secobarbital). Nonbarbiturate sedatives include chloral hydrate and paraldehyde. Recreational drug abuse with these is widespread. Other drugs include diuretics, hormone therapy drugs, vitamins, and immunosuppressive drugs. Drugs used in chemotherapy are the antitumor (antineoplastic) drugs.

Drug abuse has two major forms: recreational and medicinal. The recreational abuse of drugs has created criminal empires. In areas such as Burma or Afghanistan, where opium is produced; South America, where coca leaf is used for the manufacturing of cocaine; and other areas where other drugs producing crops are grown, have been subjected to efforts at eradication including the use of defoliants. The impact on the natural environment has been negative. Steroids have been abused to enhance sports performances. The medicinal abuse of drugs is probably even more widespread than the recreational use. Failure to handle medicines properly has contributed to drug resistance to bacteria strains. It has led to a race to continually produce new drugs against "stronger bugs." Some may consider another form of medicinal drug abuse to be the stimulation of animal growth for increasing meat production, often with negative side effects.

SEE ALSO: Antibiotics; Bovine Growth Hormone; Quinine; Vaccination.

BIBLIOGRAPHY. H. Winter Griffith, Stephen Moore, and Kevin Boesen, *Complete Guide to Prescription and Nonprescription Drugs 2006* (Perigee, 2005); Klaus Kummerer, *Pharmaceuticals in the Environment* (Springer-Verlag, 2004); Abigail A. Salyers and Dixie D. Whitt, *Revenge of the Microbes: How Bacterial Resistance Is Undermining the Antibiotic Miracle* (ASM Press, 2005).

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Dryland Farming

DRYLAND FARMING IS rainfed agriculture in arid or semi-arid areas, and growing crops and raising livestock without irrigation in semiarid and dry subhumid areas with minimal rainfall. Because dryland farming systems depend on rain and snow for their necessary moisture, they differ from arid zone systems, where irrigation is necessary, and from humid zone systems, where moisture is adequate or surplus for crops. Due to the limited and seasonal precipitation that shows considerable temporal and spatial variations and high evapotranspiration, agricultural systems in drylands have to adapt to the resulting low soil moisture and the patchiness of the ecosystem created by these conditions. This leads to a high riskiness of agricultural production, which is generally compensated by other diversified forms of income or seasonal migration in different forms of seminomadism.

Croplands cover 25 percent of the world's dryland areas, and the bulk of the world's food (60-70 percent of the world's staple crops) is provided from rainfed agriculture. Nevertheless, agriculture in drylands is considered in general as less favored, since it faces a variety of either biophysical or socioeconomic constraints. In areas of low productivity, yields are generally are less than 50 percent of irrigated systems on comparable land. The vast majority of dryland inhabitants, about 90 percent, live in developing countries. In many cases, they are the poorest of the poor, and display the lowest levels of human well-being.

Increasing degradation due to poor management of soils prone to erosion, steep slopes, saline soils, or low rainfall quantities are some of the limitations for agricultural production, frequently exacerbated by uncertain land tenure systems, growing population numbers, limited infrastructure, and market access and neglect of policy makers in previous decades. Degradation of rangeland is mainly caused by overgrazing, leading to bush encroachment.

Four categories of farming systems can be used to distinguish different development pathways of dryland farming. Traditional subsistence farming, which is based on traditional staple crops as sorghum, maize or manioc, with low opportunity costs for land and labor, have remained almost unchanged in previous decades. Economic growth and trade triggers a movement toward commercial farming in areas of low population density and higher opportunity costs for labor, leading to mechanized, large scale production systems as are observed in cereal production areas in the Argentina, Australia, or United States drylands, and exstensive pastoral livestock systems. Where labor is abundant and land is the constraining factor, intensive cereal systems develop that rely more on the use of high-yielding varieties and fertilizers to increase productivity, for instance in the intensively managed rice-wheat production systems in the Indian Punjab or the intensive rice production systems in Southeast Asia, where intensive livestock production associated with stall feeding is common. Where both land and labor are scarce, dryland farming becomes highly intensified, like the fruit and vegetable areas around the Mediterrenean.

Key factors for improved dryland farming are the increase of plant nutrient and water uptake, increase of organic matter in the systems, and exploring the possibilities for small-scale supplementary irrigation.

Within new economic frameworks, options are proposed to include land management strategies in drylands for the provision of ecosystem services. For instance, agroforestry systems could be created in drylands for carbon sequestration or other markets for the provision of ecosystem services.

SEE ALSO: Agroecosystem; Ecosystem; Fertilizers; Livestock; Soil Erosion; Soil Science; Soils.

BIBLIOGRAPHY. Lynne Chatterton and Brian Chatterton, *Sustainable Dryland Farming: Combining Farmer Innovation and Medic Pasture in a Mediterranean Climate* (Cambridge University Press, 1996); John Dixon, *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World* (FAO, 2001); A.E. Hall, G.H. Cannell, and H.W. Lawton, *Agriculture in Semi-Arid Environments: Ecological Studies* (Springer, 1979).

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Dunes

DUNES ARE PILES of granular material that have been deposited by wind and water into hills or long ridges. Dune formation begins with a process called *saltation*, in which the flow of sand across the desert floor is interrupted by an obstacle that blocks the sand's movement. It then begins to accumulate and eventually to form a hill. The heights of dunes may be shallow, or they may grow up to 500–600 feet (150–180 meters). Most dunes are sand, but white gypsum dunes are found in southern New Mexico's Tularosa Valley at White Sands National Monument. Rarely, dunes may be composed of tephra, shell fragments, or heavy minerals such as magnetite.

Dunes are sculpted by the winds into different kinds of shapes. Transverse linear dunes are formed from moderate winds that push the lighter material to form ripples perpendicular to the direction of the wind. Strong, steady winds form longitudinal (seifs) dunes. The abrasive winds gouge deep troughs in the desert floor. Sand is then deposited in parallel lines on either side of the troughs. If there are slight wind variations, then the tops of the dunes are formed into a wavy appearance. Crescent-shaped barchan dunes are formed into an arc by a constant wind moving faster around the ends of the dune than over its windward top. The horns of the crescent are downwind. In contrast, parabolic crescent dunes have horns that face into the wind. They are held in place by vegetation, so the wind scoops out the center of the dune to form the crescent shape. Star dunes are formed when shifting winds create arms as the sands radiate outward from the stable center of the dune. Whaleback dunes are very large longitudinal dunes.

Dunes occur along ocean shores or on islands. They may also be found on the shores of large lakes, such as the dunes at the southern end of Lake Michigan. Many of the dunes in the sand seas of the Sahara and the Arabian deserts (*Rub' al-Khali* or Empty Quarter) are active, "traveling" dunes. The wind pushes the sand so it moves across the desert to swallow everything that stands in its way, including towns and oases. Dunes that are fixed by vegetation are inactive. Destruction of fixed coastal dunes causes beach erosion and opens areas to flooding during storms. Some dunes give off noises as the sand in the dune shifts from place to place, and are sometimes called *singing dunes*. Great sand dunes occur in Australia, the Atacama Desert, Baja Mexico, and Cape Cod (Massachusetts). The ocean fog supplies the Namibian coastal desert with enough moisture to sustain 100 species in the rainless dunes. Fossilized dunes have been found in a number of places such as the Permo-Trias.

SEE ALSO: Climate, Arid and Semi-Arid Regions; Beaches; Deserts; Sea Level Rise.

BIBLIOGRAPHY. Dennis A. Albert, *Borne of the Wind: Michigan Sand Dunes* (University of Michigan Press, 2006); R.A. Bagnold, *The Physics of Blowing Sand and Desert Dunes* (Dover Publications, 2005); Bill C. and Karl F. Nordstrom, eds., *Coastal Dunes: Form and Process* (John Wylie and Sons, 1999).

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Dust

DUST IS MADE up of very tiny (about 1-10 µm) soil particles (fine silt and clay) and other fine particulate materials carried by wind on local to global scales. Because dust particles are so small, they can remain suspended in air for long periods of time. For this reason, dust may be transported across or between entire continents before being deposited, usually in rainfall. Dust is a form of wind erosion of soil; 40 percent of the soil eroded in the United States is eroded and transported by wind. Long-distance transport of dust can play a role in soil formation and development through the deposition of silt, clay, and soil nutrients and minerals. Scientists suspect that much of the calcium carbonate in the soils of the western United States was deposited by windblown dust. Windblown calcium carbonates and nutrients in dust originating in the Sahara Desert of northern Africa and deposited in the Amazon basin in South America are partly responsible for its fertile soils despite their high leaching rates.

Long-distance wind transport of dust can bury roads and fill drainage ditches; scour and damage fruit and vegetable crops, foliage, cars, and buildings; and choke coral reefs in shallow ocean waters. Viruses, bacteria, fungal spores, pollutants, and toxins transported to new areas in dust can cause illness to plants, humans, and other organisms. When inhaled, dust particles can lead to respiratory illnesses, and naturally occurring soil metals such as arsenic and mercury transmitted in dust can cause metal poisoning. Many fungal pathogens of crop and noncrop plant species are transmitted over long distances by windblown spores.

THE DUST BOWL

One of the most memorable historical images in the North American psyche is the American Dustbowl, which lasted about 10 years during the 1930s. Poor land management that left soil bare, and combined with several consecutive years of drought to make soil extremely vulnerable to wind erosion. Regular dust storms in the U.S. Great Plains blew enormous dust clouds of silt, clay, and organic matter eastward into the Atlantic Ocean. Huge dark clouds of dust shrouded eastern states; it is said that the dust clouds over Washington, D.C., incited Congress to pass new laws to mitigate soil erosion.

Poor land management and overgrazing continue to intensify soil erosion around the world. Billions of tons of dust blow off of arid lands every year, and the dust blows into adjacent states and around the world. Dust storms in the desert southwestern United States are intensifying as recreational motor vehicle use and grazing increase, because these activities kick up dust and kill the natural cyanobacterial biological soil crusts that prevent erosion by binding surface soil particles together. High-altitude dust storms, from places as far apart from each other as Utah and China, deposit dust on snow packs in the Colorado Rockies and cause them to melt faster due to the decreased albedo of darker surfaces.

Faster and earlier snow melt feeds western rivers and reservoirs too quickly, causing them to overflow early in spring and run low late in the summer. This shift in timing has serious economic consequences for industries and communities that rely upon a steady flow of water throughout the summer. Dust from the Taklamakan Desert in China and the Sahara in Africa falls on the Swiss Alps, and Chinese and Mongolian mountain ranges receive dust from the Gobi Desert.

If the use of semi-arid lands intensifies with increased global human populations and agricultural land degradation, the intensity and frequency of dust storms and their far-reaching consequences will likely increase as well. Scientists will continue to study how the deposition of dust from faraway lands interacts with other consequences of global environmental change to affect human and natural communities.

SEE ALSO: Desertification; Dunes; Dust Bowl.

BIBLIOGRAPHY. N.C. Brady and R.R. Weil, *The Nature and Property of Soils* (Prentice Hall Publishers, 2002); R. Harris, "Dust Storms Threaten Snow Packs," *National Public Radio, Morning Edition* (May 30, 2006) R. Harris, "Stirring up Dust in the Desert," *National Public Radio, Morning Edition* (May 31, 2006).

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Dust Bowl (U.S.)

THE DUST BOWL describes the regional environmental conditions throughout the central parts of the United States and Canada from 1931 until 1939, where soil erosion was rampant and dust storms swept across the landscape. It came from inappropriate farming techniques and resulted in an exodus of many farming families, who were left homeless during a time of general economic hardship. Many stories emanated from this period, the most famous being John Steinbeck's *The Grapes of Wrath* (1939).

In the period following World War I, there was a sharp increase in the U.S. population. As a result, there was more demand for food, with the result that large amounts of marginal land were developed for wheat, and also for cotton. Much land in what became known as the Great Plains—Oklahoma, Kansas, Nebraska, and South Dakota—was quickly sold, with some returning servicemen and others seeking the opportunity of running their own farms away from the big cities. During the 1920s these communities survived, and a few even thrived. However, the land quickly gave out.

The soil was incapable of nourishing crops for more than a few years. More importantly, the breaking of tough ground, and the destruction of native grasses that had grown in semi-arid areas for over a millennium, saw much of the topsoil carried away by water after rainstorms. Massive soil erosion resulted with the gullying of plowed land, and water full of earth running off the land during rainstorms. Strong winds then made the situation worse. The years 1933 through 1935 were unusually dry, which meant that the water tables of parts of the Plains region were sinking so low that many deep wells slowly ran dry. Thus, these farms quickly turned into desert, with vast dust storms that came to be known as the Dust Bowl. Much livestock died in the dust storms from ingesting the soil, with others unable to scratch a living afterward. From 1934 until 1939, some 500,000 or more farmers and their families were forced to migrate.

One of the states worst affected by the formation of the Dust Bowl was Oklahoma (especially the central and eastern parts of the state) where so many farms failed, it has been estimated that 15 percent of the residents of the state moved west in search of work and new opportunities. These became known as the *Okies* who made up as many as 300,000 of those forced off their land—from a state with a population of 2.3 million at the time. The other areas worst hit were much of southern Piedmont and parts of the upper Tennessee Valley, s some areas in the interior plateau of Kentucky and also in Tennessee, some of the older glacial till in the southern part of Iowa, and also the land covered with loess in Iowa on the east of the Missouri River. The effect on the farmland was that 44 million acres of previously cultivated soil was lost, and another 87 million acres seriously damaged.

From 1934–39, some 500,000 or more farmers and their families were forced to migrate out of the Dust Bowl.

One of the worst days that enlarged the Dust Bowl was on November 11, 1933, when a strong wind stripped the topsoil from tens of thousands of farms throughout South Dakota. Then on May 11–12, 1934, a two-day storm blew away much of the topsoil throughout the Great Plains. A third disastrous day was on April 14, 1935, when blizzards wreaked havoc throughout the United States. It was this storm that led an Associated Press reporter to coin the phrase *Dust Bowl* as the skies darkened with the dust and soil, which was collected up by the wind, was swirled around and deposited hundreds of miles eastward. Other parts of the United States, fearing a similar effect on their communities, started infilling gullies, building check dams, and also embarking on the reforestation of slopes that contained marginal farming land, as well as contour plowing and going back to strip cultivation.

Many of the farmers who left the Dust Bowl at the start of the problems, managed to find work in California and elsewhere. However, as the migration continued, and with increasing unemployment, gangs of men formed vigilante groups to try to keep the Okies and others from trying to take work from them. Some businesses openly exploited the migrants, paying very low wages—barely subsistence levels—and replacing them with further migrants if they complained about the pay or conditions.

The election of Franklin Roosevelt in 1932 saw many policies in the first "100 days" programs to alleviate the early effects of the soil erosion, although it did get steadily worse during his presidency. These involved trying to help many of the migrants, protecting them from the worst abuses of the times. Roosevelt also formed the Soil Conservation Service (later renamed the Natural Resources Conservation Service) to try to ameliorate the worst degradation. There have been many attempts to find a culprit for the Dust Bowl, with some blaming the farmers for bad farming practices. Others view the land speculators who had opened up so much marginal land as the people at fault. A few others believe that politicians should have done more to alleviate the suffering. Certainly in the early 1930s, many felt the problem might only be temporary. But by the late 1930s, federal money was being made available to tap into deep aquifers for more water. Effectively, the rainstorms in 1941 helped end the drought and started to allow the soil to replenish itself. By the end of that year, the United States was at war with Japan and Germany, and many of the ex-farmers and their sons had found employment in the military.

SEE ALSO: Farming Systems; Livestock; Soil Erosion; Soil Science; Soils; United States, Great Plains (Kansas, Nebraska, North Dakota, Oklahoma, South Dakota).

BIBLIOGRAPHY. Matthew Paul Bonnifield, *The Dust Bowl: Men, Dirt and Depression* (University of New Mexico Press, 1978); Timothy Egan, *The Worst Hard Time: The Untold Story of Those Who Survived the Great American Dust Bowl* (Houghton Miflin Company, 2006); David Laskin, B*raving the Elements: The Stormy History of American Weather* (Doubleday, 1996); Walter Nugent, *Into the West: The Story of Its People* (A.A. Knopf, 1999); D. Worster, *Dust Bowl: The Southern High Plains in the 1930s* (Oxford University Press, 1979).

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The Grapes of Wrath

The most evocative story about the Dust Bowl is John Steinbeck's *The Grapes of Wrath,* which was published in 1939 by Viking Press. The title comes from the reference to the "Grapes of Wrath" in the *Battle Hymn of the Republic,* and is the story of a family of poor sharecroppers who are driven from their land in Oklahoma.

The father is Tom Joad—the surname coming from the Biblical character "Job," whose faith is tested by God in the Old Testament. When Joad returns home after being paroled from prison for manslaughter, he finds the family farm in disarray and the crops destroyed in the Dust Bowl. Forced to default over outstanding debts, Tom Joad decided to take his family to California in the hope of work. The book covers the search by Tom Joad for a steady job and a house for his family. It also involves him being exploited in an orchard, and becoming a fugitive.

In 1940, Darryl F. Zanuck produced a film of the book through which many people around the world were able to see the effects of the Dust Bowl on small farms. The book has been banned in some counties of America for various reasons, and remains controversial. In 1962, John Steinbeck was awarded the Nobel Prize for Literature for *The Grapes of Wrath.*

Earth Day

THE AMERICAN CELEBRATION of the environment began on April 22, 1970, with activities from coast to coast in dedication of a renewed concern for land, water, and air. Earth Day was initiated, in part, by the moon landings and in particular from emotions stirred by the first photograph of the earth from space. Earth Day was the inspiration of Senator Gaylord Nelson (D–WI) who spent the previous eight years deeply concerned about the state of the physical environment, wanting to take action to rectify the damage. In 1962, Senator Nelson convinced President John F. Kennedy to conduct a national conservation tour to bring the issues of a degrading environment into prominent national view. The president began the tour in September 1963, but his efforts did not bring the results Senator Nelson had hoped for. Nonetheless, President Kennedy's efforts did provide an important start to the program. In September 1969, Senator Nelson announced at a conference that a demonstration aimed at garnering public support for the environment would be held in all areas of the country the following spring. The resulting notoriety from this announcement was extraordinary.

Estimates of participation in Earth Day were set at 20 million, as communities, schools, and a variety of organizations took part in a countrywide outpouring of support for the environment. In New York City, Mayor John Lindsay closed Fifth Avenue from Central Park to 14th Street for two hours in order to provide the celebration a dedicated space. The resulting series of speeches, discussions, musical performances, and Vietnam-demonstration-style "teach-ins" to raise awareness of environmental concerns carried on until midnight. Earth Day was a huge success and it ushered in a new ea in America's stewardship toward its natural endowments that became known as environmentalism.

The era of environmentalism succeeded the conservation movement, which had its greatest prominence from 1850 through 1920. The conservation approach embodied the basic relationship between humans and the natural word, an association that had been articulated in various forms throughout history. However, by 1850, U.S. urbanization brought about a new appreciation for regions of wilderness, dedication to the wise use of natural resources, and the preservation of areas of natural grandeur. The conservation movement recognized and documented human impact on the natural world, suggesting that this influence not be destructive. There emerged a philosophical basis as well for the appreciation of nature. Writers began to

Volunteers from the U.S. Air Force joined local citizens to clean up refuse on Earth Day 2001.

discuss the interface between nature and the American identity in spiritual terms, and to identify a moral connection between the urban dweller and the land. Wilderness and areas of natural beauty were not only idealized, but were also seen as places to preserve for the use of all citizens.

The conservation movement coincided with several large-scale socioeconomic changes that permanently transformed the geography of North America. The industrialization of the American economic system was at its high point of development 1850–1920. This era also marked the emergence of large-scale agriculture and the decline in the small farm. A vast expansion in the surface transportation system occurred during this period, and the emergence and solidification of the urban system took shape. By 1920, North America entered into an era of economic expansion unprecedented in world history. The Soil Conservation Service was founded in 1935 during the New Deal Era under President Franklin D. Roosevelt. In 1937, the Pittman-Robertson Act was enacted to fund fish and wildlife programs. The most ambitious and far reaching single project undertaken in this period was the Tennessee Valley Authority, aimed at taming the wild and unpredictable Tennessee River through the construction of a series of nine dams along its course and a series of electric generating stations. The conservation movement also created the national park system, the national forest system, and the Forest Service. Much of the activity in conservation followed President Theodore Roosevelt's view of conservation as a central focus of national policy.

Earth Day represented a new direction in public concern for the environment. The conservation movement aimed at warding off unwanted misuse of land, air, and water. Earth Day focused widespread attention on a degraded environment and the focus became remedial. Following years of dumping waste materials into Lake Erie, scientists studying the lake proclaimed its literal death in 1970. The Great Lakes were threatened by pollution from the many steel-making plants, taconite processing plants, refineries, paper mills, and sewage systems. Lake Erie was the hardest hit of the Great Lakes as fish life essentially ended and the water became severely fouled.

However, within a decade, the concerted efforts of the United States and Canada brought about what some experts considered a miracle in bringing Lake Erie back to a healthy state and ensuring that regulations were in place to protect the entire Great Lakes freshwater system. The Great Lakes Water Quality Agreements of 1972 and 1978 brought the two countries together in the gargantuan task of cleaning the entire water system. The Clean Water Act, enacted in the 1970s, ensures the continued monitoring of the Great Lakes and other water bodies and the immediate remediation of any environmental dangers.

During the 1970s, legislation to protect the environment appeared, including the Clean Air Act, the Water Quality Improvement Act, the Toxic Substances Control Act, the Occupational Safety and Health Act, the Resource Recovery Act, the Federal Environmental Pesticide Control Act, the Endangered Species Act, the Safe Drinking Water Act, and the Surface Mining Control and Reclamation Act. On January 1, 1970, the National Environmental Policy Act (NEPA) was signed into law. NEPA requires federal agencies to integrate environmental values into their decision-making processes. This federal requirement gave birth to the Environmental Impact Statement (EIS), a key document prepared by federal agencies including the impact on the environment of proposed actions and the listing of reasonable alternatives to those actions. The Environmental Protection Agency (EPA) was authorized under the NEPA. The mission of the EPA is straightforward: to protect human health and the environment. In place since 1970, the EPA works toward the development and maintenance of a clean and healthy environment for the American people. The EPA is headquartered in Washington, D.C., has 10 regional offices, and employs 18,000 people.

AHEAD OF HIS TIME

The founder of Earth Day and its most energetic supporter, Senator Gaylord Nelson is considered to have been far ahead of his time on the environmental front. As governor of Wisconsin in 1961, he created the Outdoor Recreation Acquisition Program. The aim of this program was the state acquisition of one million acres of wetlands, parklands, and open space for common use. While in the U.S. Senate, he authored legislation to protect the Appalachian Trail and the creation of the system of national hiking trails. In addition, he co-sponsored the Wilderness Act, the Alaska Lands Act, and worked on various aspects of consumer protection and protection of national parks. In 1990, Senator Nelson received the Ansel Adams Conservation Award, given to a federal official exhibiting commitment to the cause of conservation and to the American Land Ethic. He was also a recipient of the Only One World Award from the United Nations Environment Program. In 1995, Senator Nelson received the country's highest civilian award, the Presidential Medal of Freedom from President Clinton. The proclamation stated, in part: "As the father of Earth Day, he is the grandfather of all that grew out of that event: The Environmental Protection Agency, the Clean Air Act, and the Safe Drinking Water Act."

SEE ALSO: Environmental Protection Agency; Kennedy, John F. Administration; National Environmental Policy Act; Tennessee Valley Authority.

BIBLIOGRAPHY. G.C. Daily, *The New Economy of Nature: The Quest to Make Conservation Profitable* (Island Press, 2002); Robert Gottlieb, *Environmentalism Unbound: Exploring New Pathways for Change* (MIT Press, 1998); Mary Graham, *The Morning After Earth Day: Today's Practical Environmental Politics* (Brookings Institute Press, 1999); J.R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (W.W. Norton, 2001); Gaylord Nelson, *Beyond Earth Day: Fulfilling the Promise* (University of Wisconsin Press, 1999); J.G. Speth, *Red Sky at Morning: America and the Crisis of the Global Environment* (Yale University Press).

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Earth First!

EARTH FIRST! IS an anarchical movement relying heavily on the tenets of deep ecology. Earth First!ers embrace a biocentric philosophy whereby the earth and its many natural components receive the highest and utmost protection and consideration in any decision. You cannot become a member of Earth First!, as there is no membership. You cannot pay dues, as Earth First! is neither a club nor a nonprofit organization (like the Sierra Club). To become an Earth First!er one need only to take action in defense of the earth.

The Earth First! movement is said to have been born in a VW microbus in the spring of 1980 and to have been inspired by Rachel Carson's *Silent Spring*, Aldo Leopold's *Land Ethic*, and, most of all, Edward Abbey's *The Monkey Wrench Gang*. Environmental activists Dave Foreman and Mike Roselle, along with Wyoming Wilderness Society representatives Bart Koehler and Howie Wolke and former park ranger Ron Kezar, were upset by the actions of mainstream environmentalists and thus, according to the Earth First! history page at the Sierra Nevada Earth First! website, "envisioned a revolutionary movement to set aside multi-million acre ecological preserves all across the United States."

Anyone is capable of forming his or her own Earth First! collective (group) to work on any environmental or social issue deemed important. The group's self-description on its website notes that:

> while there is broad diversity within Earth First! from animal rights vegans to wilderness hunting guides, from monkeywrenchers to careful followers of Gandhi, from whiskey-drinking backwoods riffraff to thoughtful philosophers, from misanthropes to humanists there is agreement on one thing, the need for action!

Historically, Earth First!ers have worked to bring attention to issues such as logging, mining, grazing, wilderness protection, animal rights, transportation, development, endangered species, and so on. The online *Earth First! Journal* is a migrating literary collective of Earth First! activists. There is also a gathering and celebration of Earth First!ers called the Round River Rendezvous, in which fellow activists camp in a different national forest every July to meet new activists, organize campaigns, and celebrate the movement.

Earth First! is a mentality ascribed to by dedicated individuals who have taken a hard-line stance against anything human-induced that causes environmental and social deterioration, including capitalism, patriarchy, consumerism, corporate-state control, and technology. Often referred to as fringe or far left, the Earth First! movement represents a section of society (globally) whose official slogan is "No compromise in the defense of mother Earth."

In terms of methodology, the worldwide Earth First! stance takes a "decidedly different tack toward environmental issues. We believe in using all the tools in the toolbox, ranging from grassroots organizing and involvement in the legal process to civil disobedience and monkeywrenching."

Criticisms of Earth First! include the claim that the movement is "ecoterrorist." Proponents insist that they support no violent acts, however, and most typical actions include unfurling banners, chaining protesters to logging equipment, sitting in trees, and blocking logging roads, all of which are nonviolent, though often illegal, acts.

An Earth First march in Yellowstone in 1989 reflects their hard-line stance toward environmental and social issues.

Other critics suggest that the ecological and philosophical pillars of the movement may be flawed, including the fundamental concept of bioregionalism, which has been scrutinized for its romantic localism and anti-urbanism, which may actually be environmentally unsustainable. Nevertheless, the critical ecocentric philosophy of Earth First! still makes it a galvanizing movement for a wide range of concerned activists.

SEE ALSO: Abbey, Edward; Animal Rights; Biocentrism; Carson, Rachel; Deep Ecology; Ecotage; Leopold, Aldo; Mining; Timber Industry.

BIBLIOGRAPHY. "About Earth First!" Earth First! Worldwide, www.earthfirst.org (cited March 2006); *Earth First! Journal,* www.earthfirstjournal.org (cited May 2006); Julia Butterfly Hill, *The Legacy of Luna: The Story of a Tree, a Woman and the Struggle to Save the Redwoods* (HarperSanFrancisco, 2001); "History of

Earth First!" Sierra Nevada Earth First! www.sierranevadaearthfirst.org (cited March 2006).

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Earthquake

AN EARTHQUAKE IS usually caused by the rupture of a geologic fault, or the seam between two large blocks of land that suddenly move in different directions. The two predominant types of faults are thrust faults and strike-slip faults. A strike slip fault is the most common in the United States; it is where two geologic plates move in opposite directions relative to each other, such as the San Andreas in California. A thrust earthquake occurs when one plate moves under another. In 2004, a great earthquake off the Indonesian island of Sumatra was caused by a thrust fault; the rupture along the fault was greater than 93 miles (150 kilometers). The earthquake and the massive tsunami that was generated by the tsunami killed about 200,000 people in the Indian Ocean basin. In the United States and Canada, the Cascadia fault off shore of British Columbia, Washington, Oregon, and California, could potentially generate an earthquake of magnitude 9.0, and could generate a significant tsunami that could endanger people throughout the Pacific Basin. Nations subject to earthquake hazards include, but are not limited to, Indonesia, Iran, India and Pakistan, Turkey, Greece, Italy, China, Japan, Taiwan, Canada, Mexico, and the United States.

Its moment magnitude number, often mistakenly called the *Richter scale* that is now considered obsolete, reports the *magnitude* (M) of earthquakes. The moment magnitude scale is logarithmic, which means that a magnitude 5.0 earthquake (M 5.0) is about 31 times weaker than an M 6.0 quake, and is 1,000 times weaker than an M 7.0 temblor. The primary danger to people posed by earthquakes is from the structural failure of buildings due to ground shaking. A building can collapse partially or totally when the building loses structural integrity. This is more likely to happen when buildings are built on *unconsolidated soils*, such as sand or clay, which tends to amplify the ground motion. People are killed or injured when buildings or other structures

The San Juan Earthquake

A large earthquake struck Argentina on January 16, 1944, and shook some buildings in Buenos Aires, the capital, but caused little damage. In the far west of the country, the city of San Juan, the capital of a province of the same name, along the border with Chile, was devastated. Initially there were no communications with the area, but when news reached Buenos Aires of the damage, and the death of about 6,000 people, the population of one of South America's wealthiest cities decided to raise funds to help the victims and families of the dead.

With Argentina having become incredibly wealthy through its neutrality in World War II—it did enter the war on the Allied side in 1945—the *portenos* (urban residents) of Buenos Aires responded generously and established the San Juan Fund. It was coordinated by Colonel Juan Domingo Perón, the Secretary of Labor in the military government, and an ambitious and aspiring politician.

One of the events that Perón organized was an artistic festival, where actors and actresses, along with the military, would raise money, the highlight of which would be a massive gala performance. Perón took center stage himself in a starched white tunic and peaked cap. It was at this event, on January 22, that Perón was smitten by an actress who was performing that evening, and was wearing a black dress, long gloves and a white feathery hat. Eva Duarte was the illegitimate daughter of a businessman from a country town, and had become an accomplished radio actress. Two years later, by which time Perón was president of Argentina, they were married and his wife became better known as Evita Peron. She died in 1952 from cancer, aged 33, and Perón was ousted as president in 1955, although he was president again from 1973 until his death in the following year.

collapse; the major cause of death in the Loma Prieta (San Francisco) earthquake of 1989 was the collapse of an elevated freeway in Oakland.

A great deal of experience has been amassed on how to build or locate structures to reduce the risk of building collapse in an earthquake. Engineers know how to design buildings that may be damaged in an earthquake, but retain sufficient structural integrity to allow occupants to escape. Modern steel-frame skyscrapers tend to withstand earthquakes remarkably well. The most dangerous types of buildings are unreenforced masonry buildings, and concrete and steel structures that are not built with seismic safety in mind. The 1906 San Francisco and 1925 Santa Barbara earthquakes in California revealed the problems with unreenforced masonry buildings, but the 1933 Long Beach earthquake damaged or destroyed down many masonry buildings, particularly schools. As a result, the California legislature passed the Field Act, which required that public buildings such as schools be built to withstand earthquake forces. In the years that followed, as experience accumulated with other great quakes (1964 Alaska, 1971 San Fernando), improved building codes and practices were adopted that greatly reduced the risk to human life from moderately large earthquakes.

In the United States, various efforts, notably including the National Earthquake Hazard Reduction Program (NERHP), have promoted research, improved building practices, and better public information about the earthquake hazard. Thus, in the United States, the long-term trend has been fewer casualties, but more property damage in earthquake stricken areas. However, seismologists, engineers, and emergency managers have warned that cities like San Francisco, Los Angeles, and Anchorage have not recently experienced "the Big One," an earthquake that would catastrophically damage the region. Continued efforts to improve buildings and to manage risk will make that earthquake, when it occurs, much less likely to kill as many people as it would without these measures. Other nations in the world are not so advanced. For example, in the 1988 earthquake in Armenia, then part of the Soviet Union, poor building practices—in particular, in high-rise concrete and steel buildings that would not have been built under American building codes—catastrophically failed, killing 25,000 people and injuring at least 15,000. Recent earthquakes in Indonesia and along the India-Pakistan border have further illustrated the importance of improved building techniques.

SEE ALSO: Disasters; Geology; Geothermal Energy; Hazards; Risk.

BIBLIOGRAPHY. P.R. Berke and Timothy Beatley, *Planning for Earthquakes: Risk, Politics and Policy* (Johns Hopkins University Press, 1992); B.A. Bolt, *Earthquakes and Volcanoes: Readings from Scientific American* (W.H. Freeman, 1980); B.A. Bolt, *Earthquakes* (W.H. Freeman, 2003); Ian Burton, R.W. Kates, and G.F. White, *The Environment as Hazard* (Guilford Press, 1993); Carl-Henry Geschwind, *California Earthquakes: Science, Risk, and the Politics of Hazard Mitigation* (Johns Hopkins University Press, 2001); Roy D. Hyndman, "Giant Earthquakes of the Pacific Northwest," *Scientific American* (v.273/6, 1995).

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East Timor

THE SMALL COUNTRY 5,794 square miles (15,007 square kilometers) now known as the Democratic Republic of Timor-Leste, or more commonly as East Timor, has been alternately occupied by the Portuguese, the Dutch, and the Japanese. The most repressive occupation, however, occurred in the 20th century when the United States, Canada, Britain, and Australia supported Indonesia's brutal military occupation of East Timor from 1975 to 1999. Estimates of lives lost during this occupation vary from 100,000 to 250,000. Following the 1999 bid for independence, Indonesia retaliated by launching a military backlash and a scorched-earth policy. Around 1,300 Timorese were subsequently killed and 300,000 were forced to seek refuge in West Timor.

Part of the Malay Archipelago, East Timor is a set of islands located in southeastern Asia at the eastern end of the Indonesian archipelago. In addition to the eastern half of Timor, the nation encompasses the Ambeno region in the northwest portion of Timor and the islands of Pulau Atauro and Pulau Jaco. Bordering on the shared waters of the Timor, Banda, and Savu Seas, East Timor has a 438-mile (706-kilometer) coastline. The climate is tropical with distinct rainy and dry seasons, and the country is subject to frequent flooding and landslides and to occasional earthquakes, tsunamis, and tropical cyclones. The terrain is mountainous with elevations ranging from sea level to 9,717 feet (2,963 meters). Natural resources include gold, petroleum, natural gas, manganese, and marble.

The Indonesian occupation left East Timor with an annihilated infrastructure that included massive destruction to irrigation systems, water supplies, schools, and homes. The entire electric grid of the country was wiped out. On September 20, 1999, Australian troops led the International Force for East Timor in restoring peace to the islands. In 2002, East Timor became the first nation to establish independence in the 21st century. The infrastructure is in the process of being restored, and all but 30,000 or so refugees have returned. Current Timorese population estimates range from 800,000 to 1,000,000. Oil and gas resources are being developed, and a petroleum reserve fund has been created.

POOREST COUNTRY IN THE WORLD

At present, however, East Timor is the poorest country in the world, with a per capita income of only $400. Some 42 percent of the population live below the poverty line. An abnormally high fertility rate of 7.8 children per female is partially a response to the high infant mortality rate (45.89 deaths per 1,000 live births) that results from common childhood diseases and a low immunization rate (50 percent for children under two years of age). Approximately 8 percent of the population live in urban areas where one-fifth of adults are unemployed. Low literacy (58.6 percent) and educational (75 percent) rates make it more difficult for young people to obtain employment, and hundreds emigrate each year. Around 80 percent of Timorese depend on subsistence agriculture for survival. The UNDP Human Development Reports rank East Timor 140th of 234 countries on overall quality-of-life issues.

Current environmental problems in East Timor are a result of massive poverty leading to over-extraction

The Quest for Oil

When Alfred Russel Wallace visited Portuguese Timor in 1861, he reported seeing natural oil deposits. In 1901 an Australian chemist, Dr James Frederick Elliott, visited Dili, the capital of East Timor, and also noticed concentrations of oil when he saw crew members of his ship throw matches overboard after lighting their pipes. Some of the matches lit up on hitting the water. As a result, on his return to Australia, he put together a business concern and sent an engineer to Timor to report on whether the quantities there were viable for commercial purposes.

The result was the Australians buying a number of concessions in East Timor, and worried that the Germans might be interested in buying the entire Portuguese possession. After World War I, interest in the Australian oil concessions saw the revival of Australian government interest in buying East Timor if it was offered for sale. The Timor Petroleum Concession Limited was then established to take over what was becoming known as the Staughton Concessions named after Arthur John Staughton, who invested his money in the search for oil.

Oil was found in many places in East Timor, but the various companies that operated the Staughton Concession faced two problems. Much of the oil was of low quality, and the costs of extracting it from extremely remote locations would probably outweigh its sale. There was also a small scandal when a British mining engineer, hired by the Australians, died in Timor of blackwater fever and his widow complained that the Portuguese seized her husband's assets.

During the late 1930s, businessmen connected with Japan became interested in the oil concessions. A Belgian middle-man died in 1940, and the Japanese attack on Malaya and Pearl Harbor in the following year saw the end of plans to find oil in East Timor. During the 1980s oil was found offshore; the Timor Gap Treaty was then signed by Indonesia and Australia, then abandoned when East Timor gained its independence.

and unsustainable harvesting of forests, resulting in widespread deforestation and soil erosion. Coral reefs and fisheries have been threatened and soil eroded by droughts and seasonal rains. The burning of wood in poorly ventilated kitchens leads to a plethora of respiratory diseases. Timorese health is also adversely affected by the fact that 66 percent of the population lack access to improved sanitation, and 48 percent have no access to safe drinking water. There is also great concern that the increased exploitation of petroleum resources may result in further environmental problems, as have been witnessed in poorer oil-exporting nations around the world.

Under the guidance of the Ministry of Development and Agriculture, the Timorese government has expressed its commitment to creating a sustainable environment that will promote economic growth, eradicate poverty, enhance biodiversity, and halt land degradation.

The government is working with Australia and a number of international agencies to establish policies geared toward achieving these goals. However, environmentalism in East Timor is still in its infancy. Due to its status as a fledgling nation, East Timor has not begun participating in international environmental agreements.

SEE ALSO: Coral Reefs; Drinking Water; Fertility Rate; Fisheries; Infant Mortality Rate; Land Degradation; Pollution, Air; Poverty; Subsistence; Waste, Solid.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apfell-Marglin, eds., *Rethinking Freire: Globalization and the Environment Crisis* (Lawrence Erlbaum, 2005); CIA, "East Timor," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); UNDP, "East Timor," www.hdr.undp.org (cited April 2006); World Bank, "East Timor," *Little Green Data Book,* www.worldbank.org (cited April 2006).

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Easter Island

EASTER ISLAND, LOCATED in the South Pacific some 2,237 miles west of the Chilean mainland, is a part of the Republic of Chile, and is one of the most isolated inhabited islands in the world. Now officially known as *Rapa Nui*, it is roughly triangular in shape, covers 63 square miles, and has a population of 3,700 (according to the 2002 census).

The first European contact with the island was when the Dutch navigator Jacob Roggeveen landed on Easter Sunday, 1722—hence the name of the island. There was a population of between 2,000 and 3,000, but from oral tradition it was believed that there might have been as many as 15,000 only a century earlier. The massive decline in the population came about as a result of deforestation and overexploitation of the natural resources on the island.

From what the Europeans discovered on that and later visits, the first Polynesian settlers arrived on about 300–400 C.E., possibly with a very small population until the 12th century, when large-scale deforestation started. This appears to have accelerated rapidly by the 17th century, with evidence from archaeological digs showing a significant decline in fish and bird bones as the islanders started to have shortages of hunting tools, and also possibly the birds having no places to nest. This was made worse by the Polynesian rat, which seems to have lived by eating seeds from palm trees on the island.

The most well-known aspects of Easter Island heritage are the Moai, large stone statues that were carved probably between 1100 and 1600, although some were still being carved when the Europeans first came to the island. They caught the attention of much of the world, and Captain Cook described them in his visit in 1774. The carving of the statues, and their movement from the quarry to their final destination further depleted the supply of wood on the island, and hence the massive decline in trees. This all led to soil erosion, and the introduction of the Birdman Cult.

The Birdman Cult of the 16th and 17th centuries saw the introduction of an annual competition whereby a representative of each clan would try to swim to the nearby island of Motu Nui, to find and bring back an egg. The first to return would become the Birdman for that year, having rights over the

Thor Heyerdahl

In 1947 the Norwegian adventurer Thor Heyerdahl (1914–2002) became famous all over the world with his Kon-Tiki expedition, in which he and five colleagues managed to cross the Pacific Ocean. This led to the book *Kon-Tiki* (1950), and Heyerdahl subsequently taking part in a number of other voyages in boats recreating vessels made in the ancient world.

One of Heyerdahl's other interests was in Easter Island, and in particular the existence on the island of the large stone statues known as the *Moai*. This led to Heyerdahl returning to the Pacific in 1955, where he received a large reception from the locals because of his fame. He was asked to pitch his tents on the site attributed to the legendary King Hotu Matua, and began the first archaeological excavations ever undertaken on the island.

At that time the only regular contact with Easter Island was a Chilean warship, which called at the island each year. Heyerdahl's work on the *Moai* fascinated many of the locals and they started to attribute some supernatural powers to him. It was not long before the Norwegian adventurer was able to discover much about the past of the Easter Islanders, and also some customs which could be used to understand their history. Heyerdahl located the quarries where the *Moai* were carved, and bringing European archaeological knowledge to bear, found many other small stone carvings. He was also able to prove, by digging around the *Moai*, that many of them had torsos, and were not solely heads. Some of the Moai had toppled over, and Heyerdahl's colleagues helped put them upright again. The results of his work were published in a bestselling book *Aku-Aku.*

distribution of resources. The last such swim, across shark-infested waters, took place in 1867 and it is believed that the event was a way in which the community was trying to supplement their food supplies. By the mid-19th century the population on Easter Island had risen to about 4,000 but by 1877 had fallen to only 110. This came about from introduced diseases as well as slave-traders operating from Peru. In 1888 the island was annexed by Chile with a treaty drawn up by Policarpo Toro. Many of the locals were forced to live in a shanty town on the outskirts of the capital, Hanga Roa, until the 1960s. Now their heritage is cherished, and the island is visited by many tourists with stopovers by Lan Chile and other trans-Pacific flights stopping at Mataveri International Airport.

There are many tablets found on the island featuring a mysterious script that has not yet been deciphered, and there are some theories advanced by linguists seeking to link the culture on Easter Island with other parts of the world.

SEE ALSO: Chile; Deforestation; Peru; Soil Erosion.

BIBLIOGRAPHY. Thor Heyerdahl, *Aku-Aku: The Secret of Easter Island* (George Allen & Unwin, 1958); Francis Mazière, *Mysteries of Easter Island* (Wm Collins & Sons, 1968); Alfred Metraux, *Easter Island: A Stone-age Civilization of the Pacific* (Andre Deutsch, 1957).

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Eastern Wilderness Act of 1974

THE EASTERN WILDERNESS Act of 1974 made it possible for lands in eastern states that had recovered from past abuse to be eligible for inclusion in the National Wilderness Preservation System.

Passed in 1964, the Wilderness Act (P.L. 88-577) established a system of wilderness areas called the National Wilderness Preservation Systems. Three federal agencies were given responsibility for managing wilderness lands: the National Park Service, U.S. Forest Service, and U.S. Fish and Wildlife Service (the Bureau of Land Management was later given responsibility for managing wilderness lands after passage of the Forest Land Policy and Management Act in 1976). Provisions of the Act specified criteria for the inclusion of new units in the system. Wilderness lands were to be "…primeval in character and influence… affected primarily by the forces of nature." In addition, 5,000 acres was established as the recommended minimum size for wilderness areas. This meant that the majority of public lands large enough to qualify for inclusion in the National Wilderness Preservation System were located in western states. Between 1964–75, only four of the 95 wilderness areas established in the United States were west of the 100th meridian.

The Eastern Wilderness Act emerged in response to the limited number of wilderness areas created in eastern states after passage of the Wilderness Act. In evaluating the suitability of lands, the U.S. Forest Service had strictly interpreted language found in the Wilderness Act. As a result, areas that had been logged or otherwise altered by human activities were found to be unsuitable for inclusion in the system. The shortage of wilderness areas in the east led to calls for more wilderness lands to be designated near eastern population centers. Among proponents for eastern wilderness lands was U.S. Senator George Aiken from Vermont. A member of the Senate Committee on Agriculture and Forestry, Aiken was an advocate for additions to the wilderness system in Vermont and other eastern states where road construction, housing projects, and other activities were rapidly encroaching on the last undeveloped areas. In 1972, President Richard Nixon acknowledged the unequal distribution of wilderness lands, instructing the Secretaries of Agriculture and the Interior to hasten efforts to identify lands suitable for inclusion in the National Wilderness Preservation System. In the early 1970s Congress began debating the question of wilderness lands in eastern states. One failed proposal called for the creation of a separate eastern wilderness category within the National Wilderness Preservation System.

The Eastern Wilderness Act (P.L. 93-622) served as recognition of the need to protect wilderness lands in populous eastern states threatened by expanding populations and development. Signed into law on January 4, 1975, by President Gerald Ford, the act created 15 new wilderness areas encompassing 207,000 acres in 13 states (Alabama, Arkansas, Florida, Kentucky, New Hampshire, North Carolina, Tennessee, South Carolina, Georgia, Vermont, Virginia, West Virginia, and Wisconsin). Among new wilderness areas were the Sipsey Wilderness (12,000 acres) within Alabama's Bankhead National Forest, the Upper Buffalo Wilderness (10,590 acres) within Arkansas's Ozark National Forest, and Bristol Cliffs Wilderness (6,500 acres) in Vermont's Green Mountain National Forest. Another provision of the law was to direct the Secretary of Agriculture to review and report back within five years concerning the suitability of 17 other units for protection as wilderness. The act also affirmed that wilderness areas were to be managed in accordance with the Wilderness Act of 1964. Unless otherwise indicated, the law addressed only lands located eastward of the 100th meridian.

The Eastern Wilderness Act profoundly impacted land management practices in eastern states. As a result of its passage, wilderness areas are now located in most eastern states and include some small areas such as the Leaf Wilderness (940 acres) in Mississippi's De Soto National Forest. In addition, large wilderness areas have been established in Shenandoah and Great Smoky National Parks.

SEE ALSO: Fish and Wildlife Service; Forest Service; National Park Service; Nixon Administration; Wilderness; Wilderness Act (U.S.–1964).

BIBLIOGRAPHY. Stephen R. Fox, *The American Conservation Movement: John Muir and His Legacy* (University of Wisconsin Press, 1980); Roderick Nash, *Wilderness and the American Mind* (Yale University Press 1982); Max Oelschlaeger, *The Idea of Wilderness: From Prehistory to the Age of Ecology* (Yale University Press, 1991).

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Ecofeminism

FEMINIST ENVIRONMENTALISTS ARGUE that the domination of women by men reflects and reinforces the domination of the environment by society, and that the two are understood to be linked; patriarchal gender relations in society correspond to androcentric environmental ethics. Ecofeminism posits that the same masculinist habits of thinking and behavior that devalue, oppress, and exploit women also do so to nature; and are mutually reinforcing hegemonic processes pivoting around artificial Western binary oppositions interpreted by religion, science, government, and other androcentric agencies (superiority/inferiority and as domination/subordination that include human/nature, male/female, mind/body, reason/emotion, objective/subjective, and material/spiritual). Furthermore, classism, heterosexism, racism, and speciesism as well as sexism are all presumed to be interrelated. Thus, the liberation of women and of nature from male domination and abuse are causally interconnected. Accordingly, ecofeminism contains political as well as philosophical, theological, sociological, and ecological concerns. At the same time, there are several variants of ecofeminism that in general correspond to different foci for political thought and action within feminism, including liberal, cultural, social, and socialist feminists. However, these variants of ecofeminism have in common feminist challenges and alternatives to tyrannical patriarchal power structures that oppress, exploit, and abuse women and nature in different cultural, environmental, political, and historical contexts.

The French writer Francoise d'Eaubonne founded the *Ecologie–Feminisme* (Ecology–Feminism Center) in Paris in 1972, and coined the term *ecofeminism* in her 1974 book *Le Feminisme ou la Mort* (*Feminism or Death*). Since the mid-1970s, some of the more important pioneers in ecofeminism include Carol J. Adams, Chris J. Cuomo, Mary Daly, Greta Gaard, Susan Griffin, Wangari Maathai, Sallie McFague, Carolyn Merchant, Gloria Orenstein, Val Plumwood, Rosemary Radford Ruether, Ariel Salleh, Vandana Shiva, Charlene Spretnak, Mary Stange, Starhawk, Alice Walker, and Karen J. Warren. The United Nations Decade for Women (1975–1985) and other international initiatives by the UN and other organizations have contributed to the development of ecofeminism as well. Today there are numerous monographs, anthologies, book series, journals, websites, conferences and conference sessions on ecofeminism. However, ecofeminism has been criticized by many, including both feminists and ecofeminists, on various grounds, such as for essentializing the connection between women and nature, idealizing women in non-Western cultures, appropriating indigenous religious rituals, dividing academics and activists, and alienating ecofeminists from feminists and vice versa.

To take a particular example, the Chipko movement in the Himalayan foothills of northern India is one of the earliest political initiatives by women concerned about the environment. Many villages in India have long depended on local forests as a major source of food, fuel, fodder, materials,

Ecofeminism has been criticized by many, including both feminists and ecofeminists, for being divisive.

medicines, and spirituality. However, beginning in the 1970s, women who had been temporarily left behind in the village as men sought employment beyond had to defend their precious forests from outside loggers encouraged by government agencies. The women adopted Gandhian methods of nonviolent resistance by joining hands to encircle and thereby protect trees. The loggers were intimidated and withdrew. The Chipko movement led to the development of government policies on natural resources that were more sensitive to the concerns of local people. It has been recognized in India and internationally for preventing the deforestation of substantial areas of the country.

GREEN BELT MOVEMENT

Another specific case is the national tree planting campaign in Kenya called the Green Belt Movement. It was created by Wangari Maathai in 1977. The National Council of Women of Kenya distributes seeds and seedlings, coordinates, monitors, and assesses local programs. Local women provide free labor in the daily management of the seed collection, quality control, planting, seedling care, and marketing. They plant and maintain small plots of trees adjacent to villages, farms, homes, and schools. In the process, they become skilled foresters, earn extra cash income, elevate their social status, participate in environmental education, and meet the needs of themselves and their families. This grass roots ecofeminist movement has mobilized more than 80,000 women to take charge of their own lives, needs, and habitat through planting more than seven million trees and related activities. Children and men have also become active partners in the programs. Furthermore, planting trees helps to control soil erosion, retain soil water, and prevent desertification. The Green Belt Movement reflects an ethics of caring for other humans and for nature that emulates mothering, partnerships, and friendships as well as a deep concern for future generations. Maathai won international recognition for her environmentalist and peace activism with the award of the Nobel Peace Prize in 2004.

An additional ingredient of some ecofeminism is the women's spirituality movement that sees intimate and vital interconnections among women, nature, and the supernatural. Many consider the earth to be divine as Mother Nature or Gaia, and accordingly, she deserves reverence as well as respect, care, and love. For example, Starhawk has revitalized a variant of nature religion through her neopagan earth goddess worship. She asserts that nonhierarchy is the ethical path to perceive the interconnections and interdependencies of the living Earth. In this context, Starhawk has campaigned as an activist for many feminist, environmental, justice, and peace issues. These range from civil disobedience in anti-nuclear actions protesting the Diablo Canyon power plant and the Livermore Laboratory for research in California, to antiglobalization demonstrations at World Trade Organization meetings in Seattle, Washington, and in Genova, Italy. She has been a major influence on many environmentalists including Earth First! Since 1977 various editions of her book, *The Spirit Dance: A Rebirth of the Religion of the Great Goddess* have collectively sold more than 300,000 copies.

FOCUS ON GENDER

Even though ecofeminism is still in an early stage of development with limited recognition and appreciation, it has focused more attention on gender aspects of human ecology and environmentalism and promises much more in the future, as followers believe the liberation of women will contribute to the liberation of nature as well. Ecofeminism focuses on caring and nurturing human and natural interrelationships. In the process, it integrates and promotes social and environmental justice.

Today, ecofeminism operates at the intersections of the women's, environmental, and peace movements with considerable potential to integrate them and apply their concerns to improve both society and human–environment dynamics as demonstrated by the achievements of the Chipko and Greenbelt Movements. A better future for humanity and the biosphere depends on creating more cooperative, equitable, and healthy partnerships between men and women as well as between society and environment.

SEE ALSO: Chipko Andolan Movement; Gender; Shiva, Vandana.

BIBLIOGRAPHY. Irene Diamond and Gloria Feman Orenstein, eds., *Reweaving the World: The Emergence of Ecofeminism* (Sierra Club Books, 1990); Heather Eaton, *Introducing Ecofeminist Theologies* (T. & T. Clark Publishers, 2005); Beate Littig, *Feminist Perspectives on Environment and Society* (Prentice Hall, 2001); Rosemary Radford Ruether, ed., *Women Healing Earth: Third World Women on Ecology, Feminism, and Religion* (Orbis Books, 1996); Ariel Salleh, *Ecofeminism as Politics: Nature, Marx, and the Postmodern* (Zed Books, 1997); Noel Sturgeon, *Ecofeminist Natures: Race, Gender, Feminist Theory and Political Action* (Routledge, 1997); Jennifer Turpin and Lois Ann Lorentzen, eds., *The Gendered New World Order: Militarism, Development, and the Environment* (Routledge, 1996); Karen J. Warren, *Ecofeminist Philosophy* (Rowman & Littlefield, 2000).

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Ecological Footprint (EF)

"ECOLOGICAL FOOTPRINT" (EF) refers to a system of measurement developed for estimating human appropriation of ecological resources relative to biologically productive (bioproductive) land area. EFs can show how much land is needed to sustainably support a human population, nation, or a specific component of society, such as a commodity (e.g., soybeans), transportation system (e.g., auto transit), or lifestyle (i.e., a consumption pattern). The utility of footprint analysis (FA) is best understood by considering the ecology of a modern city. Urban inhabitants are concentrated within city bounds but they rely on the importation of resources and exportation of wastes to survive.

Therefore, the land area necessary to produce resources and absorb wastes far exceeds the actual geographic boundaries of the city (or nation)—in wealthy nations ecological flows may be distributed across the planet. FA provides a framework for tracking these resource and waste flows and converting them into a common metric—land area (hectares) per capita—by making use of widely available economic statistics.

The calculation of an EF is based on two key assumptions. First, it is possible to reasonably track most human resource consumption and waste generation, and translate these flows into bioproductive land areas. Second, it is possible to standardize varying land areas by weighting each according to their "potential biomass productivity." The latter refers to production potential that is of economic interest to society, not the diverse assemblage of other organisms necessary for human survival, or biodiversity. Biodiversity is included in national and global analyses but there is much debate over how much land must be set aside. (Estimates range from 8 to 75 percent; in practice, the conservative World Commission on Environment and Development [WCED] estimate of 12 percent of bioproductive land is simply added to the footprint total for the given social unit.) EFs omit resource uses for which conversions into bioproductive land are difficult, such as the impact of local fresh water use, as well as any impact that systematically reduces the ability of ecosystems to regenerate, such as the release of nonassimilable and/or bioaccumulating chemicals (e.g., uranium, polychlorinated biphenyls [PCBs], and mercury).

STANDARDIZATION MEASURES

The novelty of FA is in standardizing resource and waste flows in terms of bioproductive land area, instead of creating arbitrary indices or lumping together ecological and social factors. This requires analysts to distinguish between the quality of land types depending on their level of productivity. For instance, *arable land* is the most productive and is used for staple crops, such as wheat and corn. *Pasture land* is unable to support staple crops and used primarily for grazing. While pasture also produces food for human consumption, the biochemical conversion from plants to meat represents significant energy loss (a factor of 10).

Forest land represents tree farms or forests yielding timber. *Built* or *degraded land* is productive land lost to roads, buildings, and other structures. Built land is considered formerly productive because human settlement patterns indicate that arable land is ruined to accommodate infrastructure. Other types of land included are *productive sea space*, *energy* *land*, and *biodiversity land*. When calculating a footprint, resource and waste flows are first converted into one of the above land areas (in hectares) and then scaled by multiplying by an *equivalence factor* (EQ), also in hectares. EQs express differences in land productivity compared to world average productivity (e.g., in 1999 arable land had an EQ of 2.1 and pasture land 0.5). World average productivity, and consequently the productivity of each above land type, is recomputed each year to account for reductions in resource stocks, such as desertification, fishery collapse, urbanization, and so on.

Taking the example of a typical North American barbecue meal—steak, potatoes, and paper cups and plates—we can see how an EF is calculated. The steak and potatoes require pasture land for grazing, arable land to grow the potatoes, energy for fertilizer, transportation, processing, storage, and cooking, and built land for roads and buildings to transport and store the food. The paper products require forest land for production and have similar energy requirements except that the paper must either be disposed of or recycled, requiring more energy and/or land to store the waste. After each production and waste flow of the meal is converted into the appropriate land type and multiplied by the associated EQ, all of the components are summed. This gives the total EF for the meal, which might then be compared to the world average footprint for a typical meal.

Clearly, EFs can get extremely complicated, especially when doing a *component-based* calculation, as in the latter example. William Rees, who coined the phrase *ecological footprint,* notes the pedagogical utility of component-based analysis. Rees's former student and collaborator, Mathis Wackernagel, emphasizes that the more robust *compound* calculation, which takes the nation-state as its unit of analysis, achieves the central purpose of the tool: "providing a big picture analysis to put the various competing human uses of the biosphere in each other's context." While national EFs may seem even more complicated, economic data for all countries is readily available through the United Nations, and as Wackernagel and Rees note, the inclusion of every possible impact is unnecessary: "there is virtue in accurate simplicity," especially considering the complexity of ecosystem functions. Wackernagel's team has calculated national EFs for most countries back to 1960. This longitudinal analysis reveals that, excluding a conservative set aside for biodiversity, humanity's ecological demand exceeded the earth's regenerative capacity around 1980 (1970 with a biodiversity allocation). By 1999, humanity exceeded earth's capacity by 20 percent. This *overshoot*—a concept William Catton popularized and that served as an inspiration for the development of EFs—is possible because EF calculations acknowledge that populations can indeed grow beyond their carrying capacity, but they will eventually feel the effects of critical resource loss.

Wackernagel and Rees theorized EFs as a direct intervention into debates over sustainability, and particularly as a criticism of traditional economic modeling and the use of monetary equivalents for assessing sustainability (i.e., "pricing" or privatizing nature as a solution). FA implies that traditional economic models do not adequately account for biophysical limits, efficient resource use, ecologically realistic pricing, or intra- and inter-generational equity. By distinguishing human and environmental welfare, EFs provide much-needed conceptual clarity for social researchers. Indeed, the use of EFs within the social sciences is widespread and stimulating vigorous debate over the future of social organization.

SEE ALSO: Biodiversity; Carrying Capacity; Commodity; Consumption; Intergenerational Equity; Sociology; Sustainability.

BIBLIOGRAPHY. William R. Catton Jr., *Overshoot: The Ecological Basis of Revolutionary Change* (University of Illinois Press, 1980); Nicky Chambers, Craig Simmons, and Mathis Wackernagel, *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability* (Earthscan, 2000); Mathis Wackernagel and William E. Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (New Society Publishers, 1996); Wackernagel et al., "National Natural Capital Accounting with the Ecological Footprint Concept," *Ecological Economics* (v.29/3, 1999); Wackernagel et al., "Tracking the Ecological Overshoot of the Human Economy," *PNAS* (v.99/14, 2002).

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Ecological Imperialism

A CORE PREMISE of *ecological imperialism* is that the success of European colonial settlement is due at least as much to nonhuman forces, including plants, animals and pathogens introduced both deliberately and inadvertently, as it is to military, political, economic, and demographic incursions. The term has been developed most fully by Alfred W. Crosby in *Ecological Imperialism: The Biological Expansion of Europe, 900–1900,* an erudite environmental history of the relationships between ecology and European colonialism.

Crosby explores the concept to explain successful European population expansion into particular regions of the world he labels *Neo-Europes*. These areas include temperate zones of North America, South America, New Zealand, and Australia that—while oceans away from Europe—contain comparable climates in which European plants, animals, and diseases could successfully establish. In contrast, European colonial settlements generally failed in regions with tropical climates less suitable for European species and with more virulent diseases.

IMPORT INTO NEO-EUROPES

Along with new technologies, colonists brought to the Neo-Europes what Crosby cals a "grunting, lowing, neighing, crowing, chirping, snarling, buzzing, self-replicating and world-altering avalanche" that collectively supported vast ecological and social transformations. The previously unidentified, yet most important ally, of the Neo-European invaders was their portmanteau biota, "… fellow life forms, their extended family of plants, animals, and microlife…first domesticated or…first adapted to living with humans in the hearthlands of Old World civilization." Successful conquest occurred in those places with ecological similarities to western and northern Europe. "Where the portmanteau biota 'worked,' where enough of its members prospered and propagated to create versions of Europe, however incomplete and distorted, Europeans themselves prospered and propagated."

Weeds, for instance, were of vital importance to the establishment of Neo-Europes. "The exotic plants saved newly bared topsoil from water and wind erosion and from baking in the sun. And the weeds often became essential feed for exotic livestock, as these in turn were for their masters." Domesticated animals "adapted marvelously well to the Neo-Europe" with their ability to "alter environments, even continental environments, …[better than] any machine we have thus far devised." Germs, too, were of immense significance. "It was their germs, not these imperialists themselves, for all their brutality and callousness, that were chiefly responsible for sweeping aside the indigenes and opening the Neo-Europes to demographic takeover," Crosby states. Through years of isolation, indigenous peoples had their own infections (e.g., hepatitis and polio amongst Native Americans; trachoma amongst Australia's aborigines) but they had had no experience of the wide range of Old World ailments such as chicken pox, smallpox, cholera, and influenza, which were to decimate them. Indeed, Crosby suggests that smallpox may have killed up to one-third of the Australian Aboriginal population in the late 1700s. Remarkably, the flow of disease between invaders and invaded was substantially one-way, with relatively few infections and ailments having effect on the Old World.

ASIA AND THE TROPICS

By contrast, Europeans failed to build lasting settlements in Asia and tropical Africa not only for obvious reasons of heat and humidity, but much more importantly on account of their "contact with tropical humans, their servant organisms, and attendant parasites, micro and macro." In West Africa, parasites and disease prohibited European domesticates from thriving. And in Asia, along with the plants and animals that had "existed in and around thousands of villages and cities for thousands of years there had evolved many species of germs, worms, insects, rusts, molds,…attuned to preying on humanity and its servant organisms." While Europe succeeded in exploiting these regions through colonialism, permanent settlements were rarely established. In short, successful conquest occurred in those places with ecological similarities to western and northern Europe. "Europeans and their commensal and parasitic comrades were not good at adapting to truly alien lands and climates, but they were very good at constructing new versions of Europe out of suitable real estate," Crosby states.

Crosby's exposition places the indigenes of Australia, New Zealand and North America into a more complex and controversial relationship than that encapsulated by the notion of "advanced" Europeans achieving some ecological triumph over indigenous peoples. Paul S. Martin's controversial work postulates that Stone Age hunters eliminated entire species of giant animals (such as sabretoothed tigers and giant ground sloths) in a process known as *blitzkrieg*. Crosby draws from this idea to suggest that it "…places the Amerindians, Aborigines, and Maori, on the one hand, and the European invaders, on the other, in a fresh and intellectually provocative relationship: not simply as adversaries, with the indigenes passive and the whites active, but as two waves of invaders of the same species, the first acting as shock troops, clearing the way for the second wave, with its more complicated economies and greater numbers."

EUROPEAN ASCENDANCY

The concept of ecological imperialism has been extended both temporally and spatially to further explain European ascendancy and its ecological impacts. In the preface to the second edition of *Ecological Imperialism*, Crosby makes the point that more than simply establishing different patterns of social and environmental practice, ecological imperialism provided colonial powers such as Britain, the United States, Germany, and Japan with the ecological assets that allowed them make a "quantum jump" in productivity, which consequently facilitated scientific, industrial and agricultural revolutions. With resources provided by their colonies, imperialist powers were able to start and fuel enduring industrial revolution. More controversially, in *Guns, Germs, and Steel* (1997), Jared Diamond argues that the dominant position of Europe on the stage of colonialism was due to ecological and physical characteristics of Europe and Asia; for example, that the suite of successful European domesticated animals was due to the east-west orientation of Eurasia and the lack of physical barriers to the movement of technology and species.

Other uses of the term *ecological imperialism* include many accretions that link colonialism to ecological change conceptually. Johnston's interpretation emphasizes the importance of the colonists' introduction and imposition of particular forms of agricultural production and surplus distribution arrangements together with associated environmental management practices. Elsewhere, critics of international development have used the term to refer to either the disastrous impacts of current policies on or the remaining control of post-colonial ecologies.

Criticisms of Crosby's ideas have been relatively few; however, Cronon views his uncritical adoption of Martin's "blitzkrieg' theory and the lack of more explicit linkages to cultural determinants of European expansion as potential faults. Others, looking more closely at the ecology of species exchange across the Atlantic, found no inherent advantage to European species and a much more complex web of species exchange than described by Crosby. In the period from 1500–1900, plant transfers may have been more evenly balanced than Crosby suggests that "acquisition of Amerindian crop plants had a dramatic impact on 'Old World' economies and social histories." However, these criticisms remain minor corrections to Crosby's central and still compelling argument.

SEE ALSO: Colonialim; Diamond, Jared; Ecotourism; Exploration, Age of.

BIBLIOGRAPHY. William Beinart and Karen Middleton, "Plant Transfers in Historical Perspective: A Review Article" *Environment and History* (vol. 10, pp. 3–29, 2004); John Byrne, Cecilia Martinez, and Leigh Glover, "A Brief on Environmental Justice" in *Environmental Justice: Discourses in International Political Economy,* eds. John Byrne, Leigh Glover, and Cecilia Martinez (Transaction Publishers, 2002); Andrew H. Clark, *The Invasion of New Zealand by People, Plants and Animals* (Rutgers University Press, 1949); William Cronon, "Review of Ecological Imperialism" *Journal of American History* (vol. 74, no. 1, pp. 150-151, 1987); Alfred Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900*, (Cambridge University Press, New Edition, 2004); Jared Diamond, *Guns, Germs and Steel: The Fate of Human Societies*, (Jonathan Cape, 1997); C. Michael Hall, "Ecotourism in Australia, New Zealand and the South Pacific: Appropriate Tourism or a New Form of Ecological Imperialism?" in *Ecotourism:*

A Sustainable Option? eds. Erlet Carter and Gwen Lowman (John Wiley & Sons, 1994); Jonathan M. Jeschke and David L. Strayer, "Invasion Success of Vertebrates in Europe and North America' *Proceedings of the National Academy of* Sciences (vol. 102, no. 20, pp. 7198–7202, 2005); Ronald J. Johnston, *Nature, State and Economy: A Political Economy of the Environment* (John Wiley & Sons, 2nd ed., 1996); Paul S. Martin, "Prehistoric Overkill: The Global Model," *Quaternary Extinctions, A Prehistoric Revolution*, eds Paul. S. Martin and Richard G. Klein (University of Arizona Press, 1984); Elinor G.K. Melville, *A Plague of Sheep: Environmental Consequences of the Conquest of Mexico* (Cambridge University Press, 1994); Richard G. Wilkinson, "Review of Ecological Imperialism" *Ethnohistory* (vol. 36, no. 1, pp. 119-120, 1989); Timothy C. Weiskel, "Agents of Empire: Steps Toward an Ecology of Imperialism," *Environmental Review* (vol. 11, no. 4, pp. 275-288, 1987); Stephen Wroe, Judith Field, and Richard Fullagar, "Lost Giants," *Nature Australia* (vol. 27, no. 5, pp. 54-61, 2002).

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Ecological Modernization

ECOLOGICAL MODERNIZATION IS a diverse body of literature that has emerged from environmental sociology. It focuses on the institutional response of industrialized countries to environmental challenges. Arthur Mol understands ecological modernization to be the third wave of environmental concern and reform, following from nature conservation and limits to growth approaches. F. H. Buttel sees ecological modernization as "a new, and in many ways improved, synonym for sustainable development" and recognizes the appeal of optimism within ecological modernization, something that he contrasts with the pessimistic connotations of other approaches for "thinking about the problems of metropolitan transformative industry in the North."

According to Michael Carolan, the ecological modernization approach is said to have attained "near paradigmatic status within socioenvironmental circles," and Renato Orsato and Stewart Clegg view it as the "dominant approach in today's environmental policy, practice and theorization." Joseph Murphy's introduction to a theme issue about ecological modernization in the journal *Geoforum* said of geographers and other social scientists, "most of those working on the relationship between environment and society and focussing on the state, production and consumption are likely to be aware of it." This familiarity is also acknowledged by Buttel, who noted that "Ecological modernization was unknown to virtually all North American environmental scientists half a dozen years ago" but within a short span of time has "come to be regarded on a virtual par with some of the most longstanding and influential ideas and perspectives in environmental sociology."

DEBATE OVER ORIGIN

The origins of ecological modernization are debated. Some authors say that it is an idea that originated in the corporate sector in the United States in the 1980s, spread to Europe following the 1987 publication of *Our Common Future* (also known as the Brundtland report), and had a significant impact on national environmental planning in countries such as the Netherlands. Other authors claim that the German sociologist Joseph Huber should be credited as its founder and that the theory was first developed in a small number of western European countries, notably Germany, the Netherlands, and the United Kingdom.

The theory emerged as a critique of both neo-Malthusian approaches and neo-Marxism (which was popularly represented in debates with ecological modernists through the "treadmill of production" thesis). The ecological modernization approach does not reject industrial production and consumption processes, but accepts their inevitability and instead considers it desirable to focus on the changing character of these processes using ecological criteria as a measure of quality.

Ecological modernization is a perpetuation of the modernist values of rational thinking and the application of knowledge to problem solving. It recognizes that modern states can, if they are willing, incorporate environmental concerns into their regular activities. That is, the environment can be institutionalized and accorded similar treatment to social and economic issues. Since the mid-1990s, this approach has been increasingly challenged by multilateral trade agreements that make it more difficult for states to regulate environmental issues within their boundaries. The formation of trade blocs has also meant that the focus of ecological modernization research is no longer on national economies, but increasingly considers how environmental regulation may contribute to trade advantages for a country. The global nature of some important environmental issues and their policy responses, for example the issue of climate change, has also enabled ecological modernization to develop more of an international perspective in recent years.

THREE FACES

Peter Christoff noted that the increasing popularity of the term *ecological modernization* "derives in part from the suggestive power of its combined appeal to notions of development and modernity and to ecological critique." According to Christoff, ecological modernization has been used in three main ways: as a technical adjustment, as a policy discourse, and as a belief system.

The technical adjustment approach is often restricted to those sectors of the economy where such a change is profitable. Importantly, unless the economic gains from technical improvements in pollution control or energy use, for example, are reinvested in ecological modernization processes, then what has been created is greater capacity to have an impact upon the planet. In this version of ecological modernization, one of the ways environmental improvement (and hence economic gain in most cases) is achieved is through the adoption of a systems approach to resources, energy, and waste. It has similarities with the industrial ecology approach to improving environmental outcomes of production and consumption processes. Arthur Mol and David Sonnenfeld identify the early writings of authors such as Joseph Huber as being "characterised by a heavy emphasis on the role of technological innovations in environmental reform, especially in the sphere of industrial production." They indicate that from the late 1980s to the mid-1990s, the influence of technological innovation declined relative to institutional dynamics and cultural dynamics in the ecological modernization literature.

The policy discourse version of ecological modernization is most clearly represented in the writings of Albert Weale and Maarten Hajer. Similar to the corporate perspective, the key ideas of this version of ecological modernization are that economic growth and environmental responsibility are not irreconcilable, and in fact they make good economic sense for three reasons. First, improved environmental technology can generate economic savings that benefit a corporation financially, but also an urban area, state, country, or the world. Second, governments that enforce more stringent environmental regulations and encourage technological development to meet these regulations become the leaders in a sector and are able to establish valuable new industries that can earn export income. Third, there is a public relations benefit as these countries are able to project themselves as being environmentally responsible global citizens. Again, the change in policy is incremental and does not require the overthrow of existing political and economic structures.

A more radical approach is the concept of ecological modernization as a belief system. In this approach, rather than being a policy discourse to maintain existing economic relationships but to make them "greener," ecological modernization is a challenge to the market-based emphasis on efficiency. Carolan is particularly critical of the emphasis on efficiency and argues that it does not necessarily lead to sustainability. The idea of environmental modernization as a belief system is what Christoff identifies as being *strong* ecological modernization. In contrast, the *weak* version of ecological modernization Christoff identifies perpetuates existing relationships and narrow, technological-oriented thinking. This distinction is also employed by George Gonzalez to highlight the perceived limitations of the approach to climate change by the World Business Council for Sustainable Development and the International Chamber of Commerce. In this example, "these groups propose to reform the operation of capitalism through the development and deployment of technology rather than by promoting environmentally sensitive land management planning techniques." From an ecological perspective, the strong approach will likely generate the greatest ecological benefits. From cultural and economic perspectives, the implementation of a strong version of ecological modernization is fraught with challenges because it does require genuine, meaningful, and lasting change.

OTHER PERSPECTIVES

It is debatable whether the strong version of ecological modernization is really ecological modernization at all. This debate centers on who gets to define the terminology and the parameters of an idea. Depending on who is doing the labeling, the strong version of ecological modernization either refers to broad changes to institutional structures in society, democratic decision making, and an open approach to the environment and economy relationship based on what David Gibbs calls "multiple possibilities with ecological modernisation providing orientation" or it appears to include elements of neo-Marxist, neo-Malthusian and limits-to-growth thinking. While some authors see it as a strand of ecological modernization theory, it could also be interpreted as a conflicting theory or theories. This is apparent in debates between Michael Carolan on the one hand and Arthur Mol and Gert Spaargaren on the other. Ecological modernization is essentially an incremental and reformist approach, and the strong version of ecological modernization calls for more fundamental changes.

A notable attempt at bridging these divides is found in the work of Orsato and Clegg in their notions of *radical reformism* and "*critical Ecological Modernization.* These authors argue that in order to make ecological modernization a progressive force for moving toward sustainability, it is necessary that radical technological changes be made. This is often not possible unless incremental institutional changes are made, an approach that contrasts with the strong version of ecological modernization that calls for radical institutional change. According to these authors, "radical technological innovations and incremental institutional reform, together, constitute the concept of *radical reformism,* which may have important implications for the development of ecological modernization theory and its normative application."

Environmental improvement is achieved partly through a systems approach to resources, energy, and waste.

FUTURE TRENDS

Traditionally, the challenges to the ecological modernization approach have mainly come from neo-Marxists ("treadmill of production" literature) and from authors concerned about limits to growth. These approaches are predominantly concerned with physical conditions. The recent work of Mol and Spaargaren attempts to move beyond these debates by incorporating ideas from what John Urry describes as a *sociology of flows* into the ecological modernization literature. This would enable the literature to develop a more multinational approach as it questions the ability of states to regulate flows of money, capital, people, and material substances, but there is a tension about the issue of control and how much planned change can effectively be implemented in the contemporary world. This tension between the modernism inherent in ecological modernization (which is similar to neo-Marxist and deindustrialization approaches in this regard) and the recognition, and sometimes celebration, of chaos in postmodern approaches is likely to be one of the important debates within the ecological modernization literature in the near future.

The usefulness of ecological modernization is still being debated. As Gibbs noted, while it may offer some hope for better environmental outcomes, the concept "can equally serve as a cover for *business-as-usual* with a slight green tinge." This partly depends on what one perceives as being useful, and whether the perceived limitations of various strands of ecological modernization can be overcome or if they are inherent and intractable. Various options for strengthening the body of literature to overcome perceived shortcomings include bringing in notions of strategic capacities, structural frameworks, and the role of actors and notions of embedded autonomy, civil society, and state–society synergy theories derived from the Weberian tradition. Ecological modernization is likely to be developed into the future as academics and policymakers continue to articulate nature–society–economy relationships in ways that are at least more environmentally benign than previous versions of these relations.

SEE ALSO: Brundtland Report; Industrial Ecology; Policy, Environmental; Sustainability.

BIBLIOGRAPHY. F.H. Buttel, "Ecological Modernization as Social Theory," *Geoforum* (v.31/1, 2000); Michael Carolan, "Ecological Modernization and Consumption: A Reply to Mol and Spaargaren," *Society and Natural Resources* (v.17, 2004); Michael Carolan, "Ecological Modernization Theory: What about Consumption?" *Society and Natural Resources* (v.17, 2000); Peter Christoff, "Ecological Modernisation, Ecological Modernities," in Stephen Young, ed., *The Emergence of Ecological Modernisation: Integrating the Environment and the Economy?* (Routledge, 2000); David Gibbs, "Ecological Modernisation, Regional Economic Development and Regional Development Agencies," *Geoforum* (v.31/1, 2000); George Gonzalez, (2005) "Urban Sprawl, Global Warming and the Limits of Ecological Modernisation," *Environmental Politics* (v.14/3, 2005); Maarten Hajer, *The Politics of Environmental Discourse: Ecological Modernization and the Policy Process* (Oxford University Press, 1995); Annica Kronsell, "A 'Sustainable Impact' on the EU? An Analysis of the Making of the Fifth Environmental Action Program," in Stephen Young, ed., *The Emergence of Ecological Modernisation: Integrating the Environment and the Economy?* (Routledge, 2000); Arthur Mol, *Globalization and Environmental Reform: The Ecological Modernization of the Global Economy* (MIT Press, 2001); Arthur Mol and David Sonnenfeld, "Ecological Modernisation around the World: An Introduction," *Environmental Politics* (v.9/1, 2000); Arthur Mol and Gert Spaargaren, "Ecological Modernization and Consumption: A Reply," *Society and Natural Resources* (v.17, 2004); Arthur Mol and Gert Spaargaren, "From Additions and Withdrawals to Environmental Flows: Reframing Debates in the Environmental Social Sciences," *Organization and Environment* (v.18/1, 2005); Joseph Murphy, "Ecological Modernisation," *Geoforum* (v.31/1, 2000); Renato Orsato and Stewart Clegg, "Radical Reformism: Toward Critical Ecological Modernization," *Sustainable Development* (v.13, 2005); John Urry, *Global Complexity* (Polity, 2003); Albert Weale, *The New Politics of Pollution* (Manchester University Press, 1992); Stephen Young, "Introduction: The Origins and Evolving Nature of Ecological Modernisation," in Stephen Young, ed., *The Emergence of Ecological Modernisation: Integrating the Environment and the Economy?* (Routledge, 2000).

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Ecology

ECOLOGY IS THE study of the patterns and processes governing the abundance and distribution of organisms and their relationships to their environment. The environment includes abiotic factors—such as the soils, geology, sunlight, climate, and other physical and chemical factors—as well as biotic factors, such as other organisms within the same or neighboring habitats. The term *ecology* derives from *oekologie*, first coined in 1866 by the biologist Ernst Haeckel, joining the Greek *oikos*, or household, and *logos*, or study. The field of ecology combines diverse scientific traditions from natural history, experimentation, field study and mathematical modeling to advance our understanding of the processes and patterns maintaining and altering biodiversity. As a *positive* science, ecology does not make *a priori* value judgments; nevertheless, it is strongly associated with the normative goals of modern environmentalism that ascribe a fundamental intrinsic and utilitarian value to nature. As such, ecological research and study is a key component of conservation biology, concerned with understanding and protecting biological diversity at multiple scales.

Ecology is a broad field that encompasses several thematic, areal, hierarchical, systematic, and methodological foci and traditions. For instance, distinct thematic/areal traditions are reflected in tropical ecology, desert ecology, freshwater ecology, marine ecology, and so on. Distinct hierarchical scales of biodiversity correspond to behavioral ecology (individual adaptations), autecology (populations of one species), synecology (communities of multiple species), and landscape ecology (structure, composition and function of landscapes). Disciplinary and methodological approaches define chemical ecology, genetic ecology, mathematical/theoretical ecology, statistical ecology, spatial ecology, and evolutionary ecology. These distinct traditions are not mutually exclusive, but often overlap in significant ways and have evolved over time.

HISTORY OF ECOLOGICAL THOUGHT

The history of ecological thought, like that of the field of conservation biology, traces back several centuries. The earliest formal practice of ecological research on the relationship between organisms and their environment dates to the botanist Alexander von Humboldt, who in the early 19th century, described the relationship between plant distributions and regional climates. His work was followed by the publication of Charles Darwin's *The Origin of Species* in the mid 1800s, postulating an evolutionary, *mechanistic* perspective for ecology that departed from its earlier, descriptive focus. As developments in ecology continued over the next several decades, advances were made in the understanding of global bio-geochemical cycles (e.g., the nitrogen cycle); and the term *biosphere* came to be coined in 1875 by geologist Eduard Suess, to refer to that global sphere where the biota interacts with the lithosphere, atmosphere and hydrosphere. Such dynamic interactions were the focus of ecologists such as Henry Cowles and Frederic Clements toward the dawn of the 20th century, who established a tradition known as "dynamic ecology." In the coastal dunes of the Great Lakes and the western prairies of the United States, respectively, Cowles and Clement examined the process of *ecological succession*, the sequence of ecological changes following a disturbance. Succession is the process by which an ecological community progresses over time from an initial, simple state to a latter, complex state as the system approached a stable equilibrium (sometimes called homeostasis). The change in the overall ecological community over time reflects, among other things, the loss and gain of individual species. A disturbance; such as wind damage, opening up of a forest gap by treefall, plowing of a field, creation of a patch by waves in an inter-tidal zone, or a rainfall event that creates an ephemeral pool, creates new localized habitats for different species to colonize and exploit. According to *successional theory*, early colonizers or invaders tend to be those that are best adapted to reproduce rapidly and quickly colonize the new habitat, and typically have high reproductive rates and small life spans. Such species are often referred to as r–strategists. During later stages in the successional sequence, r–strategists are gradually replaced by species that are slower to exploit the initial post-disturbance conditions, but are better adapted to continuing a viable population in the long term at or near the system's carrying capacity. Such slow-growing species are often referred to as K–strategists. According to strict Clementsian interpretation, most successional patches (*seres*) in a given locality will tend eventually toward a particular assemblage of "climax" species (i.e., a "monoclimax") at the conclusion of the successional sequence, even when those *seres* reflect different stages in the successional series. The role of humans in ecological processes was viewed in a negative light, as interfering with the processes of natural succession.

The ecologist Arthur Tansley often acknowledged the significance of the work of Cowles and Clements, and yet, disagreed with the Clementsian notion of a monoclimax. He argued instead that environmental gradients and varying disturbance regimes within a climatic zone meant that later successional stages would support not a single but multiple climax communities. He took further issue with the uniformly negative portrayal of human agency in ecological dynamics, suggesting instead that human–nature interactions gave rise to anthropogenic climax communities (such as agro–ecosystems). In 1935, Tansley introduced the term *ecosystem* to refer to the interacting system formed by biota with its environment. His models were strongly influenced by emerging ideas about systems and fields in physics at that time, and suggested that organisms could best be studied as interacting components of (bio)physical systems. This method of ecological study, one that focuses on calibrating and understanding the behavior of the system's component to understand system behavior, is sometimes referred to as a *tactical* approach. The ecosystem concept was subsequently adopted and elaborated by Eugene Odum, often referred to as the father of modern ecology.

In 1953, Eugene Odum and his brother, Howard Odum, jointly authored the first definitive textbook on modern ecology, established ecology as a bona fide academic discipline and educated the first generations of ecosystem ecologists in North America. Eugene Odum was also an early developer of the *strategic* ecosystem approach to studying ecological communities, maintaining that in order to understand system functioning, it is most expedient to focus on the essence or key aspects of the system's overall behavior rather than its components in all their detail. Odum applied the strategic ecosystem approach to ecological communities in their successional paths, theorizing that older, more advanced communities should contribute to overall ecosystem stability, or homeostasis, securing protection against environmental disturbances.

THE RISE OF THE ECOSYSTEM CONCEPT

Other developments preceded and paralleled the rise of the ecosystem concept in ecology. Charles Elton expanded on the ecological form (structure) and function that exists at any given time in a successional sequence, rather than the process of change over time. In 1927, Elton proposed a set of principles in his text *Animal Ecology* that aimed to explain an organization of ecological communities focused upon the food chain and laid the foundation for present thinking on trophic interactions. Elton's food chain consisted of the photosynthetic conversion of solar energy as the first link with herbivores and predators making up the remaining two or three links, and ascribed distinct roles to plant and animal species as producers, consumers, decomposers, etc. Elton also proposed the pyramidal structure of the food chain in considering how the size and populations of a species (as food or consumer) relate to its position in the pyramid (e.g., smaller populations of slowly reproducing, large predators such as whales depend upon larger numbers of rapidly reproducing, tiny zooplankton). Finally, Elton proposed the idea of the ecological niche as the function of a species in a community, maintaining that no two species in a community could occupy the exact same niche because of competitive exclusion.

Elton, Tansley, the Odums and other ecologists influenced by developments in physics turned to the second law of thermodynamics to focus on the flow of materials (e.g., food/nutrients and water) and energy through ecosystems, and further unified the consideration of biotic and abiotic components in ecology. There were attempts to merge lessons from trophic structure and ecosystem function. For instance, Raymond Lindeman and others studied the productivity of each trophic level and the efficiency of the transfer of energy from one level to the next in order to understand the functioning of entire ecosystems. Ecosystem function began to be quantified and measured in energy units. For instance, the net primary productivity (NPP) of diverse natural and human–modified ecosystems is calculated and compared to assess aspects of ecosystem function, such as carbon sequestration (the rate at that carbon dioxide is photosynthetically removed from the atmosphere).

Several systems ecologists now include humans as part of an expanded ecosystem, the ecological–economic system. The Odums's unified theory of ecosystems as applied to ecological succession also postulated, similar to Clements, a stable, homeostatic system that expended less energy on production (therefore maintaining steady biomass) and more on ensuring stability in the face of environmental fluctuations. Unlike Clements, the new homeostasis entailed a dynamic and open ecosystem that could theoretically allow periodic flows of organisms, materials and energy across its boundaries. The Odums and subsequent ecosystem ecologists became the foremost proponents of ecosystem-focused science in the 1960s and 1970s, engaging in large-scale research projects in diverse biomes such as grasslands, deciduous forests, tropical forests, etc. to advance theoretical understanding. From a policy perspective, many ecosystem ecologists advanced the preservation of nature untouched, as far as possible, by the human hand.

COMMUNICATION AND POPULATION

Although systems ecology provides a holistic framework for the consideration of ecosystems, community and population ecology continue to be important approaches to understanding species diversity, distribution and turnover. Proponents of population ecology such as Robert MacArthur argued that *unified ecosystem theory* failed to generate testable hypotheses, producing instead abstractions that were not very useful for disciplinary advancement. Autecology and synecology play critical roles in the field of conservation biology, which is concerned with the conservation of species and other higher levels of biotic diversity. Population ecology (autecology) focuses on demographic patterns and changes, geographic distribution of species abundances and the processes that influence such patterns.

Among such processes are competition, predation, dispersal and extinctions. MacArthur and his research colleague Edward O. Wilson conducted studies of species diversity on islands in the Caribbean and the results of their work formed the basis for their theory of island biogeography published in 1967. According to *island biogeography theory*, the equilibrium number of species on an island is a function of the island's size and its distance from the mainland. An island's size has a well-established relationship to the numbers of species it can support: species are more likely to undergo extinctions on smaller islands; larger islands therefore typically retain higher numbers of species. An island's distance from the mainland influences the rate of immigration of species from the mainland. With increasing island size or decreasing distance from the mainland—or both—the rate of species increase drops off after some point, and species richness reaches an equilibrium. The theory of island biogeography is explicitly linked to the *metapopulation* concept in ecology in drawing attention not only to populations in individual patches, but also toward how those patches and their populations are connected in space and time to form a metapopulation. *Island biogeography theory* has been applied extensively in the field of conservation biology and reserve design (wherein reserves may be viewed as islands supporting species richness) and has inspired much debate about the relative biodiversity merits of single large or several small (SLOSS) reserves.

Photosynthetic conversion of solar energy was the first link in Elton's food chain; herbivores and predators rose next.

Population ecology examines the geographic range of populations (individuals of a species within a local area) as influenced by that of suitable habitat, and focuses on population dispersion (e.g., clumped, evenly spaced or random spacing of individuals), dispersal and mortality as functions of spatial variation in habitat quality and quantity, as well as of biotic interactions. The structure of a population includes the density and spatial distribution of its individuals, proportions in various age classes, and the change in each of those variables over time.

The Poisson distribution is often used to analyze spatial patterns in population data and reveal the density of populations in a given area. Local populations may interact with one another, forming metapopulations residing in a network of source and sink populations. Certain habitats may be resource rich, enabling higher reproduction rates than can be maintained in the area, forming a source population that may emigrate to lower-quality habitats that house sink populations. Processes of emigration and immigration are captured mathematically in dispersal models. Population models differ based on whether they assume seasonal or continuous reproduction, and whether or not generations may overlap. According to many equilibrium models, population increase may be regulated by factors that are density-dependent (e.g., food availability, predation, disease) or density-independent (e.g., temperature, rainfall). Prevailing theories diverge from equilibrium assumptions, focusing instead on demographic stochasticity (random variation in birth and death rates) and environmental stochasticity (random environmental variability). Developments in *metapopulation theory* afford some room for the integration of equilibrium-based population dynamics models with demographic and environmental stochasticity.

GENETIC STRUCTURE: DNA

The genetic structure of a population is studied using modern techniques of DNA analysis. Small populations are particularly vulnerable to the loss of genetic variation through inbreeding and genetic drift—often referred to as a *population bottleneck*—such as that experienced by the small, genetically uniform populations of cheetahs in Africa. Concepts such as effective population size and minimum viable population size derive from population ecology and are of particular interest in conservation biology; they relate to how large a population has to be to avoid the loss of genetic diversity and survive for a specified time.

Species interactions in ecology are generally of four kinds: competitive, predator-prey (or consumer-resource), detritivore-detritus, and mutualism interactions. Competitive relations in particular have long been a strong focus in evolutionary ecological theory. Competition can occur over resources such as space, nutrients and water, and through physical or chemical means. Charles Darwin's theory of natural selection focuses on intra-specific competition, wherein those organisms with traits that result in a competitive (and therefore reproductive) advantage are those that are selected for and prevail. Intra-specific competition is thus related to population regulation and evolutionary change. At the inter-specific level, species that are the best performers in an intense competition for limited resources tend to survive, while those that are poor competitors adapt or perish. Such competition may therefore affect community structure and composition. Experiments by Tansley and others mustered support for the importance of inter-specific competition in determining the presence of absence of a species, although the results were mediated by environmental conditions. Garrett Hardin's principle of competitive exclusion predicts that two competing species cannot coexist on a single limiting resource. The ornithologist David Lack observed, however, that several species with similar ecological needs did, in fact coexist in natural settings, and hypothesized that species may evolve to co-exist within the same habitat by diverging in their ecological needs and thereby reducing competition. Coexistence among competitors is also enabled by disturbance regimes that effectively maintain fluctuating environmental conditions (i.e., a nonequilibrium system) and prevent competitive exclusion.

Coevolution is said to occur when two species not only coexist, but evolve in a reciprocal manner in response to each other's characteristics, such as yucca plants and their insect pollinators. However, *coevolution* is usually investigated amongst local populations of interacting species. Local variation in environmental conditions means that species may interact in different ways in different populations, and therefore a coevolutionary response may be specific to two particular populations of the interacting species, rather than the two species in general across their entire ranges. The choice of spatial scale, therefore, is critical to the study of coevolutionary interactions.

Predator-prey relationships in population ecology are perhaps best summarized in the work of

Alfred Lotka, Vito Volterra, Georgii Gause and others, who tried to describe though experimentation and mathematical equations how populations of interacting species—such as a predator and a prey—reached a stable equilibrium. Predators may drive prey populations extinct, or in the presence of spatially distributed prey refuges and/or additional (source) populations of predators, result in alternative outcomes. Predator-prey relations are often considered density-dependent: increases in prey density can positively affect predator populations by improving their growth and/or immigration rates; however, the greatest number of predators is supported at an intermediate prey density, at which the prey population reaches its maximum recruitment rate. Similar mathematical formulations have been derived for other types of interactions, such as parasitoid-host interactions.

THE ROLE OF SPATIAL PATTERN

The role of spatial pattern is critical in population and *metapopulation* dynamics. The patchiness of resources, habitats and populations of predator, prey, parasite and/or host populations strongly structures processes of interaction within a local patch and across its surrounding regional context or landscape. The field of landscape ecology is distinctive for its explicit focus on spatial pattern and its implications for ecological processes. In other words, landscape ecology deals with how the structure and composition of the landscape drives the ecological patterns and processes at various hierarchical scales (e.g., organisms, populations, species, communities and ecosystems). Strongly influenced by applied fields such as forestry, landscape architecture and agriculture, landscape ecology has straddled the divide between basic and applied ecological research since its consolidation in the early 1980s. In its initial phases, landscape ecology focused on developing techniques for the quantification and scaling of spatial pattern. These efforts produced a vast array of metrics to describe the spatial arrangement of habitat patches, such as fragmentation, fractal dimension, connectivity, and contagion, as well as techniques to determine the appropriate scale at which pattern-process relationships of interest could be analyzed and correlated. With the maturation of the discipline came a more concerted effort to conduct pattern-process experiments at the landscape scale, and develop insights bridging with other long-standing ecological traditions and theories.

Because ecological questions are posed and analyzed within a broad scale, landscape ecology offers an interesting opportunity to synthesize insights from multiple ecological traditions, including theoretical and behavioral ecology, community and metapopulations, genetics and evolutionary ecology and ecosystems research. In addition, landscape ecology affords a ready interface for collaboration with other (non-ecological) disciplines and applied traditions, particularly; geography, environmental science, regional and land-use planning, photogrammetry, remote sensing and geographic information science, restoration ecology, conservation biology and wildlife management, watershed management, forestry and landscape architecture, and global environmental change—including climate change as well as land use/cover change.

LANDSCAPE HETEROGENEITY

The basic components of landscape heterogeneity include the patch, boundary/edge/ecotone and mosaic, while relevant processes may be those that define or affect disturbance, fragmentation, and connectivity. Patches are landscape units that may be considered relatively homogenous for purposes of study and analysis, and can change in area, shape, and quality over time. Boundaries or edges refer to the area of transition between two dissimilar environments (or between a patch and its surroundings, sometimes referred to as the matrix). An ecotone is typically an edge area as well, but is used to denote the varying gradient of environmental conditions in the transitional zone.

Ecotones can be sharp or gradual. The numbers of different types of patches, their relative size, shape and abundance, and their spatial arrangement (e.g., average distance between patches) together define the structure and composition of the landscape; a landscape mosaic in particular refers to a collection of patches. Landscape function refers to the interaction of landscape components and the flow of organisms, materials, and energy through the landscape.

The issue of hierarchy, scale (extent, map scale, spatial resolution or minimum mapping unit, and temporal scale), and scalar dynamics comprise important concerns in landscape ecology. Different sets of ecological criteria matter at distinct hierarchical scales. Kotliar and Wiens demonstrated, for example, that insects used different sets of criteria to select a leaf vs. a tree or patch. Studies have found that relationships between spatial pattern and process at one scale of analysis are typically not generalizable to other scales (e.g., the ecological fallacy). Landscape-scale simulation modeling experiments and percolation theory suggest critical thresholds at which particular ecological processes, such as colonization by an invasive species, or a disturbance such as fire, will spread across the landscape. Theories from population ecology, such as *island biogeography theory* or mathematical models of *metapopulation theory* have long focused on spatial heterogeneity in patchy environments, and are particularly relevant for landscape ecology. Perhaps the most interesting examples of theoretical development in landscape ecology derived from its engagement with social science theories of land use and landscape change.

Competition of the species in an ecological area can occur over resources such as space, nutrients, and water.

For instance, research in the Human Dimensions of Global Environmental Change has conducted landscape ecological studies integrating geographic, sociological and anthropological theories of human decision-making strategies, explaining and predicting deforestation and other land use transformations in tropical forests and other environments. It is precisely owing to its analytical focus on spatial heterogeneity and disturbance, and its broad synthetic scope including human roles in ecological systems that landscape ecology has particular relevance for conservation biology and land use planning. Insights into how disturbance maintains or alters landscape structure and function, biodiversity and ecosystem stability and resilience are relevant for conservation planning and reserve design. It is far more ecologically and economically feasible to manage disturbance regimes rather than restore landscapes or ecosystems after dramatic degradation.

Most ecological studies employ theoretical, mechanistic or empirical/statistical models in order to explicate the pattern-process relationships of interest in a given region or ecosystem. Models can range from simple abstractions that capture only essential elements of systems, to complex models with detailed specifications and multiple parameters that aim to accurately replicate and predict system interactions. Mechanistic models are built on a causal or process-based understanding of a system, particularly useful for scenario testing and impact assessments, but prone to problems of calibration and validation as well as to oversimplifying reality. Statistical models, on the other hand, are based on empirical data, but may capture only correlations rather than causal relationships. Most landscape ecological models today are spatially explicit, meaning that they use spatially referenced datasets, such as those derived from satellite imagery and/or maps and geographic information systems. Aside from the relative strengths and weaknesses of the modeling approach itself, models are also limited by the quality of the data. For instance, seasonal changes in highly local land uses in a tropical forest–agriculture mosaic may be difficult to derive in sufficient detail from satellite imagery, since it is often difficult to obtain cloud-free scenes in such areas. More frequent imagery, such as that provided by the Moderate Resolution Imaging SpectroRadiometer (MODIS) or the Advanced Very High Resolution Radiometer (AVHRR), may not offer data at a fine enough pixel resolution for detecting activity. Other limitations may include insufficient or inappropriate thematic resolution, spatial resolution, accuracy and uncertainty, and mismatch between social and ecological spatial variables.

The traditions in ecology constitute complementary and sometimes contradictory approaches to understanding the patterns of distribution of biological diversity and the processes that explain that distribution. They contribute to fundamental ecological concepts regarding ecosystems; the structure, composition and functioning of ecological systems; the biotic and abiotic determinants of change, stability, resilience and productivity; concepts of equilibria versus nonequilibria; and the effects of spatial heterogeneity on ecological processes. These and other insights from ecology are brought to bear upon the contemporary problem of global biodiversity loss, altered biogeochemical cycles and transforming climate regimes—all aspects of global environmental change.

ECOLOGY MOVEMENTS

Ecology's general identification with the study and valuation of nature, moreover, makes it a common if sometimes unwilling ally in the modern environmental movement since the 1960s. The social movement, as distinct from the scientific ecological tradition, has been influenced by conservation ideas and philosophies dating back at least two centuries, and is fueled by a publicly perceived global crisis of environmental contamination and species extinctions. The publication of Rachel Carson's *Silent Spring* in the 1960s inaugurated the environmental movement in the West. The focus on pesticides, and other environmental contamination in the 1960s was succeeded in the 1970s, 1980s, and 1990s by concerns about the threat of nuclear disasters, acid rain, ozone depletion and its effects on human and ecological health, rising rates and extents of tropical deforestation and biodiversity loss, and climate change (including global warming). While ecology has engaged with the environmental movement through these crises, albeit in ways that lacked a unified approach or a consistent and clear set of recommendations, a strong dissonance between the scientific ecology and environmentalists revolved around the Gaia hypothesis. Certain elements of the environmental movement draw on the concept of *Gaia* proposed by the atmospheric scientist James Lovelock in the 1960s. According to this hypothesis, the biosphere is a system that self-regulates through feedback relationships and functions as a single organism. While ecologists overwhelmingly acknowledge the interactions between biotic and abiotic components of the biosphere, as well the ability of biota to alter its physical environment, they debate the concept of homeostasis implied in the Gaia hypothesis and criticize the hypothesis itself for being overly teleological.

SEE ALSO: Biogeography; Chaos Theory; Disequilibrium; Energetics; Equilibrium; Evolution; Gaia; Succession.

BIBLIOGRAPHY. N.B. Kotliar and J.A. Wiens, "Multiple Scales of Patchiness and Patch Structure: A Hierarchical Framework for the Study of Heterogeneity," *Oikos* (v.59, 1990); R.H. MacArthur and E.O.Wilson, *The Theory of Island Biogeography* (Princeton University Press, 1967); R.E. Ricklefs and G.L. Miller, *Ecology,* 4th ed. (W.H. Freeman and Company, 2000); M.G. Turner, "Landscape Ecology: The Effect of Pattern on Process," *Annual Review of Ecology and Systematics* (v.20, 1989); B.L. Turner, W. Clark, R.W. Kates, J.F. Richards, J.T. Mathews, and W.B. Meyer, eds., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere Over the Past 300 Years* (Cambridge University Press, 1990); P.M. Vitousek, "Beyond Global Warming: Ecology and Global Change," *Ecology* (v.75, 1994); D. Worster, *Nature's Economy: A History of Ecological Ideas* (Cambridge University Press, 1994).

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Ecomanagerialism

COINED BY VIRGINIA Tech political science professor Timothy Luke, *eco-managerialism* refers to a particular type of environmental management carried out by "professional-technical workers" who are trained in environmental science and policy schools at Western universities, which emphasize "sound scientific and technical" solutions to environmental crises. Specifically, Luke argues that specially trained environmental *experts* define their managerial goals in relation ecosystem "goods" and "services," which necessitate a treatment of the physical environment primarily in terms of natural *resources*. This means that environmental managers, though charged with the protection and conservation of the physical environment, also protect the dominant economic and political interests that surround those resources.

This notion of ecomanagerialism favors a capitalistic and technocratic approach to environmental management, where efficiency and economic development are the primary motivations for environmental policy and management, rather than other potential solutions to environmental concerns, such as behavioral changes, economic restrictions, or alternative technologies. In essence, Luke's idea of ecomanagerialism attempts to acknowledge and understand how modern resource management has cast nature primarily as an economic and political "asset" that can only properly be managed by technical environmental experts. The physical environment, under a regime of ecomanagerialism, is valued far less for its preexisting ecological processes, than its function in the modern capitalist economy. Furthermore, the material and discursive practices of ecomanagerialism constitute a form of power that Luke refers to as "geopower," where only eco-managers are employed for resource management and to solve impending ecological crises. This requires that the goals of environmental management employed by eco-managers are defined in terms of modernization, where the average citizen is made to think that he or she cannot fully understand the complexities of the natural environment.

The basis of ecomanagerialism lies in the discursive transformation of ecological processes and systems into economic commodities or natural resources. Luke claims that this occurs in the modern research university. Here, students learn to manage, manipulate, and control nature as "a sanding reserve, a resource supply center, a waste reception site." This is essential for making nature and the physical environmental legible and comprehendible to various policy-makers and engineers, but also makes the physical world politically relevant (in so far as it has economic and social services). Drawing on Foucault's notions of discourse, power, and knowledge, Luke claims that these eco-managers, produced by schools such as Berkeley's Department of Environmental Science, Policy, and Management and the Yale School of Forestry and Environmental Studies, use nature to "legitimize many political projects" aimed at facilitating or sustaining capital accumulation. This is done through the exercise of disciplinary forms of geo-power in the modern capitalist economy held by a new class of experts, specialist, engineers, and planners. Similarly, this practice often disguises the role of the capitalist economy in creating the very environmental problems ecomangers are required to solve.

Luke identifies three primary forms of eco-managerialism, including resource managerialism (where ecosystem services are protected and supplied for economic production), risk managerialism (which calculates and oversees the amount of destruction on natural systems to sustain a minimum level of economic and social health), and recreationist managerialism (which manages the natural environment for recreational consumption as a resource, such as public parks). Luke's critique of ecomanagerialism lies in its assertion that only "positivistic technical knowledges" can be used as a means to address environmental concerns. This often excludes socially and politically based solutions to environmental concerns, which might not necessarily accelerate and facilitate capitalist accumulation. These practices not only obscure the complex and uneven power relations inherent in environmental management, but also the way in which eco-mangers inevitably reproduce themselves by reproducing the environmental crisis they are expected to solve. Ecomanagerialism is a self reproducing and expanding form of modern environmental management.

SEE ALSO: Capitalism; Conservation; Ecology; Economics.

BIBLIOGRAPHY. Timothy W. Luke. *Capitalism, Democracy, and Ecology: Departing from Marx*. (University of Illinois, 1999) Timothy W. Luke. "Eco-Managerialism: Environmental Studies as a Power/Knowledge Formation" in *Living with Nature: Environmental Politics as Cultural Discourse*, eds. Frank Fischer and Maarten A. Hajer (Oxford University Press, 1999).

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Economics

ECONOMICS IS THE exchange of resources. More particularly, it has historically been the social science that deals with the production, distribution, and consumption of goods and services. Some economic theorists also add that economics deals with the theory and practice of economic management.

Historically, economics has posited that economic activity occurs when humans engage in a transaction that involves the exchange of goods and/or services between parties. This interpretation of economic activity was adequate when the human population was low and its economic activity had only a limited impact on nature. However, modernization and technology has led people to engage in economic activity in greater numbers that has led to the destruction of vast areas in nature.

Since the 1970s, economic theories have arisen that emphasize that the nature of economic costs comes with direct and indirect consequences. Therefore, to preserve the biological diversity of the earth, and to promote economic equity alternatives, economic theories and approaches have been developed, which seek to make biodiversity central to economic activity.

For all humans, the exchange of scarce resources, both renewable and nonrenewable, is necessary for the development and maintenance of life. *Nonrenewable* resources include minerals and petroleum, which cannot be reproduced once consumed. However, where there may be no other resources, substitutes may be used if costs of extraction and processing are acceptable to consumers in the market; for example, diamonds and oil can be synthesized. However, the key issue will always be at what price.

Renewable resources are those resources that are harvested after being planted, cultivated, raised, or otherwise produced in a manner that allows for more of them to be produced from the same source. The very idea of husbandry is rooted in the idea of renewable resources. Successful farmers do not consume their seed corn or their breeding stock except in extreme emergencies. The range of human needs combined with human wants results in an economy of goods and services, which requires huge volumes of these natural resources that are is grown, caught on land or in waters, or mined.

Mined resources include minerals, inorganic building materials, soils, petroleum, and other resources that are used in building the foundation of modern industrial society. These types of resources have been produced by the geochemical processes at work in the earth's crust, and include sedimentary rocks, metamorphic rocks, and igneous rocks. They are considered *nonrenewable* resources because the geological conditions in which they were formed cannot be repeated by nature.

Granite, for example, is a hard, igneous rock that is found in abundant supply. It has been used in the past for cobblestone streets or in the building of large structures. Other types of mined, igneous rock include those rich in feldspar or other minerals.

Metamorphic rock can also be found in abundance. Large supplies of marble are used in sculpting or in buildings such as the United States Supreme Court. Marble for that structure was shipped from Alabama, Georgia, Vermont, Italy, and other places. In addition, marble can be ground to a fine powder and used in white paint or in hundreds of other products. There is a threat that due to the growing consumption of these mineral resources, its supply could one day be exhausted.

VALUES AND ECONOMIC TYPES

Economics is concerned with values. Some things have *intrinsic value*; they are valuable regardless of whether or not they have any use. *Instrumental value* is value derived from the utility of something. Diamonds are not of great intrinsic value. They are, however, of great instrumental value for romance and industry.

Generally speaking, there have been three types of economies: *barter economies, command economies,* and *market economies*. All three have been mechanisms for the exchange of goods and services. *Barter economies* were the first types of economies and still abound. They may exist in the industrial world when people trade goods or services in any number of ways. Or they may exist in the Third World, for example, when people gather honey in a forest in India to trade for meat hunted in the same forest. *Command economies* are economies in which the government directs the manufacture and/or the distribution of goods and services.

Modern wartime economies have usually been command economies. In modern times, socialist and Communist economies have been economies that have sought to establish economic justice by their power to control the production, distribution, and consumption of goods and services, and by means of "equitable" distribution of what is produced. However, all too often, socialist and Communist economies have been unsuccessful in producing goods and services as well as achieving their moral principle of equality of distribution. This moral failure has often been due to directing the production of luxuries to political forces.

Capitalism is a form of *market economy* that concentrates the means of production in the hands of a great many producers. Many scholars believe that capitalistic societies have been much more successful at creating vast quantities of goods and services than socialist or Communist societies. Those scholars believe that experience has shown in the last several centuries that people in pursuit of their own self-interest are producers of more goods and services in greater varieties and quantities than they are as producers for a system that distributes goods and services on the basis of inherent worth rather than productive success. Capitalism allows individuals to pursue their own economic self-interest. It therefore also promotes conditions of economic freedom to allow the trading of goods and services in market places without government intervention.

Socialism, Communism, and capitalism have had their political expressions as ideologies; that is, as systems of politico-economic thought. In the ideological partisanship that has been fought out in a variety of ways, partisans have often championed socialism, Communism, or capitalism in ways that have conveniently ignored real problems with these systems.

It is interesting to note that all three economic ideologies arose in the early days of the Industrial Revolution, when inhumane exploitation of the working class took place. These workers were often economic refugees from the countryside. The poor were compelled by economic necessity to toil in factories at poor wages. On the other hand, liberal exponents of the free market system were focused on those who defended economic privileges, government-authorized monopolies, or the restrictions of command economics. While addressing the human problem of economics, they ignored the nature side of economics.

NATURAL RESOURCES

The economic resources used to produce goods and services require natural resources. As a consequence, nature—and quite often humans—have been negatively impacted by ruthless exploitation of natural resources. For example, the clear-cutting of timber may have been the cheapest way to cut the most timber, but dire consequences have resulted from this method. Clear-cutting destroys the watershed so that during heavy rains, floods result, and the silting in streams kills fish and destroys habitat. Nature, and not the timber industry, pays the severe price of clear-cutting.

For centuries, individualistic market economies were able to externalize their costs of pollution and human capital costs. The same was usually true of socialist and communist societies, which were industrial societies. The pollution in the old Soviet Union was probably as bad if not worse than that in capitalist societies. Ultimately, the success of industrialization to extract ever greater resources, and its ability to manufacture huge quantities of goods, had a tremendous impact on nature. People took notice when they realized that streams in which they had once swam or fished in years before were too polluted to drink from—even if the water was boiled.

To combat the short-sighted exploitation of the environment, nature-oriented economic ideas and studies were advanced. Oddly enough, it was not concern for nature that was the first motivation.

Rather, it was the desire to rationalize markets with monopolistic control. For example, John D. Rockefeller was able to capture control of most of the oil production in the United States through his Standard Oil Company. The early days of the oil industry was centered in western Pennsylvania, Ohio, and West Virginia. The booms created many producers who pumped the oil as quickly as they could. Regard for the environment was little, if any. At times so much oil was brought to market that prices bottomed out. Excess oil was then dumped into creeks.

This form of unbridled capitalism—which was wide open to people with little or no capital—was in the end destructive. So also were the corporations mining, logging, or extracting resources without concern for the future destructive consequences. The only principle of concern was that profits were high and costs low.

Conservation was championed by President Theodore Roosevelt, a naturalist as well as an antimonopolist who supported enforcement of the Sherman Anti-Trust Act. He was began serious governmental regulation of the exploitation of nature.

THE PRICE OF NATURE

Concern for the environment has merged in recent decades with a concern for a fair distribution of economic production, to create several approaches to economics that involves the putting a price on all aspects of human engagement with nature. Biological conservation inevitably involved the making of economic decisions. In reality, all economic activity is human activity, and because it involves the exchange of values, it is also an ethical activity. This means that biological conservation seeks an ethical use of resources in such a way that resources are used responsibly and also shared equitably.

This view is concerned with preserving the biodiversity of the earth. For some, all living things have intrinsic worth. However, conservation biology is concerned more with instrumental values, especially as these can be converted into economic values. The issues concern the cost-benefit ratio of maintaining biodiversity.

Cost-benefit ratios are utilitarian in character. They seek to establish the pain, damage, destruction, or financial cost of doing something versus the pleasure or benefits derived, such as building a dam or clearing a section of tropical rainforest to farm or raise cattle. Costs involve more than the financial or resource outlays needed to dig a mine or build a refinery. Costs may be in fact much greater, because species of animals or plants are driven to extinction or reduced in number. The pollution that creates beautiful sunsets is also causing damage to the environment through acid rain to and to human health by damaging lungs.

Benefits are the goods that are derived from human actions. Goods may be tangible, such as cut logs, mined ores, or crops. Or it may be the intrinsic benefit of an unspoiled vista of nature or the peaceful silence of a place far from traffic and other human noise.

In calculating the economic values of human extractions from nature, it is important to recognize that at least one and perhaps as much as 3 billion people derive goods from the biota (the animals and plants of a region). For example, firewood is needed for heating and cooking by people who have no other resource. They may in many locations use deadfall or other combustible materials without any significant impact on the environment. However, in arid locations, their scavenging may be as destructive of the environment as the goats they herd.

Resource economics is a field of study that uses the concepts of natural resources and human resources. The field of resource economics includes the study of agricultural production, bioeconomics, community economic development, environmental economics, environmental policy studies, and resource utilization.

Environmental economics is a subfield of modern economics. It focuses on issues involving the environment, and uses the methods of neoclassical economics. It is usually distinguished from *ecological* or *green economics*. Much of its focus is on environmental policies—local, national, and global. Studies it develops are economic arguments or explanations that include the cost-benefit ratio of projects on the environment. It seeks to propose alternative environmental polices that prevent pollution as an external cost and to minimize the environmental impact of economic activities.

The concept of external cost is central to environmental economic theory because its proponents argue that the cost of goods and services cannot be determined merely by their price. Rather, the impact on the environment both in the short and long term must be included.

Ecological economics argues that economics is a subfield of ecology. This is a reversal of classic economic theory, which if it considered the environment at all would have considered ecology a minor topic of concern.

The field is also concerned with the *Tragedy of the Commons*. This concept is a model for showing how free access to common resources by individuals pursuing their self-interests will be destructive as each tries to maximize their gain, and are therefore inadequate. The claim that markets are efficient is not fully justified. Inefficiencies in the marketplace may result in market failures, requiring intervention by government to engage in the authoritative allocation of goods and services.

This idea clashes with ideas of economic liberty and property rights and with much of the historic legal doctrines of the common and civil law system. However, the right of an individual or company to pollute upstream waters has been restricted if not outright denied by the United States River Keepers Law of the 1880s. This law allows downstream users of water to seek remedies for torts caused by upstream pollution, even if the government will not or does not act.

Approaches to environmental economics are numerous. It has been a major influence in the development of natural capitalism, the basis of which is that the world and its resources are a form of capital just like the physical capital of houses, automobiles, or other values currently counted as capital in mainstream economics.

Natural capitalism is also concerned with globalization. It opposes permitting developers to use Third World resources without regard to their environmental impact. It seeks to stop profits gained by the sale of goods and services in economies that are restricting economic activity or redirecting it into more expensive technologies in order to protect the environment. Because of its critique of globalization, its participants have been associated with antiglobalization movements.

Ecological economics is either an approach to economics or a branch of economics. It incorporates the interdependence of human economies and natural ecosystems. It considers neoclassical economics as prejudiced and ineffective in meeting the challenges faced by both nature and humans. To achieve its objective of responsible economic activity, it must achieve a global common welfare with sustainable economic development. It promotes preserving biodiversity and opposes mere energy economics on the grounds that creating greater energy supplies without regard to environmental or human costs is destructive.

Green economics places the economy within the natural world as a subordinate part. It views economic transactions to include the whole of nature, rather than just the parties directly involved in the transaction. Its comprehensive approach to economics has used insights from a number of other new disciplines, including postmodernism, critical theory, ecology, and animal rights. It also uses insights from environmental economics and ecological economics. It is often associated with antiglobalization and localization theories.

In the struggle for survival, the only species with the power of exercising dominion over the earth is the human species. The power of free choice can make human economic decisions destructive or they can be exercises in stewardship.

SEE ALSO: Biodiversity; Capitalism; Communism; Conservation Biology; Industrialization; Industrial Revolution; Institutions; Markets; Roosevelt, Theodore Administration; Socialism; Tragedy of the Commmons.

BIBIOGRAPHY. W. M. M. Adams, *Green Development: Environment and Sustainability in the South* (Taylor & Francis, Inc., 2001); Michael Common and Sigrid Stagl, *Ecological Economics: An Introduction* (Cambridge University Press, 2005); James R. Craig. David J. Vaughan, and Brian J. Skinner, *Resources of the Earth: Origin, Use and Environmental Impact* (Prentice-Hall, 1998); Herman E. Daly and Joshua Farley, *Ecological Economics: Principles and Applications* (Island Press, 2003); Barry C. Field and Martha K. Field, *Environmental Economics: An Introduction* (McGraw-Hill, 2005); Jonathan W. Harris, et al., eds., *A Survey of Sustainable Development* (Island Press, 2001); Malcolm L. Hunter, Jr., *Fundamentals of Conservation Biology* (Blackwell Science, 1996); David Pimentel, ed., *Biological Invasions: Economic and*

Environmental Costs of Alien Plant, Animal and Microbe Species (CRC Press, 2002); Richard B. Primack, *Essential of Conservation Biology* (Sinauer Associates, 2002); Lucia A. Reisch and Inge Ropke, eds., *Ecological Economics of Consumption* (Edward Elgar Publishing, 2005); Peter Sonderbaum, *Ecological Economics* (Earthscan/James & James, 2000); Robert N. Stavins, *Economics of the Environment* (W. W. Norton, 2005); Luca Tacconi, *Biodiversity and Ecological Economics: Participation, Values and Resources* (Earthscan/James & James, 2001).

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Ecosystem

COINED IN 1935, the term *ecosystem* did not appear in titles of scientific papers until the 1940s, and was not listed in the indexing system of Biological Abstracts until 1957. Use of the term in the scientific literature did not attain wide prominence until the 1970s. The term *ecosystem* originated with English ecologist Arthur Tansley (1871–1955) in the paper: "The Use and Abuse of Vegetational Concepts and Terms," published in *Ecology* in 1935. Tansley's basic notion was that of a system that combined living organisms, the *biome*, with the physical environment. What was novel about the term to ecologists was the incorporation of the physical environment as part of the unit of study. Ecology had so far been confined to departments of biology in the academy, and was focused on community, population, and organism studies rather than the relationship between organisms and the physical environment. Thus, the key concept conveyed by the word *ecosystem* is the inclusion of the physical-chemical environment as a fundamental part of the ecological unit.

Inclusion of the physical environment by the term *ecosystem* is probably the primary aspect of the concept that nearly all ecologists agreed on, and it is still this basic concept that lies at the root of the term's definition (at least in its scientific usage). Part of what makes any discussion of the ecosystem concept problematic is that it is highly abstract. For example, *ecosystem* has often been used interchangeably with the allied concept of *community* (ideally conceived as only including the biological organisms in a particular location and their relationship with one another). As Golley states, for much of its history ecosystem studies have been "an exciting but ill-defined and poorly integrated body of science." The ecosystem concept as proposed by Tansley has been described as the machine model applied to nature. Tansley's focus was on developing the study of ecosystems along the traditional reductionist natural science model, with mathematical and experimental rigor. Tansley wanted the concept to have legitimacy as a fundamental part of natural science. However, the term soon became entangled with the holism or super-organism conception of biological communities in American and German ecological thought in the early 20th century.

EMBELLISHMENT OF THE CONCEPT

Ecologists such as Frederick Clements (1874–1945) and John Phillips conceived of ecological communities as super-organisms following a set path of development and maturation. Clements's notion of a predetermined development of ecological systems (succession) that resulted in an endpoint called a climax was compared to the growth and maturation of an organism. Although amended by ecologist Robert Whittaker in 1953, the original Clemensian notion of unspoiled nature as balanced and perfect has remained ascendant in the popular consciousness. This aspect of the concept, which was to play prominently in the development of environmentalism, suggested the notion of ecosystems striving to reach an inherent perfection that was disturbed, or thrown off course, by humans. It was a fusion of a teleological notion applied to nature with that of a supposedly scientific concept. This view had much to do with the background assumptions that led to many of the world's environmental laws and particularly protectionist laws that sought to put large areas of the planet's surface off limits to human influence.

Tansley was opposed to this embellishment of his original concept, viewing such super-organism or holism conceptions as philosophical and even theological speculation, not science. Tansley wanted the ecosystem concept to be taken seriously as a legitimate science and the study of ecosystems to be approached with standard scientific experiment and

This fusion of the holism, or super-organism concept of nature with ecosystem, has continued to the present day.

analysis, not conjectures about "emergent properties." The super-organism conception of ecosystems came out of larger cultural currents in the late 19th century. For example, concern with the disappearance of the rural, organic, peasant community because of the rapid industrialization and urbanization of Europe, as expressed by writers within the German Romantic tradition, influenced ecological thinking in the early 20th century. In her book *Ecology in the Twentieth Century*, Anna Bramwell traces this influence on ecological thought, including an analysis of how ecological holism influenced National Socialism in Germany in the 1930s where concern with the organic ties between the German people and their homeland, as expressed by the motto "blood and soil," fueled an emphasis on ecological research within the Third Reich.

This fusion of the holism, or super-organism concept of nature with ecosystem has continued to the present day, particularly among environmentalists. In this sense, ecosystem has taken the place of Mother Nature as a moniker for the totality of nature—nature as it's supposed to be; taking on precisely the moral and theological overtones that Tansley objected to. This aspect of the ecosystem concept has resulted in perhaps its most important sociological influence with respect to its dominance in popular culture, outside its original scientific venue. Since the term's inception it has carried a double valance, one being a more scientific or systems notion of the term, the other more philosophical and normative. Yet both senses of the concept often become conflated, even among ecologists.

The legacy of the ecosystem concept as envisioned by Tansley was carried forward and implemented in scientific studies by pioneering ecosystem ecologists such as Raymond Lindeman (1915–42; considered to have conducted the first ecosystem study at Cedar Bog Lake in Minnesota), Hebert Borman, Gene Likens, and Eugene and Howard Odum. Ecosystem studies became highly influenced by computer modeling, thermodynamics, and cybernetics. The dominant approach was to model the flow of energy and nutrients through a system that had semi-definite boundaries such as a lake or watershed. The diversity of organisms in these systems was simplified by the representation of trophic levels, where energy and material flow was studied with input-output models.

One of the early sources of funding for such studies was the U.S. Atomic Energy Commission (AEC). In the 1950s the AEC commissioned research on the fate of radio nucleotides in the environment as a result of atomic bomb testing and production. These studies and the funding provided a welcome boon to the fledgling field of ecosystem ecology. Early and ongoing ecosystem studies at AEC sites like the Hanford Nuclear Reservation in Washington State, and Oak Ridge National Laboratory in Tennessee, have produced an impressive body of work in ecosystem ecology. In the 1960s, the International Biological Program (IBP) funded many large-scale ecosystem studies, ushering in the heyday of computer modeling and cybernetic theory, an endeavor that did not live up to its initial expectations.

Perhaps the most well known ecosystem ecologists of the 1960s and 1970s were the Odum brothers. Howard Odum was known for his energy models of ecosystems, including his classic study of Silver Springs in Florida, and Eugene Odum, who was probably the greatest single influence on ecologists in the second half of the 20th century, author of *Fundamentals of Ecology*, which became the standard college textbook on ecological science from the 1950s through the 1970s. Howard Odum focused almost exclusively on the machine metaphor of the ecosystem, looking at energy flow and trophic level relationships of whole systems and incorporating mathematical description and computer modeling of ecosystems extensively. Eugene Odum, on the other hand, while still clearly within the natural science model of the ecosystem concept promoted by Tansley, also incorporated Clemensian conceptions that stressed determinate succession and climax states.

The ecosystem concept was also important to natural resource scientists who saw a way to make more efficient use of natural systems for the management of forestry, fisheries, and wildlife. Environmental scientists also saw utility in the concept, such as the use of wetlands for wastewater treatment. However, in a good example of institutional lag, it was the 1990s before many natural resource management agencies explicitly took on the task of managing natural resources within an ecosystem paradigm. In the early 1990s, the term *ecosystem management* was coined in an attempt to market this new emphasis in federal resource management agencies such as the U.S. Forest Service.

CONTROVERSIAL CONCEPT

The ecosystem concept has never been without controversy; not only was it poorly defined, it often took on more of the character of doctrine than science. Golley relates that ecosystem terms were often presented as pronouncements of authority, rather than scientific hypotheses to be tested, and the culture of ecosystem science tolerated little dissent. Those outside the discipline were not impressed. As Golley states, “Ecologists were not questioning the cultural paradigms, they were working within them.” By the 1980s, as the term *ecosystem* was becoming a household word in the popular culture through the spread of the environmental movement, professional ecologists were beginning to have serious doubts about the concept, and some were starting to question its relevance. A reformulation of the concept was in the making. Although controversy and debate has surrounded the concept since its inception, the reevaluation that began in the 1980s eventually took on the moniker of the new ecology.

One of the changes advocated in the reformulation of the concept was an emphasis on process and scale. Works such as *A Hierarchical Concept of Ecosystems* (1986) argued that an ecosystem is not a place or set of components somewhere between the size of a community and the biosphere, but rather denoted a set of relationships or processes that take place at multiple spatial and temporal scales, from the gut of a termite to the biosphere itself. As described by ecologists Timothy Allen and Thomas Hoekstra, ecosystems are “intangible” and consist of “pathways and processes and fluxes” that are “transformations of matter and energy” and more easily conceived as “temporally rather than spatially ordered.” Rather than something existing in nature, ecosystem is a more or less useful model of ecological phenomena that reveals some things and hides others.

Other changes that were taking place as part of the new ecology included the rise of new theories of community assembly, and rising evidence that many principles of ecosystem science lacked scientific rigor and had little empirical grounding. For example, the widely cited stability-complexity hypothesis held that complex ecosystems were more stable than simple ecosystems, even though this assertion had little empirical support. An increasing number of studies demonstrated that simple ecosystems could be very stable and complex ones highly unstable. Along with developments in systems and information theory, chaos theory, and the highly nonlinear behavior of ecosystems, led to the conclusion by many ecosystem scientists that there could be no laws in ecology. Rather than paladins of unspoiled nature and balanced perfection, ecosystem behavior was more often nonlinear, unstable, and in constant flux, with disturbance and nonequilibrium states more common than not. Ecosystems were increasingly seen as products not of nature’s design, but chance, largely dependent on the particular history of a site.

The Clemensian notion of ecological communities that had become a part of ecosystem thinking from the term's inception, along with associated ideas about equilibrium, holism, and determinate community composition, was being replaced in the 1980s and 1990s with the idea that chance and local context directed community structure. In the early 20th century, Henry Gleason (1882–1975), a contemporary of Frederick Clements, had proposed a conception of the ecological community as a random assemblage of organisms that were found together in the same place purely by chance, due to having similar requirements for climate or soil. Gleason's basic view of community structure has now largely replaced Clements's. This Gleasonian view has been formalized in a new ecological theory known as *neutral theory.* Credited largely to ecologist Stephen Hubbell, neutral theory in essence states that what organisms will be found in a particular place is simply a function of the abundance of their propagules. From the Clemensian superorganism ecosystem, science has moved closer to the view that ecosystem denotes processes that are in flux, random assemblages of components, and future development not dependent on general ecological laws, but rather the largely unpredictable idiosyncrasies of a particular site.

A PARADIGM SHIFT IN ECOLOGY

Daniel Botkin popularized what has been called the paradigm shift in ecology in the book *Discordant Harmonies: A New Ecology for the Twenty-first Century*. Ecosystems are indeterminate, unpredictable, nonlinear, and constantly in flux; there are no laws in ecology because ecosystem behavior is highly dependent on context, a condition that some have termed *all ecology is local.* Even long-term studies of a particular place have shown that generalizations are risky and that ecosystems follow indeterminate paths of change that cannot be predicted, even with many years of monitoring data. A response to the recognition of the idiosyncratic nature of ecological systems is the promotion of adaptive management among natural resource scientists. Adaptive management recognizes the failure of trying to implement broad stratagems of ecosystem use from general theory, and instead advocates a "learn as you go" philosophy, where management endeavors are carefully monitored, as well as the response of the ecological unit, so that learning can take place over time about the particularities of a given locality.

Another change occurring in parallel with the developing new paradigm in ecology was increasing interest by social scientists, particularly natural resource sociologists, in incorporating humans and the works of human culture as legitimate parts of ecosystems. Some have used the term *human ecosystem,* or *socio-biological system,* to indicate this new focus. This move to reconceptualize ecosystems as including humans and their culture is being further reinforced by environmental historians who are increasingly producing findings of the tremendous impact pre-modern humans have had on ecosystems that were once considered pristine, such as the Amazon rainforest and pre-Columbian North America.

In tandem with the new ecology, which is showing that ecosystems are not supposed to be any particular way, the latest research in environmental history is revealing an ancient dynamic interrelationship between humans and the landscapes and seascapes they inhabit. This relationship has resulted in ecosystems that are not in, or out of, some preordained configuration or balance, but simply reflect the arbitrary history of events that occurred in a particular place on the planet, whether human-caused or not.

These new developments in ecosystem science, natural resource sociology, and environmental history are revolutionizing how we understand our place in nature. This new ecosystem paradigm has implications for social policy regarding the management of natural resources and the environment. As presented in such venues as the book *Defending Illusions: Federal Protection of Ecosystems*, by Allen Fitzsimmons (1999), and at environmental law conferences, such as one held at Duke University in 1996, the conclusion is that many environmental laws that have the implicit goal of protecting some perfection in nature no longer conform to ecological science and the epistemology of the ecological or human sciences. Ecosystems are socially constructed. The ecosystem concept has its uses and insights; what it denotes and connotes will change through time, not only because of new discoveries in ecological science, but more importantly because of the different ways humans of the future will value and perceive nature. What is relevant to humans now may not be in the future; the stories we tell about nature, and ecosystems, will change.

SEE ALSO: Critical Environmental Theory; Ecological Imperialism; Ecological Modernization; Ecology; Ecomanagerialism; Environmentalism; Environmentality; Nature.

BIBILIOGRAPHY. Timothy Allen and Thomas Hoekstra, *Toward a Unified Ecology* (Columbia University Press, 1992); Elizabeth Bird, "The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems," *Environmental Review* (Winter, 1987); Anna Bramwell, *Ecology in the Twentieth Century* (Yale University Press, 1989); H.A. Gleason, "The Individualistic Concept of the Plant Association," *Torrey Botanical Club* (v.53, 1926); F.B. Golley, *A History of the Ecosystem Concept in Ecology: More Than the Sum of the Parts* (Yale University Press, 1993); T. Greider and L. Garkovich, "Landscapes: The Social Construction of Nature and the Environment," *Rural Sociology* (v.59, 1994); Lancett Gunderson and C.S. Holling, eds., *Panarchy: Understanding Transformations in Human and Natural Systems* (Island Press 2002); Stephen Hubbell, *The Unified Neutral Theory of Biodiversity and Biogeography* (Princeton University Press, 2001); L.A. Kapustka and W.G. Landis, "Ecology: The Science Versus the Myth," *Human Ecology and Risk Assessment* (v.4, 1998); Roger Lincoln, Geoff Boxshall, and Paul Clark, *A Dictionary of Ecology, Evolution and Systematics* (Cambridge University Press, 1998); Z. Naveh, "The Total Human Ecosystem: Integrating Ecology and Eonomics," *BioScience* (v.50/4, 2000); Howard Odum, "Trophic Structure and Productivity of Silver Springs, Florida," *Ecological Monographs* (v.27/1, 1957); Robert O'Neill, "Is It Time to Bury the Ecosystem Concept? (With Full Military Honors, of Course!)" *Ecology* (v.82/12, 2001); Robert O'Neill, et al., *A Hierarchical Concept of Ecosystems* (Princeton University Press, 1986); R.H. Peters, *A Critique for Ecology* (Cambridge University Press, 1991); K.S. Shrader-Frechette and E.D. McCoy, "Natural Landscapes, Natural Communities, and Natural Ecosystems," *Forest and Conservation History* (July 1995); S. Woodley, et al., eds., *Ecological Integrity and the Management of Ecosystems* (St. Lucie Press, 1993); J. Wu and O.L. Loucks, "From Balance of Nature to Hierarchical Patch Dynamics: A Paradigm Shift in Ecology," *The Quarterly Review of Biology* (v.70/4, 1995).

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Ecotage

ECOTAGE INVOLVES ECOLOGICALLY motivated acts of sabotage, such as tree spiking, uprooting genetically modified crops, disrupting power lines, liberation of caged animals, and destruction of equipment or data from controversial research. These illegal acts are also known as *ecodefense* or *monkeywrenching*. Two of the main goals of ecoteurs are to cause economic harm to corporations and to dissuade the public from wasteful or ecologically disruptive practices, like driving sport utility vehicles (SUVs) or permitting suburban sprawl in wetlands.

While ecoteurs have a range of different moral philosophies, they most often do not support causing death or injury to humans from their actions. Spiking trees with metal or ceramic nails can harm loggers, but the likelihood is small given that trees should be cut within twelve inches of the ground and spikes are placed higher. Even the most radical environmentalists usually go to great lengths to assure humans are absent from their material targets before sabotage is carried out.

ECOTERRORISM

State officials tend to classify ecotage as *ecoterrorism*, which reinforces the use of harsher penalties if saboteurs are caught. In the United States, there are various governmental agencies, including the FBI, cooperating on the investigation of radical environmentalism, which since 2001 has been considered the largest national terrorist threat. Significant resources have been invested into halting incidences of ecotage. However, the autonomous structure of ecotage cells that maintain their anonymity within loose, nonhierarchical networks defies surveillance and infiltration.

The name *ecotage* seems to have originated from the 1972 book by Sam Love and David Obst. The concept became popular as a result of Edward Abbey's 1975 novel, *The Monkey Wrench Gang*. There are a few manuals published on ecotage tactics, such as Dave Foreman's 1985 "Ecodefense: A Field Guide to Monkeywrenching." Foreman was one of the cofounders of Earth First!, a radical environmental movement known for direct action, that emerged in the 1980s. The northwest United States has been a hotspot for environmental groups, such as Earth First!, particularly in areas of old growth forest.

A number of mainstream environmental organizations have direct action trainings where members learn to climb buildings or other structures and hang banners that draw attention to ecological damage or injustice. A well-known group implementing more extreme acts of environmental sabotage is the Earth Liberation Front (ELF). ELF has created more than $100 million of damage in the United States since 1997. Although the origins of ELF are under debate, some believe that they are a radical offshoot from Earth First!. ELF has taken responsibility for arson in private logging company and U.S. Forest Service offices. In 1998, fires were set in buildings located on Vail Mountain in Colorado in a combined ELF and Animal Liberation Front (ALF) action. The mountain provides a unique habitat for lynx, and Vail was targeted to disrupt it through construction of large-scale commercial recreation facilities that required infrastructural development in fragile ecosystems.

ALF is an older organization than ELF. ALF started in the United Kingdom, but cells later developed in the United States. Well-known U.S. actions include arson in slaughterhouses and university facilities conducting animal research. In addition to "rescues," where animals are released from cages on commercial farms or in research institutes, U.S. animal rights activists have also disrupted hunts of mountain lions, bison, and other game since the 1980s. Activists in the United Kingdom pioneered strategies to disrupt hunts in the early 1960s.

Another well-known group of ecoteurs is the Sea Shepherd Conservation Society. These international activists often interfere with marine harvest at the point of extraction. Society members cut illegal longlines and harass unlicensed fishing vessels. Some larger actions attributed to this group are the sinking of two whaling vessels and the destruction of a whale processing station in Iceland.

There have been an increasing number of prominent international cases of ecotage in recent years involving resistance to genetically modified crops. Actions include uprooting of genetically engineered potatoes at the Crop and Food Research Center in New Zealand. Canadian targets have been related to research on biotech forests. In the United Kingdom, where there is a long tradition of ecotage, consistent destruction of research sites since 1997 has made ongoing study of genetic modification difficult.

SEE ALSO: Abbey, Edward; Animal Rights; Earth First!; Genetically Modified Organisms; Sport Utility Vehicles; Timber Industry; Urban Sprawl.

BIBLIOGRAPHY. Steven Best and Anthony J. Nocella, *Terrorists or Freedom Fighters? Reflections on the Liberation of Animals* (Lantern Books, 2004); Craig Rosebraugh, *Burning Rage of a Dying Planet, Speaking for the Earth Liberation Front* (Lantern Books, 2004); Bron Taylor, "Religion, Violence and Radical Environmentalism: From Earth First! to the Unabomber to the Earth Liberation Front," *Terrorism and Political Violence* (v.10/4, 1998); Paul Watson, *Ocean Warrior: My Battle to End the Illegal Slaughter on the High Seas* (Key Porter Books, 1996).

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Ecotone

AN ECOTONE IS the highly dynamic boundary between two disparate ecosystems: vegetation types and biomes. Ecotones can be very narrow and sharply defined, such as a terrestrial-aquatic boundary, or they can represent a broad transition between differing biomes, such as a gradual conversion between grassland and forest. Often, the flora and fauna found on either side of an ecotone will not be similar to one another, and species favoring one side of the ecotone will not fare as well on the other. Because of the variability in vegetation cover and abiotic factors characterized by ecotones, biodiversity across an ecotone tends to be higher than in relatively homogeneous habitats on either side of the ecotone. Ecotones can be formed by natural processes, such as floods, fires, and volcanic activity, but increasingly, human land use activities have created ecotones. Examples of anthropogenic ecotones are agricultural-pastoral boundaries, urban-rural spaces, and parks or protected land adjacent to lands used to meet human resource needs.

Ecotones typically favor certain types of vegetation and fauna over others. Species requiring a high degree of stability and habitat continuity will not be successful in or near an ecotone; species adapted to disturbances or boundaries can better exploit the resources found in these niches. Abiotic factors such as erosion, sediment deposition, snow accumulation, nutrient availability, salinity, and temperature are all affected by ecotones and tend to differ from one side of the boundary to another. Ecotones also can create microclimates, which further favors certain species over others. For example, a meadow surrounded by forest will be characterized by greater temperature extremes and more rapid changes in temperature than the surrounding forest. Additionally, direct sunlight reaching the ground will cause faster evaporation, and potentially dry meadow soils faster than those in the forest.

One concern that land managers express over ecotones is that they favor the success of invasive species. Human land uses such as road building or agricultural activities create ecotones with wholly different competition and predation regimes. Areas of undisturbed natural habitat are typically more resistant to invasive species, but patches where parts of previous ecosystems have been removed prove particularly prone to colonization by invasives, such as fire ants, kudzu, tumbleweed, or buffelgrass.

In areas characterized by naturally occurring habitat variability or "patchiness," land managers can use certain techniques such as prescribed burns, tree harvesting, or grazing by animals to create desired ecotones. The mosaic of desert, grassland, riparian areas, and forests in the western United States are typical of this highly fragmented, ecotone-rich land cover. Because ecotones are a naturally occurring part of ecosystems, it is necessary to ensure the continued existence of threatened species. The maintenance of ecotones can be one aspect of human management in protected areas.

Ecotones are typically far from stable, and undergo spatial and temporal changes. Sea level changes impact the placement of the marine-terrestrial ecotone. Forest succession at an abandoned beaver pond represents a changing ecotone. Tree lines migrate up and down mountainsides as a result of changes in temperature and precipitation. Recent concern has focused on ecotone dynamics as a result of anthropogenic effects, including climate change. Ecotones are necessary for a certain amount of ecosystem function, which humans rely on. For example, sea level rise may obliterate many productive salt marshes, coral reefs, and estuaries, which provide nursery areas for countless species of marine, freshwater, and anadromous species, leading to a decline in productivity of fisheries and other human uses.

SEE ALSO: Biodiversity; Biome; Conservation Biology; Habitat.

BIBLIOGRAPHY. G.A. Bradshaw, P.A. Marquet, K.L. Ronnenberg, *How Landscapes Change: Human Disturbance and Ecosystem Fragmentation in the Americas* (Springer, 2003); M.V. Lomolino, B.R. Riddle, and J.H. Brown, *Biogeography* (Sinauer, 2006); G.P. Malanson, Y. Zeng, and S.J. Walsh, *Professional Geographer* (v.58/4, 2006).

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Ecotourism

TOURISM IS OFTEN described as the world's largest industry and, while a small component of the overall industry, ecotourism is believed to be one of the fastest growing sub-sectors. Definitions of *ecotourism* are many, and have proliferated since the term was popularized in the 1980s. One consequence of multiple definitions is the associated difficulty in measuring the size of the ecotourism market; estimates range from 2 to 25 percent of all leisure travel. A second consequence is that ecotourism has been so broadly interpreted that its value as a tourism category has been questioned. Ecotourism options range from overnight stays in remote huts made of local materials and without modern amenities to luxury stays in exclusive eco-spas costing thousands of dollars per night. Activities can include bus tours of natural areas, passive bird watching or whale watching on guided tours, or active trekking and bush camping, sometimes without a guide. Regardless of definition, amenities, or activities, however, the popularity of ecotourism is reflected in a variety of ways; for example, the United Nations declared 2002 the Year of Ecotourism and *The New York Times* tagged ecotourism as the "buzzword of the year" for 2006.

KEY CHARACTERISTICS

While there is no universally accepted definition of ecotourism, several key characteristics appear are evident, although with varying emphasis and importance attached to them. First, ecotourism occurs "in nature," and tourists travel purposefully to areas where they can enjoy, see, and interact with nature. Second, ecotourism (and associated infrastructure) should be "low impact," with minimal disturbance to the environment. This has implications for tour operator, service provider, and tourist behavior. Third, some portion of the profits generated from ecotourism should fund conservation efforts. Increasingly, a small but growing number of ecotourists directly donate their time and labor to work for conservation, an activity labeled volunteer ecotourism. Fourth, ecotourism should educate both tourists and local people about nature (and its value). Fifth, ecotourism should provide economic opportunities for local communities, with the idea that these will translate into incentives to preserve nature. Finally, ecotourism development should be undertaken with respect for local cultures, and ideally with local participation in planning and management.

Generally, over time, ecotourism definitions have been expanded from an early focus on the purpose of ecotourism (to visit nature, provide educational opportunities and fund conservation) to incorporate principles of ecotourism (responsibilities for minimizing impacts, supporting local economic development and respecting local cultures). This evolution reflects a shift from descriptive definitions of ecotourism to more normative ones, and the normative emphasis reflects ecotourism's inclusion in the broader category of alternative tourism. Alternative tourism was popularized in the 1980s and 1990s, partly in response to the increasing evidence of the negative impacts of mass tourism on economies, cultures, and environments. Its concern is with the well being of host communities rather than that of the tourism industry. In all of these six characteristics, ecotourism is situated in contrast to traditional, mass tourism, and as such is proposed as a morally superior alternative, one that allows tourists and the tourism industry to alleviate rather than contribute to local environmental and economic problems.

RECONCILING WITH CONSERVATION

Ecotourism is a popularly promoted means of reconciling wildlife conservation with economic development, particularly in developing countries. Some developing countries are renowned ecotourism hotspots and cited as ecotourism success stories. For example, both Costa Rica and Belize rely on tourism as their largest foreign exchange earner, have protected large portions of their land (and waters) in national systems of protected areas, and cater to the ecotourist niche. Wildlife conservation organizations and park protection agencies initiated much of the discussion of the ecotourism concept. The World Conservation Union, World Wide Fund for Nature, and Conservation International, for example, all promote ecotourism as one means of achieving conservation and development. Ecotourism is often paired with community-based conservation, with community members working as tourist guides and park rangers, or investing in the provision of tourist goods and services. Proponents argue that ecotourism that provides local employment and small business development creates higher economic multipliers, and that a community approach to decision making helps to ensure traditional lifestyles and community values are respected. In the most optimistic scenarios, communities are "empowered" through ecotourism, develop a sense of "pride" in their natural resources, and even experience a resurgence in cultural traditions of interest to the discerning ecotourist. Ecotourism in this vision represents the ultimate realization of mainstream sustainable development.

SHORTCOMINGS AND RESPONSES

While ecotourism in theory aspires to meet both conservation and development goals, the ability of ecotourism in practice to deliver on these goals is increasingly questioned. There are examples of ecotourism projects that meet one or several of the criteria listed above, but overall the literature on ecotourism is dominated by impact studies of particular cases that, in general, have shown ecotourism in practice to be disappointing. Further, ecotourism often suffers the shortcomings associated with tourism in general.

First, economically, conservation revenues from ecotourism have been disappointing, with leakage (money leaving the community) remaining high in some areas, due to the presence of foreign investors, extra-local tour operators, and/or state policy that favors foreign investors. At a more theoretical level, the global push for ecotourism development reflects and reinforces an environmental-economic paradigm that commodifies nature and requires economic justification for all nature conservation.

Second, politically, local support for conservation activities through ecotourism can be lacking in spite of monetary gains, particularly if local people are treated as passive recipients of such gains rather than actively involved in ecotourism planning and management.

Third, socially and culturally, ecotourism has experienced many of the problems associated with traditional tourism, e.g., increased incidents of crime and drug use, commodification of cultural practices for tourist consumption, and erosion of local social and cultural norms. Ecotoursim has the additional impact of imposing Western visions of nature on local environments and people. These visions often focus on aesthetic nature and demand an “Edenic” experience for ecotourists. Local people associated with such nature are also required to meet tourist expectations of exotic and/or simple and, as a result, their own development aspirations can be curtailed rather than advanced by ecotourism. As a result, ecotourism has been labeled *green imperialism*, a new way for the developed north to dictate how resources are used in the south. Fourth, the aspirations of ecotourists as “alternative consumers” are often questionable, with ecotourists characterized as self-indulgent consumers of people and places, attempting to build their cultural capital. In this way, ecotourism has been called *green greed* and ecotourists *ego-tourists*.

Fifth, the popularity of ecotourism has been associated with *green-washing*, or the repackaging of traditional holidays as ecotours with minimal changes to actual activities. With ecotourism and ecotourist labels applied broadly (and some would argue indiscriminately), it has become increasingly difficult to distinguish either from traditional tourism and tourists. Finally, the sheer popularity of ecotourism and the high tourist numbers at particular sites, what some have labeled *mass ecotourism*, belies its ability to be low impact or alternative. These shortcomings can combine to translate into a failure to protect natural environments, or worse to directly damage those environments ecotourism seeks to protect.

As awareness of the shortcomings of ecotourism in practice has grown, academics and practitioners have adopted several responses. The first response focuses on “getting ecotourism right.” In this view, the original theory of ecotourism holds true and the challenge is to improve the practice. “Best practice” frameworks against which ecotourism projects can be assessed have emerged. Conservation organizations have produced ecotourist codes of conducts or developed eco-labeling schemes to distinguish ecotourism operators from the green-wash. The second response involves distinguishing between different forms of ecotourism.

For example, ecotourism (and ecotourists) can be situated on a spectrum from “hard” to “soft,” with activities at the hard end representing the ideal ecotourism described in the literature and those at the soft end resembling mass tourism. Some authors have argued that soft ecotourism, where tourists become temporary ecotourists for short periods of time as part of traditional holidays (e.g., by taking a day trip to a national park), might in fact be environmentally preferable to hard ecotourism. While the potentially high number of soft ecotourists might seem antithetical to the ecotourism concept, their impacts can be concentrated at a few well-serviced

Wildlife conservation organizations and park protection agencies initiated much of the ecotourism concept.

sites rather than dispersed in fragile ecosystems. Additionally, mass tourism providers may be better situated to implement sustainability overall (e.g., by investing in energy saving technologies or recycling), due to economies of scale. A second attempt to distinguish between forms of ecotourism is to place them on a spectrum of commodification, with least commodified forms being most desirable and closer to the ecotourism ideal; volunteer ecotourism may be one example of decommodified ecotourism. The types of distinctions made between hard and soft ecotourism, or least commodified and most commodified, allow for a more accurate assessment of the actual size of the ecotourism industry, and movement away from an overly broad label that covers too much to be meaningful while retaining a focus on the desired characteristics of ecotourism. The third response has been to more critically assess the ecotourism concept from a variety of theoretical perspectives. Advocates of this response argue that without a more sophisticated theoretical understanding of ecotourism, case study research will keep rediscovering the disappointments of ecotourism in practice. For example, understanding the political economy of ecotourism can help explain why local people receive few ecotourism benefits, and this understanding can be used to strategize ways to overcome this reality and capitalize on ecotourism opportunities. Political ecology can assist in positioning ecotourism as a phenomenon both reflecting and reinforcing human–environment relations, and can help explain why ecotourism remains so popularly promoted in spite of the disappointments of ecotourism in practice.

The final response that stands in contrast to all of the others is to abandon the term *ecotourism* altogether. In this view, ecotourism has become too ambiguous to be meaningful, and yet the label carries unchallenged assumptions that can lull tourists into a false sense of complacency. Instead of assessing the extent to which various examples of tourism meet the criteria of ecotourism, the aim should be to make all tourism (more) environmentally, economically, socially, and culturally sustainable. While there is appeal in this approach, the contemporary popularity of ecotourism suggests that both tourists and the tourism industry are invested in this market niche and that the ecotourism label is a powerful and desirable one. It is more likely that a combination of the first three approaches will continue to be pursued. Whether or not this will result in improved performance of ecotourism in practice, and more examples of ecotourism success stories, remains to be seen.

SEE ALSO: Convservation; Safaris; Tourism.

BIBLIOGRAPHY. Elizabeth Boo, *Ecotourism: The Potentials and Pitfalls* (World Wildlife Fund, 1990); Hector Ceballos-Lascurain, *Tourism, Ecotourism, andPprotected Areas: The State of Nature-Based Tourism Around the World and Guidelines for Its Development*

(IUCN, 1996). Martha Honey, *Ecotourism and Sustainable Development: Who Owns Paradise?* (Island Press, 1999); Martin Mowforth and Ian Munt, *Tourism and Sustainability: Development and New Tourism in the Third World* (Routledge, 2003); David Weaver, *Ecotourism* (John Wiley & Sons Australia, 2001); David Weaver, *The Encyclopedia of Ecotourism* (CABI, 2001).

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Ecuador

ECUADOR, A NATION on the west coast of South America, straddles the Amazonian lowlands, the Andes, a humid coastal plain, and the Galapagos Islands. The population of about 12 million (2001 census) is well along in its demographic transition, with low and declining death rates and declining birth rates. Approximately 1.5 million migrants overseas (especially New York and Spain) provide an important support for the country's economy through their remittances. Almost all of the population identifies as Mestizo, with small but important indigenous and Afro–Latin American minorities. Almost half the population lives in or near the three main cities, Quito (the capital), Guayaquil (the largest city and main port), and Cuenca (most important city in the southern highlands).

Agriculture has been practiced in the highlands for thousands of years, resulting in the deforestation of this part of the country. Traditional agriculture deploys a wide range of crop species and varieties, and sophisticated systems of irrigation and crop rotation on sloping land. Commercial agriculture provides important exports, including bananas. Recently, flower cultivation has been a heavy user of scarce water supplies in the highlands, while shrimp farms on the coast have done away with much of the country's mangrove habitat. Much of the highlands have been reforested with exotic species (especially Eucalyptus and Monterey Pine) for local use. High altitude environments (*páramos*) are managed by burning and are used for grazing sheep and cattle.

The country has several active volcanoes that present a significant hazard. Much of the Quito urbanized area is at risk from lava flows from the Cotopaxi volcano. Earthquakes are also a hazard; several cities have been destroyed in the last few centuries. A nationwide monitoring program is in place, managed by the Polytechnic University in Quito, to provide early warnings.

Water resources are especially critical for the country's future. A sophisticated water system has been installed for Quito relying on high altitude reservoirs (and associated ecological services from local communities), but other cities and towns often make do with unsafe and unreliable water supplies.

The first national park was created in the Galápagos Islands in 1936. The system of parks and preserves now covers almost 20 percent of the national territory, and is managed by the Ministry of Environment. Tourism, including ecotourism, provides growing support for the country's economy,

Petroleum exploitation in the Amazon basin began with the drilling of the first productive well in 1967. In subsequent decades, oil became the country's major export. The construction of roads led to an influx of colonists, especially in the northeast, which in turn led to deforestation and pressure on indigenous communities. There have been oil spills and contamination of local waterways associated with oil production, and continuing struggles with local indigenous communities over impacts on their land and livelihoods.

SEE ALSO: Amazon River Basin; Drilling (Oil and Gas); Ecotourism; Eucalyptus.

BIBLIOGRAPHY. Allen Gerlach, *Indians, Oil, and Politics: A Recent History of Ecuador* (SR Books, 2003); Gregory Knapp, *Andean Ecology: Adaptive Dynamics in Ecuador* (Westview, 1991); Douglas Southgate, *Economic Progress and the Environment: One Developing Country's Policy Crisis* (Oxford, 1994); Erik Swyngedouw, *Social Power and the Urbanization of Water* (Oxford, 2004); Lola Vázquez and Napoleón Santos, *Ecuador: Su Realidad 2005-2006* (Fundación José Peralta, Quito, 2005).

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Eden, Garden of

THE GARDEN OF Eden appears in the writings of the Abrahamic religions, Judaism, Christianity, and Islam. In the biblical creation story of Genesis, it is a beautiful garden of trees planted by God in the land of Eden and watered by a river. God intends that the first man and woman, Adam and Eve, live there in contentment and innocence. God takes all the animals that he has created there so that Adam can name them. At the center of the garden are two fruit trees; the Tree of Life and the Tree of Knowledge. Adam and Eve, encouraged by a serpent, ignore God's prohibition not to eat from the Tree of Knowledge. They thereby gain an awareness of good and evil but lose their innocence. God drives the couple from the Garden, placing an angel at the entrance to prevent their access to the Tree of Life and immortality. God further condemns Adam, and thus all humans, to secure food by hard labor in the fields, making the ground cursed and choked with weeds rather than naturally abundant as in the Garden.

Elsewhere in the Bible, the Garden of Eden is represented as the "garden of God," a paradise of lush growth and majestic trees, a place of comfort and contentment for humans, and the utter opposite of deserts and wastelands. The prophet Isaiah assures Israelites in Babylonian captivity that one day God will convert their harsh environment into a new Eden. It is thus a symbol of the renewal of both land and society, and an image of promise.

In the rabbinical tradition, the Garden of Eden was the embodiment of perfection, the ultimate reward for righteous souls after death. The Garden of Eden is also mentioned in the Qur'an and is associated with paradise.

The Garden of Eden has also been described as a mythological creation story, a future celestial paradise that awaits the virtuous or a real place on earth that was destroyed by the Flood. Some have sought the location of a real Garden, still in existence long after its primeval role in Creation but lost to the knowledge of humans. Medieval legend tells of St Brendan making a seven-year Atlantic voyage in search of it. Some European voyages of discovery in the early modern period were partially inspired by the search for an earthly, utopian paradise. The American tropics were particularly seen as edenic lands. Columbus thought that the great Orinoco river might be one of the four rivers of Eden. In more recent times, satellite imagery has been used to suggest that the dried-up Wadi Batin and the Karun River, combined with the nearby Tigris and Euphrates, make up the four rivers, placing the Garden under the waters of the Persian Gulf.

Any geographical location for Eden is hypothetical, but the garden has also been a compelling symbol of a once-effortless relationship between humans and the divine, and of harmony between society and the environment. Medieval scholars claimed that Adam's control of the garden and the obedience of animals in Eden gave humans complete authority over all plant and animal life, which was clearly put on earth to serve them. Around this same time, the Garden of Eden was also seen as a model for botanical gardens. Some tried to recreate the garden, which they believed had been swept away by the Flood, by gathering all the plant species from the known world for study. Botanical gardens today continue assembling the plants of the world, although their aim is species conservation, not spiritual inspiration.

The nostalgic longing to recover a lost paradise, an ancient golden age when humans lived in harmony within an abundant nature, is common in many cultural traditions around the world. Some anthropologists suggest that the Garden of Eden story represents a cultural memory of simpler times when humans lived freely as hunters and gatherers rather than toiling at agriculture in fixed locations. Environmental historian Carolyn Merchant argues that the "recovery narrative" implicit in the story of the Garden of Eden was used as a powerful justification in American history to convert the "wilderness" into a garden and, within the early national parks movement, to forcibly evict indigenous peoples from areas designated as pristine.

The concept of "the last Eden" is still applied to a number of relatively "unspoiled" and inaccessible places on earth, which harbor a diversity of rare plant and wildlife, such as the rainforests of the Amazon, the Congo Basin, or Borneo. The aim of restoring or preserving such parts of the world in a "wild" Edenic state can cause conflict over the rights and aspirations of indigenous peoples, environmentalists, tourism developers, and industrialists.

SEE ALSO: Amazon River Basin; Botany, Tigris–Euphrates River.

BIBLIOGRAPHY. Jean Delumeau and Matthew O'Connell (trans.), *History of Paradise: the Garden of Eden in Myth and Tradition*, (Continuum, 1995); Dora Jane Hamblin, "Has the Garden of Eden Been Located at Last?" *Smithsonian Magazine*, www.ldolphin.org/eden (May 1987, 18(2)); Richard Heinberg, *Memories and Visions of Paradise: Exploring the Universal Myth of a Lost Golden Age*, rev. ed. (Quest Books, 1995); Carolyn Merchant, *Reinventing Eden: The Fate of Nature in Western Culture* (Routledge, 2003).

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Edge Effect

AN EDGE EFFECT refers to the effect of a prevailing boundary between contrasting spatial environments within an ecosystem or landscape. Landscapes are comprised of heterogeneous mosaics of habitat patches of varying size, shape and quality; these characteristics change over space and time. The edges or boundaries between habitat patches have implications for ecological processes between patches (e.g., animal movement) as well as within them (e.g., light penetration from patch edge to interior affecting within patch resource availability). The spatial configuration of patches—or landscape spatial pattern—includes the degree of fragmentation of or connectivity among habitat patches within the landscape, thereby influencing ecosystem and landscape-level processes such as seasonal animal migration, effective range and dispersal, as well as the ecological impacts of natural or anthropogenic disturbance.

Edge regions among contrasting environments within a landscape are often referred to as *ecotones*. An example of a commonly considered edge is that between a forest patch and an adjacent non-forest land cover, such as pasture. Such an edge would define a sharp *ecotone*, and the forest patch would be characterized by a gradient of environmental conditions from its edge to its interior, with varying degrees of available light, ambient air temperature, wind exposure and soil moisture conditions. Close to the forest/nonforest edge, penetration of light and wind into the forest patch creates microhabitats that favor particular light/gap-loving, opportunistic plant and animal species. Increased "understory" growth closer to forest edges because of an increase in the dominance of light-loving plants, combined with lower soil moisture conditions may increase the risk of forest fires at edge locations, further creating new edge areas.

Widespread fragmentation of eastern and Midwestern forests in the United States has increased the abundance of the pasture-loving, brown-headed cowbird, which increasingly parasitizes the nests of interior-dwelling forest birds, driving a widespread reduction in their populations. Predation on bay scallops by fish and invertebrate species is much greater in patchy seagrass areas than in large homogenous expanses of seagrass.

The ratio of forest patch edge to its interior area is one commonly used metric in the field of landscape ecology, and characterizes the degree of forest fragmentation and edge habitat in a landscape. While much of landscape ecological research has focused on the quantification of landscape pattern, including edge-interior ratios and fragmentation and connectivity indices, increasingly studies are examining the ways in which such patterns influence ecological processes, and edge effects comprise a significant area of focus. It is estimated that the forested area of the Amazon Basin that was subject to edge effects in 1988 by virtue of being located within 1 kilometer of a deforested site (341,000 square kilometers) exceeded the extent of actual deforestation (approximately 230,000 square kilometers). Several anthropogenic environmental changes, particularly changes in land use and cover, thus have both direct and indirect consequences for ecological systems.

SEE ALSO: Amazon River Basin; Ecotone; Forests.

BIBLIOGRAPHY. E.A. Irlandi, W.G. Ambrose, and B.A. Orando, "Landscape Ecology and the Marine Environment: How Spatial Configuration of Seagrass Habitat Influences Growth and Survival of the Bay Scallop," *Oikos* (v.72, 1995); R.E. Ricklefs and G.L. Miller, *Ecology,* 4th ed. (W.H. Freeman and Company, 2000); D.L.

Skole and C. Tucker, "Tropical Deforestation and Habitat Loss Fragmentation in the Amazon: Satellite Data From 1978-1988," *Science* (v.260, 1993).

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Education

EDUCATION IS VALUED around the world as a means of promoting individual advancement and well-being, and for its potential to encourage economic growth and employment, empower women and minority groups, and reduce infant and child mortality rates. Universal access to education has been an international policy goal since the creation of the Universal Declaration of Human Rights in 1948, and since the 1960s it has also been increasingly linked to environmental management and international development efforts. This has been especially true since the United Nations Conference on Environment and Development (also known as the Earth Summit) was held in Rio de Janeiro in June 1992. One of the important documents to come out of the conference was *Agenda 21*, a key set of plans and international agreements aimed at achieving global sustainable development in the 21st century. Education has a central role in the plans outlined by *Agenda 21*:

> Education, including formal education, public awareness and training should be recognized as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable development and improving the capacity of the people to address environment and development issues. While basic education provides the underpinning for any environmental and development education, the latter needs to be incorporated as an essential part of learning.

While many people agree with the spirit of the ideas outlined in *Agenda 21*, there is active debate about how best to implement them in practice. Educators, policymakers and activists around the world question what the content and aims of such educational programs should be, as well as what their benefits and costs might be for individual nations and communities. Governments, international organizations, and conservation and community groups promote environmental learning under a number of different labels, and employ a variety of different topics of study and teaching methods. These programs may be formal or informal, may be found in many different settings, and may address a number of different audiences.

Formally organized programs usually take place in schools, classrooms, museums, or protected nature areas (including national parks and privately-owned conservation areas), while less formal community development and popular education projects or public awareness campaigns occur in other ways, such as through public meetings or the use of mass media. Public awareness campaigns, for instance, employ mass media such as newspapers, television and radio to spread environmental messages to the general public. Programs may do a variety of things; including promoting awareness of environmental concerns such as pollution or deforestation, encouraging environmentally sustainable behaviors such as recycling, reforestation, or the increased use of public transportation, or working to promote or protect specific kinds of knowledge about—and interactions with—local environments (for example, encouraging the use of local or traditional agricultural and harvesting practices).

UNDERSTANDING ENVIRONMENTAL EDUCATION

The contemporary environmental education movement began in the 1960s and 1970s—an era of history characterized by growing concern over the state of the natural world and also increasing interest in ecosystem and species preservation from the international scientific community. Environmental education in this period relied heavily on a style of public education and awareness-building that emphasized learning in the natural sciences, and especially in biology, botany, and ecology. Topics of particular interest included the scientific study of food and agriculture; tropical forests; biological diversity; desertification and drought; fresh water; oceans and coasts; energy; atmosphere and climate; solid waste and sewage management; and hazardous substances; as well as related concerns such as population growth, global security, and development.

The idea of promoting knowledge about the environment was also taken up by international conservation and development movements around this same time. Organizations such as the International Conservation Union (IUCN) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), for example, had begun creating curriculum materials for all levels of formal education as early as the mid–1960s. International support for environmental education continued to grow throughout the 1970s and 1980s, and it was a major topic of discussion at a succession of important international meetings. The United Nations Environment Program (UNEP) and UNESCO co-founded the International Environmental Education Program, for instance, and formally launched it at an International Workshop on Environmental Education in Belgrade in 1975. This important conference produced the first inter-governmental statement on environmental education, *The Belgrade Charter—A Global Framework for Environmental Education*. A followup conference, the First Intergovernmental Conference on Environmental Education, was hosted by UNESCO in Tbilisi, Georgia, USSR in 1977. The final report of this conference, known as the *Tbilisi Declaration*, contained recommendations for the implementation of environmental education in formal and informal education, as well as a framework for international co-operation that is still in use today. The next major international initiative came in 1980, with the publication of the *World Conservation Strategy* by IUCN, UNEP and the World Wildlife Fund. Further statements have followed, including the 1987 publication of *Our Common Future* (a reformulation of the *World Conservation Strategy*, often known as the Brundtland Report), as well as the publication of *Agenda 21* in 1992.

Although the term *environmental education* has dominated policy language and practitioner vocabulary for the last several decades, its meaning changed significantly between the publication of *The Belgrade Charter* and *Agenda 21*. The text of *The Belgrade Charter* focuses on description of the unprecedented economic growth and technological progress of the 1970s, and how this is linked to severe environmental consequences. It identifies the goal of environmental education as: “To develop a world population that is aware of, and concerned about, the environment and its associated problems, and which has the knowledge, skills, attitudes, motivations and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.”

The document also calls for the use of environmental education to develop “a new global ethic… which espouses attitudes and behavior for individuals and societies that are consonant with humanity’s place within the biosphere.” Environmental education, in this view, is intended to raise public awareness of the damaging effects of human activity on the natural world, and to encourage individuals and nations to adopt more environmentally friendly behaviors and lifestyles.

Education is critical for promoting sustainable development and to address environmental issues.

While the language of *The Belgrade Charter* emphasizes the need to protect the natural world from human activities, *Agenda 21*, on the other hand, suggests that a balance must be found between addressing the needs of the environment and those of humankind. It specifically describes the interconnections between environmental management, and economic and social development, and therefore moves away from blaming environmental problems solely on human mismanagement. Environmental education—in this view—is not just about raising awareness of environmental problems like pollution or deforestation, but is an integral part of more complex and integrated relationships: "To be effective, environment and development education should deal with the dynamics of both the physical/biological and socio-economic environment and human (which may include spiritual) development."

This changing understanding of the links between environmental management, education, and society had already begun in the late 1980s alongside criticism of the idea of *development*. The introduction and growing popularity of the concept of "sustainable development" led many educationalists to rethink the terms they used to describe their work. Some of these new terms included: *education for sustainable development, education for sustainability,* and *education for a sustainable future*. Narrow definitions of environmental education, which saw it as roughly equivalent to science education or nature study, were also expanded by some educators to encompass related ideas such as peace education, population education, and human rights education.

Some educators and theorists also added various qualifiers to the term in order to signal the expanded scope of their work, resulting in new concepts such as *socially–critically environmental education or grassroots environmental education*. Advocates of these alternate approaches argued that early understandings of environmental education—such as those found in *The Belgrade Charter*—focused too heavily on the protection of natural environments and did not sufficiently take into account the needs and rights of human populations. International discussions about the relationships between environmental management and education since that time have centered on the different opportunities and limitations of these various approaches to education about the environment, as well as their potential to encourage environmentally friendly behaviors and social change.

Debates about education and the environment in the contemporary world, therefore, are closely related to wider discussions about how best to go about managing both the environment and the development process. In the simplest terms, these debates can be divided between perspectives that emphasize the teaching of science and those that seek to actively link environmental and social issues. Some styles of environmental education, for instance, promote awareness of environmental problems and the scientific or technical solutions for them (for example, the creation of strictly protected nature areas). Advocates of such science—oriented styles of education argue that when students are taught about these issues they will learn to love—and therefore be inspired to protect—the natural world from destruction. Other educators, however, argue that environmental concerns cannot be understood in isolation, but should be linked to the economic and social factors that influence human activity. This second kind of perspective on education reflects the increasing popularity of the idea of sustainable development, and encourages critical thinking about issues such as human rights, peace, poverty, and gender inequality, and the ways that these issues relate to both the successes and failures of environmental management.

IMPLEMENTATION

The style of educational programming promoted in a particular place, however, is often as much the result of national or local conditions and worldviews as it is of academic or policy debates. This is not just because of differences in perspectives on education and the environment in different locations, but is also related to the kinds of actors involved in the process. Nongovernmental organizations (NGOs), and especially international conservation groups, have been some of the most active promoters of environmental education since the 1970s. The World Wildlife Fund, for instance, is one of many international conservation NGOs with established educational programs and projects used by teachers and students around the world. National parks and protected areas in many nations also routinely include environmental education programs as part of their work in conservation, research, and tourism. Since 1992, and in accordance with the recommendations of *Agenda 21*, many national governments have been working to create national environmental education plans and strategies that address the inclusion of environmental topics in state school systems, higher education, government, and business. At the local level, schools and community groups often take an active role in promoting environmental topics, either through activities in the classroom or outside the school walls (for example, visits to protected areas or participation in neighborhood clean-up campaigns).

SPECIAL INTERESTS

Decisions about what are the most appropriate form and content of educational programs in a particular place are rooted in the interests and understandings of the specific organizations or individuals promoting them. Conservation NGOs or organizations that own large protected areas, for instance, are likely to employ programs that support their views on environmental protection, research, and advocacy. Sustainable development NGOs or advocacy groups, on the other hand, may choose to place a stronger emphasis on the social links between environmental management and society, or even more specifically on the interconnections between environmental management and the livelihoods of women, indigenous groups, or ethnic minorities. Schools or other formal education institutions are likely to promote learning when and where it fits most easily into existing teaching demands—whether that be within science or social science curricula.

The different needs and interests of these many actors can be a source of both conflict and collaboration. In Costa Rica, for instance, the state has taken a very active role in the promotion of environmental learning in the national education system since the late 1980s. The current national curriculum covers issues in ecology and biology, as well as making broader linkages to topics such as public health, poverty, and Costa Rican society. Support for these efforts has arisen from businesses, research and conservation groups, educational organizations, and individual citizens, many of whom have received significant financial benefits from the successful promotion of the nation as a premiere international ecotourism destination. In the United States, on the other hand, conflicts between powerful business interests, governments, conservation NGOs, and community groups, have meant that environmental education remains marginal to mainstream education systems and has instead been largely promoted by environmental NGOs and private conservation interests. Such different realities of environmental education practices illustrate that decisions about the content of programs or styles of teaching, as well as opportunities for collaboration and conflict, depend on complicated economic, political, and social factors in every location.

Indeed, decisions about the implementation of environmental education, as well as its actual effectiveness in practice, often occur under serious economic and political pressures. National and international policymakers work to maximize investment in both basic and higher education in order to reduce poverty and to promote economic and social development, but these processes involve a wide array of individuals and organizations and are therefore far from simple. International financial organizations, such as the World Bank, have considerable influence on the national education policies of many developing countries, and have tended to provide more funding for science, technical and vocational subjects than for the arts and social sciences.

National education actors, such as education ministers and legislators, must therefore address international demands for education provision while also providing socially and culturally appropriate education that meets the expectations of educators, parents, and employers. At the local level, educators may be under significant pressure to meet state curriculum guidelines in order to prepare students for exams and to gain recognized qualifications, but must also remain sensitive to local economic and social conditions, and especially to local perspectives on the environment. Educators may also face pressure from local employers or other community members to provide students with knowledge and training that will lead to future employment.

Naturally, these relationships between educational actors do not just involve the imposition of pressure from the top downward. Each nation's influence within international organizations also provides policymakers with opportunities to participate in negotiations of international educational policy and aid decisions. To take the example of Costa Rica again, national leaders and policymakers have a significant voice in international discussions of environmental management, education, and development, and have frequently been applauded for progressive legislation and programs. At the community level, too, students, adults and local organizations have the power to make their own decisions about participation in environmental education programs, as well as about the creation of locally appropriate projects for young people or the general public.

The economic, political, and social circumstances of individual nations and communities, in fact, can have a huge influence on how people think about—and advocate—particular kinds of environmental knowledge and education. This is true both in terms of the specific topics chosen (such as reforestation, pollution reduction, water or waste management, or the participation and empowerment of vulnerable groups in environmental decision making) and the methods of teaching used (formal programs in schools, informal workshops provided by community organizations, or the use of mass media for public awareness campaigns). Education about the environment in every location and at every level—local, national, or international—is a dynamic process that involves many diverse actors, interests, and understandings of the links between the human and natural worlds.

SEE ALSO: Agenda 21; Costa Rica; World Wildlife Fund (WWF).

BIBLIOGRAPHY. P.J. Fensham, "Stockholm to Tbilisi—The Evolution of Environmental Education," *Prospects* (v. 4, 1978); John Huckle and Stephen Sterling, *Education for Sustainability* (Earthscan Publications, 1996); Rosalyn McKeown and Charles Hopkins, "EE ESD: Defusing the Worry," *Environmental Education Research* (v.9, 2003); Joy A. Palmer, *Environmental Education in the 21st Century: Theory, Practice, Progress and Promise* (Routledge, 1998); Lucie Sauvé, "Environmental Education and Sustainable Development: A Further Appraisal," *Canadian Journal of Environmental Education* (v.1, 1996); UNCED, *Agenda 21, The United Nations Program of Action from Rio* (United Nations, 1992); UNESCO–UNEP, "The Belgrade Charter," *Connect*, (v.1, 1976).

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Efficiency

EFFICIENCY IS THE ratio of outputs to inputs in a system, whether that is benefits to costs, results to effort, or action to energy. Economic efficiency is satisfied when an activity's benefits exceed its costs; or, stated otherwise, the ratio of benefits divided by costs is greater than one. Energy efficiency is measured in a similar way by the ratio of work divided by effort. In practice, this tends to be a measure of work accomplished relative to the energy required to produce the work. Dividing benefits/work by costs/effort allows comparison across options.

The range of costs and benefits associated with an option might be limited to effects with well-recognized dollar values, and only those costs and benefits accruing directly to those involved in the decision-making process, such as an individual business. Alternatively, efficiency assessments might include consideration of costs and benefits experienced by the larger community, and costs and benefits that do not have market-determined values. Such social efficiency measures are commonly used for assessing environmental policy options.

Assessing social efficiency gains can be conducted a number of ways. Comparing benefit-to-cost ratios across options and choosing the greatest does not consider the distribution of costs and benefits. Comparing only net social benefit assumes that if those experiencing increased net benefits (benefits minus costs) could more than compensate those experiencing decreased net benefits, the option increases social efficiency. In practice, it is rare that any such transfer compensation occurs. This measure, *Kaldor-Hicks efficiency*, is the efficiency typically employed for cost-benefit analysis. An alternate, more equity-demanding efficiency measure considers that an efficiency gain only occurs if no one experiences decreased net benefits. This is known as Pareto efficiency. Other comparisons of options give greater consideration to equity, although they experience rare usage in policy settings. Distributive efficiency involves identifying the allocation of resources or costs and benefits that provides the greatest net social welfare. Another method entails maximizing the product of individual net benefit gains, thereby identifying the most equitable distribution of gains, inspired by the Nash Bargaining Solution in game theory. The *maximin* principle advocates maximizing the least individual net welfare or net welfare gain, inspired by John Rawls's theory of justice.

EFFICIENCY MEASURES

Efficiency measures are typically employed to prevent or minimize waste and seek to identify options that do not expend unnecessary energy, while economic efficiency measures are used to avoid wasted expenditures. Demand for water usage in areas such as agricultural irrigation and watering lawns can often be equally well met with less water when using more water-efficient technologies. In agriculture, achieving the same production with less water, all else being equal, demonstrates more water-efficient methods. Demand for gasoline is not based on a demand for gasoline itself, but for the transportation it allows. Transportation efficiency, the energy needed to transport a given object a given distance, provides a good case study for consideration of how different perspectives on efficiency—in which benefits and costs are most important—can lead to different policy recommendations.

Fuel efficiency is often targeted as a goal for addressing environmental concerns such as air pollution and climate change. Fuel efficiency for automobiles typically refers to the mileage per gallon (mpg) of gasoline. In 1975, in the wake of high oil prices due to the 1973 Arab oil embargo, the Energy Policy and Conservation Act set fuel efficiency standards that automakers were required to meet on average across their entire fleet. These are known as Corporate Average Fuel Economy (CAFE) standards.

Fuel efficiency improvements equate to reduced gasoline demand and reduced air pollution, such as carbon dioxide and particulate matter. If people drive the same amount with vehicles achieving greater fuel efficiency, less gasoline is consumed. The extent of gasoline demand reductions depends on the price responsiveness of drivers to the cost of driving, or in economic terms, the price elasticity of demand for driving. The more responsive, or elastic, demand for driving, the less there will be a reduction in gasoline consumption. Elastic demand for driving will equate to increased driving with reduced driving costs. This response reflects the joint influence of supply costs and consumer demand on gasoline consumption and the associated pollution and traffic concerns. Many urban planners seek to increase use of public transportation by making it less costly, more convenient, or making driving more expensive as through tolls and parking fees. Public transportation is more energy efficient than individual driving because more people can be moved with the same amount of energy. Therefore, while fuel efficiency in cars does save costs and reduces air pollution, a more fundamental goal of energy efficiency, minimizing the energy required for transporting people, is likely to have greater net energy conservation benefits.

From an economic standpoint, transportation considerations of energy efficiency are closely tied to economic efficiency. Once a vehicle is built, if it has greater fuel efficiency than an earlier model, it will be less costly to drive and therefore be more economically efficient. However, more fuel efficiency in vehicles, all else being equal, typically requires more advanced engine and energy management technologies that are more expensive. Therefore, an individual's private considerations of economic efficiency might change when considering the total costs, if the individual does not personally see much benefit from reduced pollution and societal gasoline consumption. Total private cash costs of transportation with a more fuel efficient vehicle might be greater or less than those with a less fuel efficient vehicle, depending on the price of the vehicle and the price of gasoline. Even if total private cash costs are greater with a more fuel efficient vehicle, net benefits to society might be increased, due to health and environmental benefits from reduced pollution and gasoline demand. The case of transportation efficiency reveals the varying conclusions depending on the type of efficiency considered, the time frame for costs and benefits, and the size of the group considered. Fuel efficiency and transportation efficiency maximizing can lead to different conclusions because of different consideration of and consequences for resource depletion, pollution, and congestion.

Because most market-based decisions are made by individuals, only individual economic efficiency considerations are typically included. Achieving more socially efficient outcomes can require incentives for individuals to change their economic decisions. These incentives can come from private or governmental organizations. In some cases, where the more socially efficient outcome is deemed of great importance, direct government intervention might be necessary. An example would be regulations to keep lead out of drinking water so as to avoid birth defects, even though the added cost might reduce an individual company's economic efficiency.

SEE ALSO: Cost-Benefit Analysis; Corporate Average Fuel Economy (CAFE) Standards; Equity; Justice; Nash Equilibrium.

BIBLIOGRAPHY. Herman Daly and Joshua Farley, *Ecological Economics: Principles and Applications* (Island Press, 2003); Robert Frank and Ben Bernanke, *Principles of Economics* (McGraw-Hill, 2003); Joseph Stiglitz, *Economics of the Public Sector* (Norton Publishing, 2000); James Winpenny, *Managing Water as an Economic Resource* (Routledge Publishing, 1994); Donald Wulfinghoff, *Energy Efficiency Manual* (Energy Institute Press, 2000).

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Egypt

AS ONE OF the oldest civilizations in the world, the Arab Republic of Egypt has a long and rich history. Throughout much of that history, Egypt's prosperity depended on its ability to benefit from the annual flooding of the Nile River as it deposited fertile soil from other countries onto the Egyptian shore. Egypt's system of levees designed to control the Nile has been traced as far back as 3,000 B.C.E. In the capital city of Cairo, the Nile broadens to meet the Mediterranean Sea. Egypt's importance to the global transportation sector was renewed in 1869 with the completion of the Suez Canal, linking the Indian Ocean with the Mediterranean Sea. The importance of the canal led Britain to seize control of Egypt in 1882, but independence was regained after World War II.

After a long history of colonization, by the 1950s, Egypt had become one of the poorest nations in the world. The completion of the Aswan High Dam in 1971, the largest rock fill dam in the world with the capacity to store three years of Nile water flow, was thought to be an engineered solution to the country's underdevelopment. While the dam allowed increased intensification of agricultural production, and paired well with a massive influx of development assistance and foreign expertise, most of these technical experiments and interventions did little to reduce real poverty and in many cases dismantled local and regional agro-ecological traditions. Although the dam also provided electricity for some 20,000 rural residents, moreover, many critics believe that the environmental impact of the dam was too great a price to pay, particularly since the rich silt from the Nile is no longer available to increase soil fertility and a large amount of water is lost to evaporation.

The tourist industry, which engages 10 percent of the work force, is essential to Egypt's economy, producing around $6 billion a year in government revenue. The industry received a major blow on April 25, 2006, when bombs ripped through popular resort towns on a national holiday. Officials have estimated that 125 people were killed in Egypt by religious terrorists over an 18-month period. With a per capita income of $4,400, Egypt is ranked 141 of 232 countries in world income. One-fifth of the Egyptian population lives in poverty, and 10 percent of Egyptians are unemployed. While 68.3 percent of males over the age of 15 can read and write, only 46.9 percent of adult females can do so. The United Nations Development Program (UNDP) Human Development Reports rank Egypt 119 of 232 countries on overall quality of life issues.

With a 2,450 kilometer coastline bordering the Mediterranean and Red Seas, Egypt encompasses 6,000 square miles of inland water sources. The 995,450 square kilometer of land area includes the Asian Sinai Peninsula. Egypt shares land borders with the historically contested Gaza Strip, Israel, Libya, and the Sudan. Egypt is made up an extensive desert plateau interspersed with the Nile valley and delta. Elevations vary from 133 meters at the Qattara Depression to 2,629 meters at Mount Catherine. The desert climate produces hot, dry summers and moderate winters, along with periodic droughts, flash floods, and landslides. Earthquakes are common. In the spring, Egypt experiences the khamsin, a driving windstorm, and dust and sand storms are frequent. Natural resources include petroleum, natural gas, iron ore, phosphates, manganese, limestone, gypsum, talc, asbestos, lead, and zinc.

As the population of Egypt has increased currently to 77,500,000, partially through an influx of refugees, fertile agricultural lands have been lost to urbanization and windblown sands. Over 95 percent of the population is concentrated in less than five percent of land area around the Nile, vastly straining resources. Carbon dioxide (CO_2) emissions per capita metric tons rose from 1.0 in 1980 to 2.1 in 2002. Egypt produces 0.6 percent of the world's total of CO_2 emissions, and the country has one of the highest levels of air pollution in the Middle East and North Africa. Soil salination is occurring in the areas below the Aswan High Dam, and wide areas of Egypt are being subjected to desertification.

Oil pollution has damaged coral reefs, beaches, and marine ecosystems. Water has become increasingly polluted from agricultural runoff, raw sewage, and industrial effluents. In areas outside the Nile Valley, fresh water resources are limited. While 98 percent of Egyptians have access to safe drinking water, only 68 percent have access to improved sanitation. In 2006, scientists at Yale University ranked Egypt 85 of 132 countries on environmental performance, below the relevant income and geographic groups. Low scores were received in the areas of air quality, production of natural resources, and biodiversity and habitat. Although only 0.1 percent of Egypt's land area is forested, the government has protected nearly 10 percent of the land. Of 98 endemic mammal species, 13 are endangered, as are seven of 123 bird species.

In 1977, the government initiated the Sekem project, a network of 150 biodynamic farms established to promote sustainable development. In 1996, the Egyptian government introduced a plan to reclaim

The Curse of the Pharaohs

Following the discovery and the opening of the tomb of Tutankhamun in the Valley of the Kings in November 1922, there were a number of rumors about a possible "Curse of the Pharaohs." Some have claimed this was more than a psychological "curse," but was actually the result of poisons or hidden mosquitoes.

The idea of the curse of the Pharaohs received much attention when, in March 1923, a British novelist Marie Corelli wrote that there would be terrible consequences for the people involved in opening the tomb of the dead boy pharaoh. The goddess Wadjet, represented by a cobra, was a protector of the pharaohs. When it became known that on the day Howard Carter opened the tomb, his pet canary was eaten by a cobra, the theories of Corelli received greater attention. A few weeks after Corelli's prediction, Lord Carnarvon, who had financed the work of Howard Carter, died of pneumonia in Cairo, leading to much speculation about the curse. It was also claimed that all the street lights in Cairo went out when Lord Carnarvon died, although some have suggested that this was a regular occurrence given the poor power supply; and also Lord Carnarvon's dog, Susie, apparently died in England at the very moment her master died.

Many writers have speculated over the curse of the Pharaohs, including Arthur Conan Doyle, the author who created the fictional character Sherlock Holmes. However, detailed medical studies, some published in the *British Medical Journal* and other learned publications, have suggested that there is no evidence to link reports of a large number of early deaths to the opening of the tomb—indeed, many of the people involved in the opening of the tomb, and those who visited soon afterward, including members of the Belgian Royal Family, lived long and active lives. The death of Lord Carnarvon could largely be put down to poor health from a car accident twenty years earlier, and the rest of the events mere coincidence.

Osman Ahmed Osman

Born at Ismailia, Egypt, Osman Ahmed Osman attended Cairo University, and his first building project was the construction of a single garage for his neighbors. Three years later, he and his brother Mohammed formed Osman Company, which by 1950 employed 2000 men. His early projects included work on the enlarging of the harbor of Port Said at the northern end of the Suez Canal, and also a new international airport for Cairo.

He submitted an estimate for work for the $1.5 billion Aswan Dam because, he later said, he "wanted to be part of the great project, to have his place in history." To make sure his costings were correct, Osman set up two teams of estimators, each unaware of the other, while he and a few of his associates formed a third team. The three estimates only varied by 2 percent, and not only was Osman able to submit a very low estimate—so low that the Supreme Court thought he had made a mistake—he was able to realize a profit of 500,000 Egyptian pounds.

At one stage during the building of the dam, when Soviet trucks donated by Nikita Khrushchev were found incapable of moving soil fast enough, Osman had to buy British trucks, which were hidden when the Soviet leader visited the project. At the completion of the Aswan Dam project, the Egyptian President Nasser nationalized the company but allowed Osman to control projects outside Egypt. The company was renamed Arab Contractors.

Osman was appointed Minister of Reconstruction in November 1973 after Egypt's defeat in the Yom Kippur War, and was appointed deputy prime minister in 1981. He later published his memoirs, *Pages from My Experience.*

millions of hectares from the Western Desert. Like the Aswan High Dam project, the land reclamation project was criticized as an environmental disaster. In 1994, Law 4 was passed to restructure the environmental ministry, creating the Egyptian Environmental Affairs Agency and charging it with planning, policy development, coordination, and enforcement of environmental laws and regulations. The Cairo Air Improvement Project was also implemented to deal with the growing problem of air pollution, and the Environmental Protection Fund promoted projects dealing with solid waste management.

In 1999, Egypt joined nine other riparian nations in the Nile Basin Initiative designed to promote sustainable resource development and transboundary cooperation along the Nile. Egypt also participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: Aswan High Dam; Nile River (and White Nile); Tourism.

BIBLIOGRAPHY. Central Intelligence Agency, "Egypt," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Energy Information Administration, "Egypt: Environment," www.eia.doe.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC–CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (Jefferson, North McFarland, 1993); T. Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity* (University of California Press, 2002); Margaret Alice Murray, *The Splendor that was Egypt: Revised Edition* (Dover Publications. 2004); Richard F. Nyrop, *Egypt: A Country Study* (Government Printing Office, 1983); One World, "Egypt: Environment," uk.oneworld.net (cited April 2006); United Nations Development Programme, "Human Development Report: Egypt," hdr.undp.org (cited April, 2006); World Bank, "Egypt," www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Ehrlich, Paul R. (1932–)

PAUL R. EHRLICH, the Bing Professor of Population Studies at the Department of Biological Sciences at Stanford University, is an entomologist and author on human overpopulation. He is well-known around the world for his book *The Population Bomb* (1968).

Ehrlich was born on May 29, 1932, in Philadelphia, Pennsylvania. He earned his B.A. in zoology at the University of Pennsylvania, and his M.A. from the University of Kansas. In 1957, he completed his Ph.D. at the University of Miami, and then worked at the Department of Entomology at the University of Kansas. Two years later, Dr. Ehrlich joined the faculty at Stanford University and became a professor of biology in 1966, and Bing Professor eleven years later. His academic interests were initially in the field of entomology, but he has also become interested in the field of population growth. His first book, published in 1960, was *How to Know the Butterflies*. It was followed three years later by *Process of Evolution*.

In 1968, *The Population Bomb* was published. It expanded on ideas raised in an article he wrote for *New Scientist* magazine in December 1967. In the book, Ehrlich predicted that the world might face major famines between 1970 and 1985 owing to a massive growth in population and the inability of food supplies to keep up with this. Some scholars saw Ehrlich in the mold of early 19th-century economist Thomas Malthus, who had also predicted that the population was increasing at a rate that was outpacing the ability to produce more crops. Ehrlich said that he was more influenced by William Vogt's *Road to Survival* (1948), which he had read while at high school.

There has been extensive criticism of Ehrlich's ideas, since the widespread famines he predicted did not occur, and because other scarcity-reducing innovations have occurred over the recent period of population growth, including the Green Revolution, in which agronomists developed ways of increasing food production. His supporters argue, however, that his book reinvigorated debate on the issue of overpopulation.

In 1968, Paul Ehrlich and others formed the Zero Population Growth group. He issued a revised version of his *The Population Bomb* in 1971, and has since written many more books, including *The End of Affluence* (with A.H. Ehrlich, 1974), *The Race Bomb* (with S. Feldman, 1977); *Machinery of Nature* (1986); and *The Birder's Handbook* (with D. Dobkin and D. Wheye, 1988).

His most recent major works were *One with Nineveh: Politics, Consumption and the Human Future* (with A.H. Ehrlich, 2004); and *On the Wings of Checkerspots: A Model System for Population Biology* (co-edited with Ilkka Hanski, 2004). He has also published over five hundred articles.

AWARD-WINNING EFFORTS

Ehrlich's work has earned him the Crafoord Prize in 1990, along with biologist E.O. Wilson. The prize was established in 1980 in Sweden and awarded by the Royal Swedish Academy of Sciences, to support those areas of science not covered by the Nobel Prizes. Ehrlich has also won many other awards, including the Volvo Environmental Prize in 1993; the United Nations Sasakawa Environment Prize in 1994; the Heinz Award for the Environment in 1995; the Tyler Prize for Environmental Achievement and the Dr. A.H. Heineken Prize for Environmental Sciences in 1998; the Blue Planet Prize in 1999; the Eminent Ecologist Award of the Ecological Society of America; and the Distinguished Scientist Award of the American Institute of Biological Sciences in 2001.

SEE ALSO: Fertility Rate; Green Revolution; Malthus, Thomas; One Child Policy, China; Overpopulation; Population; Zero Population Growth.

BIBLIOGRAPHY. Paul Ehrlich, *The Population Bomb* (Ballantine, 1968); Paul R. Ehrlich, John P. Holdren, and Anne H. Ehrlich, *Ecoscience: Population, Resources, Environment* (W. H. Freeman Company, 1977); Raymond Fredric Dasmann, *Called by the Wild: An Autobiography of a Conservationist* (University of California Press, 2002); *The International Who's Who 2005* (Europa Publications, 2006).

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El Salvador

POLITICALLY UNSTABLE THROUGHOUT the 1980s, peace was achieved in El Salvador in 1992. The agreement between the existing government and leftists rebels paved the way for much-needed reform in El Salvador. Bordering on the northern Pacific Ocean, El Salvador has a coastline of 190 miles (307 kilometers) and is the only country in Central America that does not have a Caribbean coastline. Along the Pacific coast, the climate is tropical. The rainy season, which lasts from May to October, is followed by a six-month dry season. In the uplands, the climate is temperate. El Salvador's terrain is mountainous with a narrow coastal belt and central plateau.

Due to the presence of volcanic activity, El Salvador is sometimes called the Land of Volcanoes. The country is also subject to frequent, potentially destructive earthquakes and hurricanes that damage the environment and threaten human life and property. Nearly a third (31.85 percent) of El Salvador's land is arable. Although 59 percent of Salvadorans live in densely populated urban areas, there are only 30 passenger cars per 1,000 people. Other natural resources include hydropower, geothermal power, and petroleum.

Though it is the smallest country in Central America, El Salvador is the third richest. With a per capita income of $5,100, El Salvador ranks 131st of 232 countries in terms of income. Family income is unequally divided, however; among the population of 6,704,932, the wealthiest 10 percent of the population hold 39.3 of national resources. The misdistribution of resources and the large population of landless peasants form the roots of historical unrest in the country, with implications for the nation's future.

Major environmental issues in include deforestation, soil erosion, and water pollution. Soils are also highly contaminated from improper disposal of toxic wastes by chemical and fertilizer industries. In addition, El Salvador faces a rising threat to the human environment with an HIV/AIDS rate of 0.7 percent. It is estimated that some 29,000 are living with this disease, which has been responsible for 2,200 deaths. A 2006 study by scientists at Yale University ranked El Salvador 73rd of 132 countries on environmental performance. This ranking placed the country below the relevant income group average (67.2) and significantly below the geographic group average (72.3). The lowest scores were received in the areas of biodiversity and habitat protection and air quality. The Salvadoran government

Land of Volcanoes

El Salvador has been described by some writers as a "land of volcanoes," and although it is the smallest mainland nation in the western hemisphere, only about the size of Massachusetts, it has 25 significant volcanoes, four of which are active. It is partly from these volcanoes that El Salvador has some of the most fertile soil in Central America, being ideal for growing coffee, the largest crop in the country.

The largest volcano in El Salvador, Santa Ana, is 7,800 feet (2,377 meters). A major tourist attraction, the eastern slope has the Lago de Coatepeque, a 4 mile (6 kilometer) wide and 392 foot (120 meters) deep volcanic lake, around which are located a number of expensive holiday houses belonging to wealthy people from San Salvador, the nation's capital.

The newest volcano, and the most famous, is Izalco, in the west, located on the same fault line that affects California. Much of the volcano of Izalco was created on February 23, 1770, when there was a minor eruption followed by other eruptions. This quickly led to the formation of a mountain of 6,000 feet (1,829 meters). At Lake Ilopango, an eruption near there in 1879–80 was attributed to the fury of a goddess who lived in the lake.

Each year since 1922, on September 1, there has been a festival to commemorate the eruption of a volcano on that day. In addition to the volcanoes, El Salvador is regularly affected by earthquakes, with some happening in 1575, 1594, 1671, 1719, 1798, 1806, 1815, 1839, 1854, 1873, 1917, and on May 3, 1965.

has protected 0.4 percent of the land, and particular attention has been paid to the Los Cóbanos Reef and the wetlands of Guija Lake, Olomega Lake, Cerrón Grande, and El Jocotal. None of the 141 bird species endemic to El Salvador are threatened, and only two of the 135 endemic mammal species are endangered.

The Ministry of the Environment and Natural Resources is actively involved in educating Salvadorans in environmentalism. Through the Environmental Law of 1998, the ministry has the responsibility for conservation and protection of flora and fauna, improving air quality, promoting access to clean water and improved sanitation, and integrating the management of water resources and waste management. Under the Joint Declaration Central America–USA (CONCAUSA), the United States provides El Salvador with assistance in environmental planning and policy implementation with the goals of protecting natural resources, conserving biodiversity, encouraging energy development, and reducing pollution levels.

El Salvador has demonstrated commitment to the global environment by participating in the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection, and Wetlands. The Law of the Sea agreement was signed but has never been ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome; Deforestation; Drinking Water; Pollution, Water; Soil Erosion.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apffel-Marglin, eds., *Rethinking Freire: Globalization and the Environmental Crisis* (Lawrence Erlbaum, 2005); CIA, "El Salvador," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental Issues* (ABC-CLIO, 2004); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); TLC C.A. USA, "National Action Plan for Trade Capacity Building: Meeting the Challenge of Globalization," www.ustr.gov (cited April 2006); UNDP, "Human Development Reports: El Salvador," www.hdr.undp.org (cited April 2006); World Bank, "El Salvador," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Electrical Utilities

ELECTRICAL UTILITIES ARE organizations that are responsible for generating and marketing electricity to the public and government sectors. Because of the strategic importance of electricity to society and the economy and the fact that many geographically remote areas would not be profitable to supply, many electrical utilities are publicly owned. State-owned agencies have in some countries superceded private sector projects that were the first to be constructed, although in some cases the two sectors may share the burden of providing power. In some places, comparatively small, not-for-profit utilities can also exist to supplement the larger power grid and help in protecting the interests of rural households and communities. However, over the last few decades, many governments have been experimenting with different forms of privatization and deregulation, which in many cases have led to higher prices for consumers and high levels of profit for shareholders. In some cases, such as California, manipulation of the energy markets has led to massive levels of profit achieved through price gouging.

THREE FUNCTIONS

Electrical utilities deal with all or some of the three functions of the industry: generating electrical power, distribution of the power, and the collection of fees. In some cases, there may be brokers who buy and sell power but are not responsible for producing or distributing it. State-owned utilities customarily perform all of these activities, but may disaggregate for privatization or corporatization. Clearly, some parts of the process offer more opportunities for profit-making and are more popular than others with potential shareholders. In any case, the privatized corporation is likely to be regulated by a designated public office, and legislation will generally have to ensure that its future behavior is appropriate. Regulatory areas of concern include the maintenance of the distribution system, the safety of the generating plant and its environmental impact, the secure provision of services, and the degree to which prices are permitted to vary.

Since a great deal of electricity generation is based on hydrocarbons, which may be sourced internationally and on an open market, it is inevitable that the price will vary. However, electric power is essential for safety and health institutions, whose abilities to pay are generally not flexible enough to accommodate significant price fluctuations. Consequently, these institutions benefit from regulations that cap prices and provide guarantees in terms of safety and security of delivery.

Despite some inefficiencies involved in distributing power over long distances, this option is still quite feasible in many cases. The development of hydroelectric power in Laos, for example, has been affected through both World Bank funding and extensive investment from Thailand, which is expected to produce a demand for power that is unlikely to occur domestically for many years. Cross-border provision of electricity poses a number of questions about taxation, responsibility for environmental impacts, and equity issues concerning the desirability of transferring valuable domestic resources overseas. These questions are customarily dealt with by using market or semi-market based transactions with negotiations involving government agencies and representatives.

Providing an appropriately fair and transparent regulatory regime is important in encouraging private-sector investment in renewable energy generation and the accompanying utilities. Incentives may also be necessary for this investment in cases where initial production is unlikely to be strongly profitable, at least not in the short term. The exact extent to which regulation is required remains uncertain: some countries, such as those that are part of the European Union, maintain heavy frameworks that are more rigorous than in many other countries. Harmonizing regulations across borders where institutional differences are influential remains a very complex task.

SEE ALSO: Electricity; Energy; European Union; Laos.

BIBLIOGRAPHY. Gerald Granderson, "Externalities, Efficiency, Regulation, and Productivity Growth in the U.S. Electric Utility Industry," *Journal of Productivity Analysis* (v.26/3, 2006); Leonard S. Hyman, Andrew S. Hyman, and Robert C. Hyman, *America's Electric Utilities: Past, Present and Future* 8th ed. (Public Utilities Reports, 2005); Eva Niesten, "Regulatory Institutions and Governance Transformations in Liberalising Electricity Industries," *Annals of Public and Cooperative Economics* (v. 77/3, 2006); Organization for Economic Co-operation and Development (OECD), www.oecd.org (cited Nov. 2006).

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Electricity

ELECTRICITY IS A term for energy that can be present or flow as an electric charge. It is visible in lightening flashes. Electric eels, electric catfish, and electric rays use electricity for hunting or defense. Electricity occurs at the subatomic level in the form of electrons that orbit the nuclei of atoms. Electrons form force fields to hold atoms together as solids.

Electricity can be static or conducting. Static electricity occurs when there is an imbalance between materials that are positively and negatively charged with electrons. Electric currents are a flow of electric charges through a conducting material, such as copper, and can be harnessed for useful purposes. The production of conducted electricity, its use in electronics, and in electric power motors is one of the great developments of the 20th century, and has created enormous changes in human life.

The environmental impact of electricity has been enormous. The invention of the electric light bulb almost destroyed the Standard Oil Company created by John D. Rockefeller. The advent of kerosene oil for lamps probably saved whales from extinction because it ended much of the demand for whale oil used for decades to light lamps.

To supply electricity, electrical generating plants had to be built. The power to turn an electrical dynamo came from water power. Great numbers

Conducted electricity is one of the great developments of the 20th century, creating great changes in human life.

of the dams built in the United States and around the world since 1900 have been for the purpose of generating *hydroelectricity*. The whole Tennessee Valley Authority system was designed not only for flood control, but also for the generation of electricity. Other famous dams such as Hoover Dam and the Boulder Dam were built for supplying water for irrigation, but also for electrical generation. The dams have had an enormous environmental impact on industrial, urban, and suburban growth.

Other energy sources that supply electrical power can also be created by the heating of water that creates steam for turning the turbines of electrical dynamos. Coal, gas, oil, and atomic power are the principal fuels. These fuels all have ecological consequences. Coal mining's environmental impact is considerable, because the vast quantity of coal needed for electrical generators is often the cheaper kind that is produced by strip mining. The cleanest option is likely natural gas, but it too has a negative impact as the methane in natural gas is converted into carbon dioxide, which contributes to global warming and the buildup of greenhouse gases. Nuclear power is at the same time the cleanest and the dirtiest of the fuels used for powering electrical power plants. The immediate impact of nuclear fuel is insignificant unless a disaster such as Chernobyl occurs. Spent nuclear fuel can be recycled in some cases; however, it is often recycled into weapons-grade nuclear material. If it is to be disposed of as waste, there are enormous difficulties in finding a place that will be safe for thousands of years from leaks that could poison the environment over vast areas for centuries.

Electrical transmission lines crisscross the more developed areas of the world, marring the natural beauty; however, they have also brought electricity to rural homes and a better way of life by enabling contact with population centers via radio, television, and Internet connections. Electric cars were popular from the 1880s until the 1920s, when the low cost of gasoline and the greater range of gasoline engines pushed consumers into buying gasoline-operated automobiles. However, since the 1970s, the development of electric-powered vehicles from personal golf carts to larger cars has proceeded steadily to replace gasoline engines.

SEE ALSO: Coal; Dams; Electrical Utilities; Hydropower; Nuclear Power.

BIBLIOGRAPHY. Laurie Burnham, ed., *Renewable Energy: Sources for Fuels and Electricity* (Island Press, 1992); *Electricity and the Environment* (International Atomic Energy Agency, 1991); Bureau of Naval Personnel, *Basic Electricity* (Barnes & Noble, 2004); Van Balkenburg. *Basic Electricity* (Thomson Delmar Learning, 1995).

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Elephants

THERE ARE TWO main species of the elephant (*Elephas maximus*), which are commonly known as the African elephant and the Indian elephant. The African elephant is the largest living land creature and can weight up to eight tons and measure several meters in height. The Indian elephant is slightly smaller. Elephants are well known for their trunks and for their tusks, which are made of the highly prized substance ivory, making elephants a major target of poachers. The number of elephants in the wild has declined considerably as a result of encroachment onto their natural habitat and through poaching. There are estimated to be somewhere between 300,000–600,000 African elephants remaining in 37 different countries, and between 35,000–50,000 Asian elephants in 13 countries. Hundreds are known to die each year as the result of human action, either directly or indirectly. Some elephants aggressively respond to such human action, and may even suffer from post-traumatic stress disorder. The area of ground that they have been able to inhabit has declined considerably, as many parts of the world have undergone climate change. Elephants were, for example, prevalent throughout much of China, but are now limited to the narrow strip of the Xishuangbanna on the borders of Laos and Burma (Myanmar), where less than 300 wild animals remain.

Elephants are related to a wide range of other mammalian creatures, including extinct tusked creatures, and those that have survived, such as the dugong. They live customarily in social groups of up to 100 or more, and recognize all members of the tribe. Family relationships are very strong. Large and powerful animals, elephants have an important role to play in shaping and preserving the environment in which they live. The roadways they create by regular movement through the forest enable light and smaller animals to reach areas that might otherwise be inaccessible. These roadways also act as

Elephants of War

As well as beasts of burden, elephants were used in warfare by many peoples, with varying degrees of success. Hannibal's use of elephants was probably the most famous, but he was only one of many commander to use them in battle.

The soldiers of Alexander the Great encountered war elephants for the first time at the battle of Gaugamela in 331 B.C.E. when a small number of Indian elephants were deployed by the Persians. The only reference to them being at the battle identifies them as Indian elephants. However, it was not long before Alexander the Great's army faced some 200 elephants from the army of Porus, King of India, at the battle of Hydaspes in 326.

The Macedonians used elephants in their armies during the Diadochi Wars, with Ptolemy having 73 and his opponent Antiochus having 102 at the battle of Raphia in 217. However, it was their use by the Carthaginians that captured the imagination of Roman writers. With the Carthaginian Empire based in North Africa, small North African elephants were trained for battle, along with some Indian ones. In 219–218, Hannibal took 34 elephants with him from Spain in his invasion of Italy. Only seven of the elephants survived the journey, causing great shock among the Roman soldiers. One lived on in Italy for a few years, with some coins of the period showing it as an Indian elephant. When the Romans attacked North Africa, Hannibal deployed large numbers of elephants at the Battle of Zama in 202 B.C.E. However, the Romans were prepared for this, and making loud noises, they drove the elephants back onto the advancing Carthaginian armies, contributing to the Carthaginian defeat.

By this time elephants were being used by armies in India, China, and in southeast Asia. The Khmer empire of Angkor and their opponents, the Chams of central Vietnam, both used war elephants in their battles, as did the Thais who captured and destroyed the city of Angkor in 1432.

conduits for seeds, some of which are fertilized by elephant dung, as well as being possible firebreaks or drainage channels. Loss of elephants, therefore, can affect a wide range of flora and fauna. However, many African villagers consider elephants to be large pests, since the passing of a herd through a village can cause its destruction. Elephants don't migrate very often, but may be forced to search for safe habitat and food. Elephants have been domesticated for approximately 4,000 years and have been used as beasts of burden, as a means of lifting heavy objects, and in warfare. Elephants are not aggressive, but permit troops to mount them, to shoot arrows, or wield melee weapons. Elephants continue to be taken from the wild for their labor in the contemporary world. Some, as in Thailand, are kept to perform for tourists and are often abused.

SEE ALSO: Animal Rights; Animals; Communication, Interspecies; Keystone Species.

BIBLIOGRAPHY. Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (Yale University Press, 2004); Cynthia Moss, *Elephant Memories: Thirteen Years in the Life of an Elephant Family* (University of Chicago Press, 2000); Caroline Williams, "Elephants on the Edge," *New Scientist* (v.189/2539, 2006); World Wildlife Fund (WWF), www.worldwildlife.org (cited October 2006).

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El Niño–Southern Oscillation (ENSO)

THE EL NIÑO–SOUTHERN Oscillation (ENSO) is a phenomenon that occurs in the tropical Pacific Ocean approximately every two to five years and typically lasts nine to 12 months. ENSOs, and the opposite condition, called La Niña, represent severe disruptions of the normal weather patterns over the Pacific and have significant impacts on weather around the world. These events typically start around August, reach their peak intensity in December through April, and dissipate in the spring and early summer. However, particularly strong events can persist for up to four years.

ANATOMY OF THE PHENOMENON

Under normal conditions, the northeast trade winds push surface waters westward across the tropical Pacific ocean. These waters warm as they absorb solar energy and pile up in the western Pacific near Australia and Indonesia. Here, the warm water contributes to low air pressure, and the resulting convection, along with evaporation from the warm ocean, creates plenty of rainfall. At the same time, the eastern Pacific (off the coast of South America) normally has cool surface temperatures, due to cold surface currents flowing toward the equator from higher latitudes. In addition, cold water is brought up to the surface to replace the water that has moved westward, in a process known as upwelling. Because the ocean surface tends to be cold in the eastern Pacific, the air pressure tends to be high and there is little rainfall. However, the upwelling brings nutrients to the upper layer of the ocean, so even though the land is dry the ocean is extremely productive and fisheries thrive.

When an ENSO occurs, this normal condition is altered. In the ocean, warmer-than-normal surface waters move eastward along the equator, and sea surface temperatures become unusually warm in the eastern tropical Pacific Ocean (along the equator between the International Date Line and South America). Off the coast of Peru, fisherman historically observed unusual warm currents around Christmastime and referred to them as *El Niños*, referring to the Christ Child. The name was later extended to refer to the entire warming event.

The warm waters in the eastern Pacific cause lower than normal air pressure in that region, while the unusually cool surface waters in the western Pacific create high pressure. This is the Southern Oscillation part of the phenomenon, and can be thought of as a seesaw-like shift in the air pressure pattern across the tropical Pacific. Because the pressure pattern is reversed across the tropics during the ENSO event, the trade winds slow down or even reverse. The oceanic and atmospheric parts of the phenomenon reinforce each other: weaker trade winds allow more warm water to accumulate in the eastern ocean, while warm water in the east contributes to a weakening of the trades.

The reverse of the El Niño pattern is referred to as a La Niña and is characterized by unusually cold sea surface temperatures along the equator, lower-than-normal pressure in the western Pacific (near Indonesia and Australia), higher pressure in the central and eastern Pacific (near South America), and stronger-than-normal trade winds. La Niñas frequently occur immediately after El Niño events. Although the names El Niño and La Niña are common, it is increasingly preferred among atmospheric scientists to refer to these events as the "warm phase ENSO" and "cold phase ENSO," respectively.

HUMAN IMPACT

ENSO events have been occurring for at least 5,000 years based on paleoclimatic and archaeological evidence and have had significant impacts on human societies around the world. The most obvious impacts are seen around the Pacific Basin, where ENSO events bring heavy rainfall, flooding, and mudslides to the normally dry west coast of South America. During the 1982–83 event, one of the largest El Niños on record, approximately 600 people were killed in Ecuador in Peru. At the same time, the cold upwelling off the coast of South America was cut off, and fisheries declined. The economically important Peruvian anchovy industry was decimated during the 1982–83 event and has yet to fully recover. In the western Pacific, El Niño brings lower-than-normal rainfall and drought to Indonesia and northern Australia. During the 1997–98 event, another extremely strong El Niño, forest fires in drought-stricken Indonesia resulted in billions of dollars in damage and serious air pollution that was responsible for at least one deadly airline crash.

ENSO events have significant weather impacts outside of the Pacific Basin as well. When the warm ocean water shifts eastward, the main area of low surface pressure and convective storminess shifts eastward as well. This shift in pressure patterns results in altered patterns in the upper-level winds, which flow west-to-east at the top of the troposphere. Because the upper-level winds play a major role in determining where storms will form and move, they link the tropical Pacific to the rest of the world.

In the United States, ENSO events are associated with unusually wet and mild spring conditions across the southern half of the country, along with drier and warmer conditions across the northern half. ENSO events frequently produce stronger-than-normal upper-level winds across the southern United States and out into the tropical Atlantic Ocean. These upper-level winds disrupt the formation of hurricanes in the Atlantic Basin, and so El Niño years tend to have a reduced chance of hurricanes in the Gulf of Mexico and the Atlantic Coast. However, the strong jet stream over the southern United States gives this region a greater likelihood of severe weather, including tornadoes. Also, El Niño contributes to increased hurricane frequency in the eastern Pacific.

La Niña events tend to have the opposite effect on the United States. During a La Niña, the jet stream is shifted northward. As a result, the northwest coast and the Midwest often experience wetter-than-normal winter and spring weather, while the southern half of the country is warmer and drier than usual. Severe weather and tornado outbreaks are less likely than usual in the southern states. However, La Niñas produce upper-level patterns that are favorable for hurricane formation in the Atlantic and these storms become more likely to make landfall on the Gulf and Atlantic coasts.

Globally, El Niño events have been linked to increased precipitation in eastern equatorial Africa and parts of the Indian Ocean, while Brazil, India, southeastern Africa, and Madagascar generally experience drought. The opposite patterns tend to occur during La Niña events.

ONGOING STUDY OF ENSO

Although ENSO events have been occurring for thousands of years, a full understanding of the phenomenon had to wait until the latter part of the 20th century, when a sufficient amount of observational data in the tropical Pacific became available. The earliest piece of the puzzle was provided by Gilbert Walker, who first identified the Southern Oscillation while seeking an explanation for the occasional failure of the monsoon in India (which resulted in devastating famine when the rains did not arrive). In the 1950s, Jacob Bjerknes made the connection between the Southern Oscillation and the sea surface warming in El Niño episodes. Bjerknes hypothesized the complex ocean–atmosphere linkages known as ENSO in 1969. His hypothesis was able to be tested during the strong ENSO of 1977–78, and again during the event of 1982–83. Subsequent events have provided opportunities to refine our understanding of the process and impacts of this major source of variability in the global climate. One of the major questions still remaining is what impact global warming will have on the intensity and frequency of ENSO events. Thus far, there is insufficient evidence to determine whether or not any relationship exists.

SEE ALSO: Atmosphere; Currents, Ocean; Fisheries; Global Warming; Hurricanes; Oceans; Precipitation; Trade Winds.

BIBLIOGRAPHY. Edward Aguado and James E. Burt, *Understanding Weather and Climate,* 3rd ed. (Prentice-Hall, 2004); Climate Prediction Center, "El Niño—Southern Oscillation," www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml (cited December 2005); Brian Fagan, *Floods, Famines, and Emperors: El* Niño *and the Fate of Civilizations* (Basic Books, 1999); Glenn R. McGregor and Simon Nieuwolt, *Tropical Climatology,* 2nd ed. (Wiley, 1998); Greg O'Hare, John Sweeney, and Rob Wilby, *Weather, Climate, and Climate Change: Human Perspectives* (Prentice-Hall, 2005); William K. Stevens, *The Change in the Weather: People, Weather, and the Science of Climate* (Delta, 1999).

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Enclosure

THE CONCEPT OF *enclosure* refers to the conversion of communal or commonly held public lands into private ownership. It is used most often to refer to the vast changes in land tenure in the English landscape between the 15th and 19th centuries, when over 6.8 million acres—21 percent of the English land area—were "enclosed." Enclosure involved the reorganization of both public and private open field and meadow land properties, and also the reclamation of unused commons, moors, heaths, and other lands designated as wastes. Open fields and scattered cultivation plots were considered to be inefficient, and communal management strategies were thought to inhibit innovation. Other motivations for field enclosure included securing the right of way for roads and additional building lands for townships, establishing mineral rights, and stemming soil fertility decline due to overuse of common open fields. Finally, larger farm units made for easier administration and collection of rents.

Enclosure in England was both a public and a private process. Acts of Parliament to enclose public lands were initiated in 1604, but were mainly legislated between 1760 and 1830. Parliamentary acts dominated after 1750, with more than 5,000 acts of enclosure in the subsequent century. "General enclosures acts" were implemented upon petition from a landlord or following a formal agreement signed by parties including, for example, a landowner and communal land users. In cases of division of public or common lands held by a township, commissioners were employed to assess the claims of the various users and assign rents. As a private process, individual users of manor properties negotiated to establish leaseholds, often allowing the manor owner to charge increased rents.

TRANSFORMATION OF AGRICULTURE

Despite popular protest and a series of rebellions by the traditional users of the common lands, the completion of the enclosure acts in England affected more than just changes in land tenure. It resulted in the transformation of traditional models of agriculture based on open fields and communal grazing areas without fixed boundaries into small, private holdings separated by physical barriers including ditches, fences, and hedges.

The social and economic results of English parliamentary enclosure included the dispossession of small farmers and landless laborers, contributing to what Karl Marx and others have referred to as the creation of the English working class, which played a major part in driving the Industrial Revolution. The loss of open fields led to a decline in access to grazing for small husbandry and reduced access to nonwage sources of subsistence including the gathering of fuel wood, fruits, herbs, and other wild resources and reduced ability to glean the remains of harvest from common fields. According to one estimate, enclosure negatively affected not only those entirely dependent on the open field structure for economic survival, but up to 60 percent of families already working for a wage by the end of the 17th century.

The concept of enclosure has been used in critiques of contemporary land and natural resource conservation policy in reference to the creation of conservation areas through the exclusion of traditional users. The theory of the Tragedy of the Commons and the assertion that rural productivity and the environment are threatened by the absence of property rights, suggest that erecting formal property boundaries to eliminate open-access to forests, rangelands, and other resources will improve both conservation and economic outcomes.

Conservation and development initiatives based on these ideas have produced "conservation refugees" in what has been referred to as *greenlining* or *ecological expropriation* as the rights to traditional subsistence areas are restructured to limit use by certain populations. The estimated displacement of local peoples by nature reserves and national protected areas in Africa, for example, numbers in the millions. The lack of political leverage by the affected populations to contest the enclosure of their traditional lands has contributed to an increase in poverty with little documented improvement in conservation outcomes, in addition to the added costs of resettlement and park monitoring. In addition, common property research has shown that many common land use areas are managed by a well-developed system of community rules and regulations.

SEE ALSO: Common Property Theory; Conservation; Industrial Revolution; Preservation; Tragedy of the Commons.

BIBLIOGRAPHY. D. Chatty and M. Colchester, eds., *Conservation and Mobile Indigenous Peoples: Displacement, Forced Settlement, and Sustainable Development* (Berghahn Books, 2002); Charles Geisler and Ragendra De Sousa, "From Refuge to Refugee: The African Case." *Public Administration and Development* (v. 21, 2001); Jane Humphries, "Enclosures, Common Rights and Women: The Proletarianization of Families in the Late Eighteenth and Early Nineteenth Centuries" *Journal of Economic History* (March 1990); G. E. Mingay, *Enclosure and the Small Farmer in the Age of the Industrial Revolution* (Macmillan, 1968); Michael Turner, *English Parliamentary Enclosure: Its Historical Geography and Economic History* (Archon Books, 1980); J. Yelling, *Common Field and Enclosure in England 1450-1850* (MacMillan Press, 1977).

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Endangered Species

DEPENDING ON THE status of their populations in the wild, animals and plants may be designated as rare, threatened, and under extreme conditions, endangered. The 1800s in the United States were a period when a number of large, highly visible mammals, such as the plains bison *Bison bison* and the eastern subspecies of the elk *Cervus elaphus canadensis* were being hunted. The disappearance of such important prey increased the threat to the wolf and mountain lion, both predators dependant on ungulates (hoofed mammals) for food. In 1966, the United States Congress passed the Endangered Species Preservation Act, which provided limited means of protection to native animals. The Endangered Species Conservation Act of 1969 took a wider view and provided protection to species facing extinction globally.

Finally, The Endangered Species Act (ESA) signed by President Richard Nixon into law in 1973, defined the term *endangered species* "as any species that is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary (of the Interior) to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man." Section 4 of the ESA lists the various factors that help determine endangered status for a particular plant or animal. It requires the development and implementation of species recovery plans, as well as the designation of critical habitat for listed species. The ESA went even further, bringing together the provisions of Acts passed in the 1960s, resulting in the application of the same laws to U.S. and non-U.S. species. All classes of invertebrates became eligible for protection and all federal agencies were required to start conservation programs for endangered species.

The U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) share responsibility for administering the ESA. The USFWS generally manages land and freshwater species while the NMFS manages marine and anadromous species (fish born in fresh water that migrate to the ocean and return to spawn in fresh water). Of the 1,869 species currently listed under the ESA, 1,300 are found partly or completely within United States territory. At present, NMFS has management responsibility for 62 species, including the endangered blue whale *Balaenoptera musculus* and the marine leatherback turtle *Dermochelys coriacea*. The NMFS protects marine species from accidental capture in fisheries, habitat destruction, pollution, overharvest, and harmful contact with vessels by implementing time and area closures, modifications to fishing equipment, safe sea turtle handling practices, minimizing the effects of intense underwater sound, and minimizing strikes from ships by providing information on whale locations to ships at sea.

ENDANGERMENT BY DEVELOPMENT

In historical terms, as nations developed, increasing numbers of species have become endangered. Only the nature of the threat has changed, from excessive harvest of species to habitat change and destruction largely due to expanding agriculture and urbanization. The ESA is one of the most comprehensive wildlife statues implemented anywhere; its provisions spark direct conflict with industrial and commercial interests. Its impact is such that in the United States, the National Mining Association, an organization of the mining industry that employed over 250,000 workers in 2004, accused the USFWS of using the ESA to delay or stop mining projects altogether and called on the U.S. Congress to step in and "reform" the ESA.

The loss of biodiversity is a global concern. There are indications that current species extinction rates are 1,000 to 10,000 times the natural or "background" rate, higher than at any time for the past 65 million years. Populations of many species have collapsed to very low levels. Captive breeding programs are being run for endangered species such as the Himalayan musk deer *Moschus chrysogaster* spp. in China and India, and the USFWS's breeding program for the Black-footed ferret *Mustela nigripes* in Colorado and Utah. Other endangered animals are strictly protected in wildlife reserves, such as elephants, tigers, and the wild buffalo *Bubalus bubalis*.

THE RED LIST

In 1963, international concern at the loss of species and habitats led to the idea of a global list of threatened species. This compilation of species of special interest has come to be known as the International Union for the Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species, or the Red List for short. Also known as the World Conservation Union, the IUCN was founded in 1948. IUCN's Species Survival Commission (SSC) made up of about 7,000 volunteer scientists and species experts, is one of the six commissions that guide the work of the IUCN. The SSC's members are constituted into Specialist Groups, such as the African Elephant Specialist Group, that provide the scientific information necessary to assess the status of an animal or plant species. This evaluation determines whether a species is listed in the Red List, and if so, at what level of threat.

The Red List is the world's comprehensive and authoritative inventory of the best-known conservation status of plants and animals. It provides an index of the threat status of two groups that have been completely assessed—birds and amphibians. The Red List is also considered an indicator of the results of wildlife conservation programs. It assists in monitoring global trends of biodiversity and helps focus public attention on species that require immediate protection.

Species in the Red List of 2004 are assigned to one of nine categories of conservation status—Extinct; Extinct in the Wild (such as the Hawaiian Crow *Corvus hawaiiensis*, last seen in the wild in 2002); Critically Endangered (882 species); Endangered (1,779 species); Vulnerable (2,337 species); Near Threatened; Least Concern; Data Deficient; and Not Evaluated. The categories Critically Endangered, Endangered, and Vulnerable are for species at risk of extinction. The updated 2006 Red List contains 16,119 animals and plants facing the risk of extinction. Between 1996 and 2004, the number of species at risk of extinction in most groups of animals and plants has increased, indicating that man-made causes of environmental change continue to outpace conservation efforts. Particularly, the dramatic jump in threatened amphibians points both to better knowledge of their conservation status, and an increase in threats to wetlands. The degree of threat and risk of extinction is calculated in an intensive data-driven process depending on five biological criteria: rate of species decline, population size, area of geographic distribution, extent to which population and distribution are fragmented. The small size of many islands makes their animals and plants particularly prone to extinction, as in Hawaii where half of the approximately 100 land bird species were lost as a result of the activities of the native Polynesian islanders.

The causes of species endangerment are numerous. Human populations in species-rich developing countries continue to increase, with about 40 percent of the people living in abject poverty and depending on forests for firewood, timber, bamboo, and for cattle fodder. Dry and moist forests are being logged, then overgrazed, and finally com-

The Red List of Threatened Species lists the African Cheetah as "threatened indirectly by loss of prey base through human hunting activities and directly because it is considered to be a threat to livestock."

pletely denuded contributing to the loss of precious topsoil. The draining of wetlands, water diversion and pollution, the introduction of exotics, hunting, and unsustainable use of resources are other common factors. More recently, human migration and displacement, armed conflict, and global warming have emerged as direct and indirect factors contributing to species endangerment.

SEE ALSO: Endangered Species Act; Extinction of Species; Fish and Wildlife Service (U.S.)

BIBLIOGRAPHY. Walton Beacham, Frank V. Castronova, and Bill Freedman, eds., *Beacham's Guide to International Endangered Species* (Beacham Publishing Corporation, 2000); Tim W. Clark, Richard P. Reading and Alice L. Clarke, eds., *Endangered Species Recovery: Finding the Lessons, Improving the Process* (Island Press, 1994); Brian Czech and Paul R. Krausman, *The Endangered Species Act: History, Conservation Biology and Public Policy* (The John Hopkins University Press, 2001); Ben Davies, *Black Market: Inside the Endangered Species Trade in Asia* (Ten Speed Press, 2005); Otto H. Frankel and Michael E. Soule, *Conservation and Evolution* (Cambridge University Press, 1981); Lakshman D. Guruswamy and Jeffrey A. McNeely, eds., *Protection of Global Biodiversity: Converging Strategies* (Duke University Press, 1998); Joel T. Heinen and Ganga R. Singh, *A Census and Some Management Implications for Wild Buffalo (Bubalus bubalis) in Nepal* (Biological Conservation 101(3): 391-394, 2001); IUCN (World Conservation Union), *IUCN Red List of Threatened Species: A Global Species Assessment*, Jonathan E.M. Baillie, Craig Hilton-Taylor, and Simon N. Stuart, eds., (Gland, Switzerland, 2004); IUCN (World Conservation Union), "The 2006 IUCN Red List of Threatened Species," www.redlist.org/ (cited April 2006); Jeffrey A. McNeely, Kenton R. Miller, Walter V. Reid, Russell A. Mittermeier, and Timothy B. Werner, *Conserving the World's Biological Diversity* (IUCN, Gland Switzerland; WRI, CI, WWF–U.S., and the World Bank, 1990); Richard B. Primack, *A Primer of Conservation Biology* (Sinauer Associates, 2004); United States Fish and Wildlife Service, "The Endangered Species Act of 1973," www.fws.gov (cited April 2006).

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Endangered Species Act (1973)

WIDELY REGARDED AS the strongest and most significant piece of environmental legislation in the world, the Endangered Species Act (ESA) makes the protection of rare or imperiled species of plants and animals the highest priority of the U.S. federal government, at least in theory. Its core features are: a list of protected plants and animals; designation of "critical habitat" for listed species; mandatory compliance of all federal agencies and actions with the terms and objectives of the ESA; and the right of the public, through the National Environmental Policy Act, to petition for listing and to sue for compliance. Although the ESA's overall efficacy is disputed and political wrangling about it is intense, it nevertheless enjoys widespread support among the general public.

The 1973 Act replaced two earlier and weaker laws passed in response to surging environmental sentiment following publication of Rachel Carson's 1962 book, *Silent Spring*. The Endangered Species Preservation Act (1966) aimed to save the whooping crane and other charismatic birds such as the bald eagle by authorizing the Secretary of Interior to create a list of endangered domestic fish and wildlife and to spend a limited amount of money to buy habitat for their protection. The Endangered Species Conservation Act (1969) expanded the Secretary's authority to cover foreign species and banned imports of products made from listed species, in hopes of protecting the world's whales. A subsequent dispute with the Pentagon over listing the sperm whale—whose oil was used in submarines—helped motivate the stronger law and foreshadowed the legal–bureaucratic dramas yet to come.

Congress passed the new law almost unanimously. It extended protection to plants and invertebrates as well as fish and wildlife; required the designation of critical habitat for all listed species; forbid federal agencies from authorizing, funding or carrying out any action that might jeopardize the continued existence of listed species or that "destroys or adversely modifies" critical habitat; and forbid any party from "taking" a listed animal species without a permit. It defined *take* as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Penalties can rise to $50,000 and a year in prison, although prosecutions for "take" are virtually unheard of. Enforcement authority resides in the U.S. Fish and Wildlife Service for land and freshwater species (the vast majority of the total); the Department of Commerce's National Marine Fisheries Service (now known as NOAA Fisheries) is responsible for marine and anadromous species.

Ever since its passage, the ESA has been prone to unintended consequences, political firestorms, and scientific uncertainty. That private landowners might intentionally kill a species or destroy its habitat just before listing (or "shoot, shovel, and shut up" after listing, as the saying goes) prompted amendments and administrative reforms through the 1980s and 1990s in search of mechanisms to indemnify landowners who conserve or create habitat. From the snail darter (which nearly killed a Tennessee Valley Authority dam halfway through construction) to the spotted owl (celebrated or blamed—rather misleadingly—for decimating the timber industry in the Pacific Northwest), the nation's highest courts have consistently upheld the ESA's constitutionality and its priority over political and economic expedience. Yet in several cases Congress has then exempted projects, suspended listings, or enfeebled enforcement.

The ambiguity and ambivalence can be traced directly to the act itself, which walks a thin, tortured line between the simple ideal of preventing extinctions and the complex political economy of on-the-ground preservation. The law stipulates, for example, that critical habitat be determined "solely on the basis of the best scientific and commercial data available," yet it also directs the Secretary of Interior to consider "the economic impact, and any other relevant impact, of specifying any particular area as critical habitat." It then gives the Secretary discretion to exclude "any area from critical habitat if he determines that the benefits of such exclusion outweigh the benefits" of inclusion, *unless* he determines that exclusion will result in outright extinction. As more and more species have been listed over time—from fewer than 300 in 1980 to more than 1,300 in 2006 (excluding foreign species)—the limitations of scientific knowledge have become ever more acute, resulting in ever wider discretion. Only 475 listed species have had critical habitat designated in their behalf, even though habitat loss and modification dominate the causes of endangerment (for the U.S. excluding Hawaii and Puerto Rico, the top four are urbanization, agriculture, reservoirs and related water installations, and tourism and recreation development).

SEE ALSO: Endangered Species Act; Extinction of Species; Fish and Wildlife Service (U.S.)

BIBLIOGRAPHY. Bonnie B. Burgess, *Fate of the Wild: The Endangered Species Act and the Future of Biodiversity* (University of Georgia Press, 2003); Brian Czech and Paul R. Krausman, *Endangered Species Act: History, Conservation Biology and Public Policy* (Johns Hopkins University Press, 2001); Stanford Environmental Law Society, *Endangered Species Act* (Stanford University Press, 2000).

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End-of-Pipe Regulatory Approach

THE END-OF-PIPE REGULATORY approach focuses primarily on the costs and issues relating to the point of origin of substances that cause environmental problems. The substances emerge from the end of a pipe, linking an industrial process with the external environment. Consequently, the burden of responsibility for any costs arising from this interaction is to be borne by the individual or organization that owns the pipe. Regulations have been created to try to ensure that pipe owners, therefore, meet any costs that accrue. This approach has been effective in minimizing environmental problems, since it has been clear whose responsibility any emission would be, and what penalties would apply in the event of noncompliance with regulations. Nevertheless, a number of dissenting voices have been raised against the approach and, while most of these can be discounted as the special pleading of industrial interests unwilling to accept responsibility for their own actions, some more cogent arguments have also been raised. It has also been argued that the approach has been too often inflexible and has failed to reduce a great deal of the toxic spillage that continues to occur.

In 2003, the U.S. Environmental Protection Agency (EPA) concluded that the rising number of regulations needed to monitor and control all of the possible forms of substance emission represented an inefficient and expensive approach to the problem. Further, the approach fails appropriately to take account of the various upstream economic or industrial activities that may have more influential impacts on the natural environment than those taking place at the dripping of the pipe-end. Regulating upstream activities may be undertaken as a separate stage of activity in which the responsible party may be monitored and, if necessary, penalized or else causing a single organization to be considered responsible for the whole process from production to delivery of industrial products and all stages along the way. The EPA has accepted the need for a more sophisticated approach to environmental pollution and the reduction or simplification of the existing regulatory regime to face current and future challenges.

The end-of-the-pipe approach also assumes that what happens at the end of the pipe is somehow inevitable and necessary. On the contrary, some environmentalists argue that the impact of the results of end-of-pipe activity depend upon such factors as the structure and extent of demand, which may itself be subject to well-judged intervention. For example, driving an automobile results in the burning of hydrocarbon fuels that have a detrimental effect on the environment. Therefore, in many countries, motorists are taxed on fuel purchases. Much of the contemporary understanding of how the negative impact of this activity should be managed is based on this approach. However, it is possible that alternative energy sources or changes in lifestyle and urban planning might significantly reduce the need for burning so much hydrocarbon fuel. Fixation on an end-of-pipe approach, therefore, can blind innovators to problems throughout the line when resolving environmental issues.

SEE ALSO: Catalytic Converters; Environmental Determinism; Environmental Protection Agency (EPA); Fate and Transport of Contaminants.

BIBLIOGRAPHY. Federal Advisory Committee to the U.S. Environmental Protection Agency, *Advancing Environmental Justice through Pollution Prevention* (June, 2003); Al Iannuzzi, Jr., *Industry Self-Regulation and Voluntary Environmental Compliance* (CRC, 2002); George Monbiot, "An Ugly Face of Ecology," *The Guardian* (May 6th, 2005); Peter Cleary Yeager, *The Limits of Law: The Public Regulation of Private Pollution* (Cambridge University Press, 2003).

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Energetics

ENERGY, SUCH AS lightening or sunlight, flows from one place to another. Energetics scientifically studies the way energy flows when it is being transformed from one form of energy into another form.

Energetics is a very broad scientific discipline that encompasses many disciplines, such as biological energetics, biochemistry, chemistry, ecological energetics, and thermodynamics. The boundary between these disciplines and other branches of energetics is a matter of considerable debate. The general aim of the discipline of energetics is to discover principles that can describe the useful and nonuseful tendencies of energy flows under transformation. The principles are statements that describe the way in which the phenomena observed as energy flows occur whenever they are observed in the same set of conditions. The ultimate goal of science in this and other areas is to identify and understand uniformities of nature than can be stated as laws of nature, or scientific principles. For example, the discipline of thermodynamics has developed principles that are usually referred to as the Laws of Thermodynamics. These descriptive statements of uniformities of nature can be called Laws of Energetics, as well.

Among the basic principles of energetics, the first is that if two systems are in a thermal equilibrium, and if the first of the two systems is also in equilibrium with a third system, then the second of the first two systems is also in equilibrium with the third system. A second principle says that the Second Law of Thermodynamics applies to a system so that over time, entropy increases so that energy is lost for further useful application. A third principle says that as energy increases in a system from an outside source, some of it is expended as work. A fourth principle states that as a system loses heat, all processes decline and eventually stop completely as the system approaches absolute zero.

The study of energetics in ecology systems is a quantitative discipline that is concerned with the flow of energy through environmental systems. Its goal is to discover the mechanism that allows energy to flow through ecological networks. The networks are composed of levels of energy-using or trophic relationships. A systemic approach seeks to discover the ecosystem energy interconnections.

Biological energetics studies the work done by organisms, everything from metabolism to reproduction to defensive actions. It measures work in either units of kilojoules (kJ) or units of kilocalories (kcal). The units measure how work is converted to heat or how heat can be used in work in the three biologically important forms of energy: chemical, electrical, and radiant energy, all of which may exist as potential or kinetic energy.

Organisms, fish, mammals, and all other life forms need to constantly acquire sources of energy such as food, and require the expenditure of energy to exist and to perform the functions of life. The energy facts of life are that the First and Second Laws of Thermodynamics apply to all living organisms. There is a real sense that death is a successful operation of the Second Law of Thermodynamics in the life of an organism. Energetics studies the way in which energy is transformed from potential to kinetic energy by the mechanisms of an organism.

The discipline of energetics has an ancient lineage. The ancient Greek philosopher-scientists were the first to study the subject. Energetics was advanced by the German philosopher Gottfried Wilhelm Leibniz (1646–1716). It was given modern expression in the work of William John Macquorn Rankine (1820–72), a Scottish engineer and physicist. Rankine was, with Lord Kelvin (William Thomson) and Rudolf Clausius, an important contributor to the development of thermodynamics in the 19th century. His paper "Outlines of the Science of Energetics," published in the *Proceedings of the Philosophical Society of Glasgow* in 1855, is often cited as the beginning of the formal discipline of energetics.

The application of energetics to human–ecological problems in recent years has allowed new views onto old problems. Human ecologists have, for example, compared energy flows through differing agricultural systems, examining their relative efficiency, as in Bayliss-Smith's comparative work, which reveals the remarkable efficiency of traditional agrarian practices relative to modern farming. Energetics has also been used to make more spurious and functionalist claims, however, using energy efficiencies as an explanation for cultural practices. Overall, the potential for energy-based analysis in modern environmentalism is arguably yet unrealized.

SEE ALSO: Energy; Heat; Thermodynamics.

BIBLIOGRAPHY. T.P. Bayliss-Smith, *The Ecology of Agricultural Systems* (Cambridge University Press, 1982); Hal Caswell, *Food Webs: From Connectivity to Energetics* (Elsevier Science & Technology Books, 2005); Roger A. Hinrichs and Merlin Kleinbach, *Energy: Its Use and the Environment* (Thomson, 2002); Neil Rooney, *From Energetics to Ecosystems: The Dynamics and Structure of Ecological Systems* (Springer-Verlag, 2006); Stanley J. Ulijaszek, C. G. Mascie-Taylor, and R. A. Foley, eds., *Human Energetics in Biological Anthropology* (Cambridge University Press, 2005); R. G. Wiegert, ed., *Ecological Energetics* (Elsevier Science & Technology Books, 1976).

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Energy

ENERGY HAS DIFFERENT meanings in different contexts. In layperson's terms energy can be defined as the measure of potential to bring changes in a system. In physics parlance, energy refers to capacity of doing work. Energy can occur in various forms: kinetic, potential, electromagnetic, sound, and so on. Energy of a moving car is kinetic energy, whereas the energy of water stored in a dam is potential energy. Energy can be converted from one form to another. For example, when water falls from a dam, the potential energy of water gets converted into kinetic energy, which drives turbines to produce electrical energy. When a car crashes into a wall, the kinetic energy of the car is converted into heat and sound energy. When such a conversion occurs, some of the useful energy is lost. As a result, not all energy can be converted to useful work. However, energy can neither be created nor destroyed (First Law of Thermodynamics). In SI units, energy is measured in Joule (J), which is equivalent to the work done when one Newton force is applied to move an object by 1 meter. Maintaining vital cellular activities that are necessary for survival requires a minimum of 4,000 kJ/day; whereas 20,000 kJ/day are required for activities such as bicycle riding, jogging, or construction work.

Energy sources have been broadly categorized as renewable and nonrenewable. Renewable energy refers to the energy that can not be depleted either due to its short-time frame of regeneration (e.g., biomass, ethanol from corn) or a source itself is inexhaustible for a considerable period of time running into millions of years. Traditionally, energy from sources such as solar, wind, geothermal, and biomass are considered to be renewable. Nonrenewable energy, on the other hand, can be depleted faster than it is regenerated, which usually occurs over a geologic time frame, that is, millions of years. Examples of nonrenewable energy sources are coal, oil, and natural gas.

Energy is very critical for industry, economy, and ecosystems since without energy, none of these can function and would not have existed today. The primary energy driving the earth system is solar energy, with tidal (lunar) and crustal energies being the next two most prominent sources. One example is the hydrological cycle. Solar energy heats up the oceans evaporating water into the atmosphere. Water vapors rise up due to lower density and eventually cool down to form clouds. Precipitation in the form of ice, snow and rain occurs from the clouds, which feed rivers, lakes, and groundwater, providing much-needed fresh water for humans and other living organisms. In ecosystems, primary producers (plants, green algae, diatoms, etc.) capture solar energy through photosynthesis and store it in carbohydrates, ATP, and acetate in the form of chemical energy. This stored chemical energy meets the energy demand of all other species higher up in the food chain or at higher trophic levels, including detritus. In addition, producers also release oxygen, an important component of cellular respiration that provides energy for all life functions of living organisms including movement, growth, and reproduction. Detritus plays an important role in an ecosystem by breaking down the dead plants and animals and releasing nutrients back into the ecosystems. In doing so, detritus derives energy from dead plants and animals. These nutrients, in turn, support the growth of primary producers. Industry derives materials and energy from the ecosystems that fuel growth and economic development. Fuels such as coal, oil, and natural gases, which are predominantly used by economy, are derived from energy stored in dead plants and animals through a series of transformations over a period of millions of years. Many of valuable materials we derive from ecosystems such as medicines, timber, foods, and biofuels are all products of biochemical pathways involving solar energy.

However, energy can also be destructive. Violent meteorological processes such as lightening, tornadoes, snow avalanches, and geological processes such as earthquakes, tsunamis, volcanoes are all manifestations of highly concentrated forms of energy derived either from sunlight or from the energy stored in the mantle of the earth.

HISTORY OF ENERGY USE

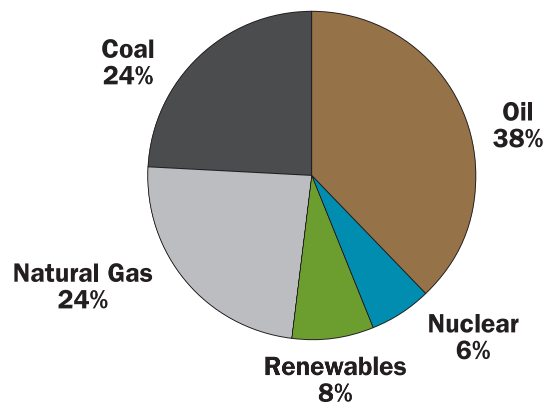
Other than sunlight, fire from biomass is probably the earliest reported use of energy by humans. In preindustrial societies, wood, straw, and charcoal were used to meet energy needs such as home heating, cooking, and ore smelting. Many such sources have been severely depleted due to their use in a nonrenewable manner. Energy required for labor was derived from the muscular power of humans and animals. For example, people used to plow agricultural fields with the help of animals. Seeding, planting and harvesting of crops used to be done manually by hand. Activities such as grain milling and transportation involved the use of cattle such as water buffaloes.

More sophisticated types of energy devices such as waterwheels and windmills were introduced only toward the end of the preindustrial period. In the early eighteenth century, the renowned scientist Lavoisier designed a 1,700 degree C solar furnace that concentrated solar energy and converted it to heat.

With advent of the industrial revolution, the demand, use, and diversification of energy substantially increased. For example, per capita annual combustion of fuels was 500 kg of wood equivalent by 1850s, which is very nominal compared to the current energy consumption. Taking into account the differences in energy efficiencies, annual per capita consumption of energy in 1995 was 20 times higher than in the 1850s. From early 1990s, electricity production from fossil fuels began. In 1990, less than 1 percent of fossil fuels were devoted to electricity production, which rose to 25 percent by 1990. Hydroelectricity came into existence in mid-1890s, and its global production has been increasing ever since. However, hydroelectricity production has almost leveled off in the United States since the 1970s, as virtually all viable sources of hydroelectricity have been utilized.

In 1956, the dream of the harnessing nuclear energy through controlled atomic fission was realized when the first commercial fission reactor came into operation. Initially nuclear energy was heralded as the energy of the future and a viable substitute for fossil fuels. In a flurry of activities, several nuclear power plants were built in the 1960s and 1970s, mostly in the developed countries. However, due to high construction costs, stringent safety requirements, containment of nuclear waste and disposal, and possibility of nuclear disasters (Three Mile Island Accident), and low crude oil prices, nuclear power plants became a less-preferred option. Very few nuclear plants were commissioned after 1980, and the much-hyped nuclear energy solution failed to live up to its earlier prediction.

In last 20 years, alternative sources of energy such as solar, wind, and biomass have received more attention. In terms of electricity production, wind energy is emerging as an attractive option. Production of biofuels such as ethanol and biodiesel is gradually increasing, which find their applications in automobiles as substitutes for gasoline and diesel. Brazil leads the world in biofuel production. Brazil produced 14 million m^3 of ethanol from sugarcane in 2002. In the renewable energy category, hydroelectricity still predominates. In 1997, the share of hydropower in the renewable sector was 55 percent, followed by biofuels (38 percent) and geothermal (5 percent), whereas solar and wind energy accounted for only 2 percent of renewable energy produced in the United States. Nonrenewable energy including oil, gas, and coal had the largest share (86 percent) of the total marketed energy worldwide in 2003. The total primary energy consumed worldwide in 2005 was 9800.8 million tons oil equivalent (toe).



World marketed energy use by fuel types in 2003 (totals do not equal 100 percent due to rounding errors).

PLANETARY ENERGY FLOWS

The earth receives 3.93×10^{24} J/yr of solar insolation. The oceans capture 5.2×10^{19} J/yr of tidal energy resulting from gravitational forces of attraction of the sun and moon acting on the earth. The earth's crust draws 4.74×10^{20} J/yr of the heat energy from the mantle. In addition, it derives the heat energy from the radioactive decay of radioactive elements present in the interior part of the earth that equals 1.98×10^{20} J/yr, making the total crustal heat energy 6.72×10^{20} J/yr. Solar insolation and tidal energy contribute 6.49×10^{20} J/yr of heat by passing some of the energy as compression and chemical potentials. Thus, the total heat outflow in the earth system is 13.21×10^{20} J/yr. An ecosystem captures only 1% of solar energy falling on it. When energy is transferred from autotrophs to consumers at higher trophic levels, energy gets lost. Only 10 percent of the energy entering a given trophic level gets transferred to the next trophic level.

FOSSIL FUELS

Fossils fuels comprising petroleum, natural gas, and coal are primary energy sources. All fossil fuels are products of a series of biological, chemical, and physical transformations of plant and animal remains over geological time frames. It is estimated that total reserves of fossil fuels in the earth was about 317,700 × 10^{18} J in 1999.

Coal: Coal, which led to the growth of fossil-fueled civilization, is a solid black or brown mass obtained from the arrested decay of the metamorphosed remains of plants that were buried in marshes and bogs millions of years ago. First plant debris got converted to peat through bacterial and chemical transformation. Thereafter, a series of actions involving heat and pressure converted peat into various types of coal. Coals are not identical because of differences in original vegetation, the extent of transformation, the magnitude and duration of pressures, and temperatures. Coal primarily consists of carbon and small amounts of sulfur, nitrogen, and ash. Good-quality coals—*anthracite and bituminous* coal—were obtained from the wood of large, scaly barked trees that grew in large coastal swamps about 2 million years ago. The low-quality coals—*lignites*—are the youngest, and soft with a brown tinge. Due to appreciable amounts of moisture, sulfur, and ash, they have low heat content and emit substantial amounts of oxides of sulfur and nitrogen. Coal is extracted either by surface mining or underground mining.

Petroleum: Petroleum, also known as *rock oil*, is a liquid present in the upper earth crust. Like coal, petroleum is derived from biological, chemical and physical transformations of plant and animal debris over millions of years. Petroleum is a complex mixture of hydrocarbons with a varying molecular weight and physical and chemical attributes. Petroleum, being a hydrocarbon, primarily consists of carbon and hydrogen with small amounts of nitrogen and sulfur and a few metals. Petroleum is processed and refined to produce gasoline, diesel, jet fuel, methyl tertiary butyl ether (MTBE), tar, and other products.

Natural Gas: Natural gas occurs in the underground reservoirs of porous rocks. It also occurs as a mixture with petroleum and is recovered by petroleum refineries. Natural gas consists of methane as a major component (70–90 percent by volume) with smaller amounts of ethane, propane, butane and other paraffins. In addition, natural gas consists of inert gases such as nitrogen and carbon dioxide along with hydrogen sulfide. Natural gas is distributed to consumers (industrial, commercial, residential) via pipelines. Natural gas is also liquefied and transported by special tankers.

BIOMASS ENERGY

Biomass refers to plant-based organic products such as wood, corn, soybean, crop residues, and organic wastes. Biomass can be burned directly to produce heat and electricity or converted to liquid fuels and gas through pyrolysis, fermentation, and anaerobic digestion. Biomass is an important part of the renewable energy supply in developing countries and is used primarily for heating and cooking. It is gaining importance in developed countries for electricity production and automobile transport. Biomass has chemical energy stored in carbohydrates and other complex organic compounds that can be harnessed for different uses. Biomass as an energy raw material is attractive due to its wide distribution, availability, and renewability, which make it possible to develop decentralized energy production and distribution systems. However, its low energy content, the need for drying, transportation, and competition for land with other uses such as food, wood, and shelter undermine its advantages.

Biomass, including wood, switchgrass, and bagasse has been used to generate process heat, steam, and electricity either through direct burning or gasification. The biomass gasifiers yield gaseous products whose composition varies depending on the nature of feedstock and reactor conditions. Short-rotation woody crops such as sycamore, poplar, and eucalyptus have been studied for use in electricity production through co-firing or gasification. Biomass can also be converted to gaseous products and coke through pyrolysis that can be used for space and water heating, cooking, and process heat. Ethanol is derived from sugarcane and corn by fermentation, and has been used as a transportation fuel. In the United States, the total ethanol production from corn topped 4 billion gallons in 2005. Recent studies suggest that ethanol can also be produced from cellulosic feedstock, expanding the possibility of ethanol production. It is estimated that the global potential for ethanol production from crop residues and wasted crops could be 442 GL/year. Biodiesel has been synthesized from a variety of oilseed plants, including soybean, jatropha, rapeseed, and sunflower through transesterification.

Biomass such as municipal wastes and cattle manure is used to produce methane through anaerobic digestion. Methane digesters are more popular in developing countries. Thousands of homes have benefited from installations of methane digesters. These digesters mainly rely on cattle manure for energy feedstock. A typical digester consists of a digester chamber, where an anaerobic reaction occurs; a metal dome with a pipe to collect biogas (methane); an inlet to feed the digester with manure; and an outlet connected to overflow tank that collects digested slurry. The digested slurry is applied to farmlands to improve soil fertility and increase productivity. Biogas is mainly used for cooking and lighting. Since biomass burns more cleanly than fuel wood, it has reduced indoor air pollution and respiratory diseases, particularly for women, since women normally prepare meals for their families in developing countries.

SOLAR ENERGY

Due to widespread availability of solar power, people have been harnessing solar energy in many ways since time immemorial. An example is the passive energy system utilized by the homes of the Anazasi Indian Tribes in the southwest United States. The solar energy technologies can be broadly categorized into four groups: passive heating, active heating, solar-thermal electric, and solar photovoltaic.

Passive solar technology relies on design and placement of windows and walls to optimize heat collection, and retention in buildings. The characteristics of building materials such as cement, clay, stones are also taken into consideration. The term *passive* implies the absence of moving parts and controls. Active solar technology, on the other hand, is designed to capture greater amount of available solar energy by utilizing collectors and a circulating coolant that transfers heat from the collector to the point of use. The term *active* implies that it has moving parts and controls. A solar water heater is one example of active technology. There are several types of collectors that have been used: flat-plate collectors, focusing collectors, evacuated tube collectors, and parabolic dish solar collectors. Of these, flat-plate collectors are most widely used, mostly in homes.

The principle of a solar-thermal electric system is same as that of active solar heating. The only difference is that the heat captured from the coolant is used to heat a primer fluid that can be pressurized water or compressed air that drives a turbo generator unit to produce electricity. Focusing or parabolic dish solar collectors are used for such an application.

A solar photovoltaic system is based on the principle of the photoelectric effect. A photovoltaic system converts solar energy to electrical energy when solar rays fall on the p-n photvoltaic device, causing the release and migration of electrons from an n-type semiconductor to a p-type semiconductor. Silicon dioxide, cadmium telluride, and copper indium diselenide are the commonly used semiconductors in photovoltaic cells. Features such as simplicity, low maintenance requirements, absence of moving parts, and scalability make it attractive. Nonetheless, the main concerns of photovoltaic have been the cost and efficiency. Efficiency of solar-electricity conversion has improved from a few percent to 20 percent, and costs have decreased from $250/W to $2.5/W or less. These numbers are still not good enough for large-scale commercial production and adoption, especially considering low costs of fossil fuels.

WIND ENERGY

Wind power technology utilizes the energy of the sufficiently strong winds to drive turbines and produce electricity. The differential heating of the earth's land and sea surfaces produces winds by creating a pressure gradient. Air moves from the area of high pressure to low pressure, creating a wind. Wind electricity production is basically the extension of traditional windmills. Wind power plants are usually installed in the areas that experience regular and reasonably strong winds with speeds greater than 5.5 m/s. Theoretically, it is possible for the earth's winds to provide 5,800 quadrillion BTUs of energy per year, which is 15 times more than the present world energy demand.

The worldwide wind-electric capacity has been increasing steadily. The world wind power capacity was 58,982 megawatts (MW) in 2005, which was less than 1 percent of the worldwide electricity supply. In 2005, Germany was leading wind power production with 18,428 MW capacity, followed by Spain, The United States, India, and Denmark. Although wind energy is relatively economical among renewable energy alternatives, concerns about aesthetics and noise pollution, failures of some product lines, remoteness of suitable sites from highly populated areas requiring high voltage transmission systems, and daily and seasonal variation in wind speed are obstructing its rapid expansion.

GEOTHERMAL ENERGY

Geothermal energy is the energy extracted from the porous and permeable hot rocks with or without fluid present in the earth's crust, a few miles below the surface. The upward conduction and convection of the heat from the mantle, and the heat energy produced by radioactive disintegration of radioactive elements heat up the rocks. Occasionally, magma also intrudes the earth crust, transferring heat to the rocks. At places where subterranean faults and cracks are present, rainwater and snowmelt seep underground and come in contact with the hot rocks, where the water is heated and returns back to the surface in the form of hot springs, geysers, and mud spots. If the heated water cannot rise to the surface due to the presence of impermeable rock above, it fills the pores and cracks of the hot rocks below, creating geothermal reservoirs. The temperatures of water in geothermal reservoirs are far greater than those of hot springs, reaching more than 350 degrees C. The hot water can exist as a supercritical liquid or saturated steam, and can be extracted by drilling and used for electricity generation or space heating. The hot water either rises to the surface naturally or has to be pumped up. Generally, shallower geothermal reservoirs with lower temperatures (41-149 degrees C) are used for heating in spas, greenhouses, industry, and homes.

The majority of geothermal power plants under operation today are flashed steam plants. When the hot water is suddenly released from the reservoir pressure, it boils and produces steam, which drives the turbines and generates electricity. To maintain the reservoir pressure and recharge the reservoir, cold water is recycled back to the reservoir. Since the installation of the first geothermal system at Larderello, Italy in 1904, its use has increased worldwide, with the current production capacity standing at 8,000 MW.

NUCLEAR ENERGY

Nuclear power has a share of 17 percent of the world's electricity supply and contributes about 7 percent of the world's energy supply. Nuclear energy is primarily derived from the atomic fission of heavy isotopes such as ^{235}U and ^{239}Pu. When fission of heavy isotopes occurs upon neutron bombardment, it is accompanied by the release of more neutrons and a net mass loss. This lost mass manifests itself in the form of energy according to the famous equation, $E = MC^2$. When a fission reaction occurs uncontrollably in a critical mass, a massive amount of energy is released, which is the basis of atomic bombs used in the World War II. However, if the fission reaction is controlled and kept in a steady state by using control rods such as cadmium that capture neutrons, thus preventing them from causing more fission reactions, heat energy can be generated in a sustained manner. This heat energy is used to produce steam that drives turbines to produce electricity. The first constructive application of nuclear energy was the nuclear driven submarine that used a small boiling water reactor.

There are different types of nuclear reactors used for producing electricity. They are: light-water reactors (LWR), pressurized-water reactors (PWR), boiling water reactors (BWR), large tube type reactors (RBMK), heavy-water cooled reactors (also known as CANDU), gas-cooled reactors (GCR), and liquid metal reactors (LMR).

An important component of nuclear energy is the fuel itself. The fuel, mainly uranium, is extracted from earth as uranium-bearing ore by surface mining. Uranium is separated from its ore in a chemical leaching facility as U_3O_8. This is followed by its conversion to gaseous uranium, UF_6, which facilitates its enrichment via gaseous diffusion or centrifuge-based process. The enriched UF_6 is converted into UO_2 and fabricated into rods for use in nuclear reactors. The enriched uranium contains 3% or more of ^{235}U. When the fuel rods no longer become usable, they have to be removed and stored as spent fuels to avoid radioactive contamination in the surrounding environment. The long-lasting containment of the spent fuel is one of the concerns afflicting the nuclear power technology.

HYDROPOWER

Hydropower is the largest renewable energy used in the world and contributes 20 percent of the worldwide electricity production. Hydropower comes from moving or falling water that drives turbines and generates electricity. In the process the potential energy of water is converted into electric energy. This has been possible due to the hydrologic cycle, which is driven by the solar energy. The amount of power that can be extracted from water is a function of the head (difference in height between the water's outflow and the turbine), volumetric flow rate of water, and efficiency of the turbine.

Energy stored in water is tapped in three different ways: creating a reservoir by dam construction, diversion hydropower in which a part of the river is diverted through a canal and made to fall from a suitable location that provides adequate head, and pumped storage, wherein power in off-peak hours is used to pump the water from the source to the reservoir located at the higher elevation and its energy is subsequently tapped during the peak hours. Hydropower installations are economical and known for robustness and durability. Some hydropower plants are operating even after 100 years. Canada is the largest producer of hydropower, which meets 70 percent of the total electricity demand. Virtually all of Norway's electricity comes from hydropower. Iceland meets 83 percent of its electricity demand from hydropower. Overall, it is estimated that it is economically feasible to harness more than 7,300 TWh/yr of hydropower worldwide.

Fossil fuel use has dramatically increased, leading to an unprecedented rise in carbon dioxide levels.

TIDAL ENERGY

Since ocean tides embody vast amounts of energy, they have become a part of an effort to harness earth's renewable energy dating back to medieval periods. Tidal waves offer possibilities of harnessing energy in two ways: kinetic energy that results from the currents between the high (surging) and low (ebbing) tides, and potential energy due to the head between high and low tides. However, all tidal energy installations at present exploit the potential energy of tides, even though harnessing kinetic energy also looks feasible. High and low tides are due to the earth's rotation and gravitational force of attraction between the moon and earth, and the sun and earth.

To capture the potential energy, barrages consisting of sluices and turbines are built to trap the ocean water in the basin during the high tides. During the low tides, the head is created between the water levels inside and outside the barrage. Due to this head, water flows back to the ocean when sluices are opened, thereby driving turbines and generating electricity. This mode of operation is called ebb generation. Alternatively, tidal energy can be captured through a flood generation method. A barrage is built to hold back the incoming high tides that create a head difference across the barrage. As water flows into the basin, turbines rotate producing electricity. This is a less efficient mode of operation A tidal power plant cannot provide continuous electricity, because high and low tides occur only twice a day. Typically, a conventional tidal plant generates electricity for 6–10 hours a day irrespective of a mode of operation. Today the worldwide tidal power capacity stands at about 11,000 MW.

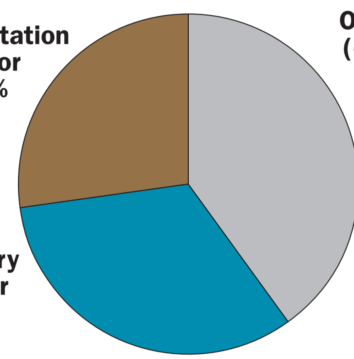
ENERGY USE

Energy finds its use in every facet of human and ecosystem activity, such as transportation, industry, and commercial and residential buildings.

Transportation is an important component of our daily life and, on average, a person spends 10-15 percent of their income for transportation. Energy consumption in the transportation sector accounts for one-fourth of the total national energy use in the developed countries. Most of this energy goes into driving personal vehicles and heavy trucks. Automobiles require 5,874 Btu of energy per mile per vehicle. Sport utility vehicles and light trucks consume even more energy per mile (7,247 Btu/mile). Air transportation consumes about 10,481 Btu/passenger-mile. Almost all personal vehicles and other means of transport are fueled by petroleum although renewable energy is finding its way in. For example, natural gas constitutes 2.5 percent of energy consumption in the transportation sector whereas the electricity accounts for 1.2 percent in the United States.

Industry accounts for the largest energy use in the world. In the United States, the industry sector consumes about 35 percent of the total national energy output. Worldwide it accounted for 33 percent of the total energy consumption in 2003. The most energy-intensive industries are paper, chemicals, primary metals, and petroleum. Fossil fuels are used in the petroleum and petrochemical industries not only as fuels, but also as feedstock. Since the majority of energy used in industry comes from fossil fuels, carbon dioxide emissions from the industries is significant. Industry contributes about 20 percent of the total air pollution.

The reason why commercial and residential buildings consume a substantial amount of energy is that energy is required not only for their construction but also for operation and maintenance. Production of building materials are highly energy intensive. To produce 1 ton of aluminum requires 150-220 GJ of energy, whereas 1 ton of steel needs 25-45 GJ. However, other building materials such as brick, concrete, and wood consume far less energy. In residential buildings, space and water heating alone accounts for 80 percent (worldwide average) of the total energy use in buildings. Refrigeration and lighting accounts only 9 percent of energy consumption in buildings.



Shares of world-wide energy consumption by sectors in 2003 include transportation, industry and other uses.

ENVIRONMENTAL IMPACTS

Whether energy is renewable or nonrenewable, impacts of energy on the environment at all stages, from the cradle to grave, is inevitable. Even seemingly benign technologies such as solar and wind have indirect impacts on the environment. Manufacture of components used in wind turbines and blades require fossil fuels, which emit greenhouse gases and other air pollutants. Wind power plants have been criticized for their impacts on natural aesthetics and threat to certain bird species. Solar cells and batteries use toxic chemicals that need to be disposed off carefully or recycled. Production of biofuels requires agrochemicals, fossil fuels, and capital equipment that emit harmful pollutants into the environment directly or indirectly. Agrochemicals such as pesticides and fertilizers impact surface water bodies (eutrophication, aquatic toxicity) whereas fossil fuel use emits greenhouse gases and other air pollutants including PM10, volatile organic compounds, sulfur dioxide, carbon monoxide, etc. Large-scale hydropower developments alter river and riverside habitats, disrupt sediment flow and natural fish migration, submerge large lands, and displace local communities.

The magnitude of environmental impacts can become severe with nonrenewable energy. For example, underground mining in the Appalachian regions of the United States has severely contaminated local water supplies, rivers and streams mainly from acid mine drainage. Surface mining of coal left thousands of hectares in Appalachia and midwest denuded that they could not be restored or reclaimed for other uses. Also, acid drainage and spoils banks were more severe.

Moreover, when coal is finally combusted in power plants or other industry, it releases carbon dioxide (CO_2), nitrogen oxides, sulfur oxides, and other air pollutants. Sulfur and nitrogen oxides are formed from sulfur and nitrogen present in the coal as impurities. Acid rain caused by sulfur-containing coal burning especially from power plants has been documented, which has had serious impacts on some lakes and streams of northeastern United States and Canada. In addition, coal combustion can cause serious health problems, such as respiratory diseases and irritations. The deadly smog that killed thousands of people in London in 1952 was associated with coal combustion. Coal power plants are also blamed for mercury emissions.

Use of coal and other fossil fuels in electricity production (diesel, gasoline, natural gas, transportation and industry) has dramatically increased since the last century, leading to an unprecedented rise in carbon dioxide levels. Carbon dioxide is believed to be a major culprit behind global climate change. It is estimated that 22 gigatons (Gt) of CO_2 are released into the atmosphere every year from combustion of fossil fuels. Consequences of climate change can be serious, such as polar ice melting causing a rise in sea levels and subsequent submerging of coastal cities, extreme weather patterns such as extended drought, heavy rainfalls, and hurricanes, loss of species, and emergence of new tropical diseases.

Nuclear energy also has its share of environmental impacts and critical health and safety issues. Since the fuel, uranium, used in the nuclear reactor has to be mined, it presents similar environmental problems as other mining activities, which include destruction of the local habitats and contamination of water bodies. Workers working in uranium milling can be exposed to harmful radiation. In addition to the safety issues that arose in the context of the Chernobyl and Three Mile Island accidents, the long-term disposal of spent nuclear fuels is another unresolved problem. These spent fuels continue to emit harmful radioactive rays even for thousands of years due to long half-lives of radioactive isotopes. The spent fuels have to be isolated and stored in a safe and remote place, which creates unique technological and institutional problems.

THE FUTURE

What kind of energy mix we will have in the future is largely determined by the availability of fossil fuels and their cost, as well as the energy needs and corresponding energy policies of individual countries and their collective global strategies. Costs of renewable energy technologies such as solar and wind have come down significantly over the decades. However, renewable technologies, except hydropower, are still expensive and cannot survive without subsidies and incentives. Further decrease in costs is possible, but will not occur immediately. As long as costs of fossil fuels remain low, expansion of renewable energy technologies is likely to occur at a slow pace, and the current energy mix may remain unaltered for the near future. Intermittent or variable energy production and diffuse nature of renewables make them unsuitable for distribution over large areas. The proximity of renewable resources to the major population centers may improve their appeal since they require little investments in transmission and distribution networks. Renewables are an attractive option for decentralized energy production.

SEE ALSO: Coal; Dams; Drilling (Oil and Gas); Energy Crisis (1973); Geothermal Energy; Hydropower; Nuclear Power; Solar Energy; Wind Power.

BIBLIOGRAPHY. E.S. Cassedy and P. Z. Grossman, *Introduction to Energy: Resources, Technology, and Society*, 2nd ed. (Cambridge University Press, 1998); Energy Information Administration (EIA), *International Energy Annual 2003,* www.eia.doe.gov (cited May-July 2005); International Energy Agency (IEA), *2003 Energy Balances for the World*, www.iea.org (cited 2006); S. Kim and B.E Dale, "Global Potential Bioethanol Production from Wasted Crops and Crop Residues," *Biomass and Bioenergy* (vol 26, 2004); O. Levenspiel, *Understanding Engineering Thermo* (Prentice-Hall, 1996); Oak Ridge National Laboratory (ORNL), *Transportation Energy Data Book*, 18th ed. (U.S. Department of Energy, 1998); V. Smil, *Energies: An Illustrated Guide to the Biosphere and Civilization* (The MIT Press, 1999); J. W. Tester, E. M. Drake, M.J. Driscoll, M. W. Golay, and W. A. Peters, *Sustainable Energy: Choosing Among Options* (The MIT Press, 2005).

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Energy Crisis (1973)

THE ENERGY CRISIS refers to the social and political-economic disruptions resulting from an abrupt change in the price and availability of world oil supplies in 1973. The crisis was triggered when Arab members of the Organization of Petroleum Exporting Countries (OPEC) declared an embargo on oil exports to Western nations supporting Israel in the Yom Kippur War. During the same period, OPEC countries (at the time responsible for more than half of world oil production) began to regulate the price and volume of their deliveries. As a result, the price of crude oil quadrupled, from around $2 per barrel in October of 1973 to nearly $10 per barrel in June of 1974.

OPEC's actions had immediate effects. By exercising control over a commodity critical to the global economy, Middle Eastern oil-exporting countries enhanced their geopolitical power in relation to industrialized nations. The dramatic rise in oil prices also led to a rapid accumulation of wealth in exporting countries such as Saudi Arabia. Meanwhile, for industrialized countries that had become increasingly reliant on cheap imported oil to fuel post–World War II economic expansion, supply disruptions and higher energy prices contributed to a period of inflation and economic recession. In the United States, lengthy lines at gasoline stations became symbolic of the 1973–74 "oil shocks."

The environmental implications of the energy crisis have been complex. Recognizing the precarious nature of their dependence on foreign energy sources, oil-importing developed countries made attempts (with uneven success) to reduce demand through conservation and investment in alternative energies. Thus, Japan stepped up its development of energy-efficient vehicles, and France invested heavily in nuclear power. However, industrialized countries also acted to secure non-OPEC energy supplies through more intensive exploitation of oil fields under their control and increased exploration. For example, the United States developed Prudhoe Bay reserves in Alaska; the United Kingdom and Norway intensified development of North Sea offshore deposits; and production increased in Mexico and the Amazon in the decades following 1973. This spatial expansion of oil production contributed to a decline in OPEC's power and to a return to relatively low oil prices in the late 1980s, thereby helping to guarantee the world's continued dependence on fossil fuels. It also served to integrate these peripheral regions into the global economy and subject their ecologies to the often-devastating impacts of oil extraction and distribution, for example, the *Exxon Valdez* spill in Alaska and the pollution, deforestation, and social dislocation resulting from post-1973 oil development in the Ecuadorian Amazon.

IMPACT OF OIL WEALTH

The wealth generated in oil-producing countries by the 1973–74 price hikes also had environmental consequences, although more indirectly. Many of these "petrodollars" were circulated through international financial institutions and then lent to developing countries seeking finance capital. With the debt crisis of the 1980s and ensuing structural adjustment policies, many developing countries intensified the exploitation of their natural resources—often by liberalizing their extractive and agricultural sectors—in an attempt secure the foreign exchange necessary to pay off their debts. Thus, the social and environmental impacts of the recent increase in nature-based production in the developing world are, in part, legacies of the 1973 energy crisis.

SEE ALSO: Alternative Energy; Automobiles; Conservation; Corporate Average Fuel Economy Standards; *Exxon Valdez*; Fossil Fuels; Oil Spills; Organization of Petroleum Exporting Countries; Petroleum.

BIBLIOGRAPHY. Mohammed Abu al Khail, "The Oil Price in Perspective," *International Affairs* (v.55/4, 1979); Daniel Lewis Feldman, "Revisiting the Energy Crisis: How Far Have We Come? *Environment* (v.37/4, 1995); Reijo K. Helle, "Spatial Expansion of Oil Prospecting and Geopolitical Balance," *GeoJournal* (v.14/2, 1987); Bruce Podobnik, *Global Energy Shifts: Fostering Sustainability in a Turbulent Age* (Temple University Press, 2006); Daniel Yergin, *The Prize: The Epic Quest for Oil, Money and Power* (Free Press, 1993).

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Enron

ENRON IS THE name of the company that caused a major corporate accounting scandal and related financial irregularities in 2001 that disrupted financial markets. In 1985, Houston Natural Gas merged with InterNorth, a natural gas company based in Omaha, Nebraska. The new company was renamed Enron, and in 1986, Kenneth Lay becomes chief executive. At the same time, Lay found another avenue for greater wealth: deregulation of the natural gas industry. He used his connections and had Enron make political donations in order to influence Congress to make natural gas an unregulated, tradable commodity. In 1989, as the natural gas was deregulated, Lay created the Gas Bank. This initiative was to form a bridge between producer and consumer, ensuring consumers long-term supplies at set rates while stockpiling reserves of natural gas bought from producers.

In 1990, Lay hired former business consultant Jeffrey Skilling to look after the companies' energy trading operation. Andrew Fastow, who later became the mentor of the firm's dubious accounting practices, was one of the first hires. The same year, Lay was given $1.5 million in cash compensation, along with millions of shares of Enron stock. Enron's chief financial officer (CFO), Andrew Fastow, found a new use for the Gas Bank: he created Cactus, the first of what would eventually amount to 3,500 dummy companies created by Enron. Enron would make phony deals with the Gas Bank and assume, as supposedly separate and independent companies, any debts the Gas Bank incurred. By keeping Cactus off the books, Enron's actual indebtedness would be hidden. Thanks to Cactus and other dummy companies created by Fastow, none of Enron's earning's reports would be accurate, but to unsuspecting observers Enron seemed to do very well.

Enron's corporate culture changed radically during the mid–1990s. Bonuses and salaries became dependent on the closing of deals, and employees starting battling each other for the rights of each deal made. In May 1995, James Alexander, an executive in Enron's Global Power & Pipelines division, warned Lay of suspicious accounting of the division's finances. Lay did not act on the warning. In 1997, Skilling was promoted to president and chief operating officer. Fastow created a series of companies—codenamed Chewco and Jedi—designed to keep debt away from Enron's books while inflating the firm's profits. That year, *Fortune* magazine named Enron the most innovative company in the United States. In 1999, Fastow set up the first of the secret partnerships, which generated huge bonuses for him and his associates, while hiding Enron's many poorly performing assets and investments. At the same time, Enron launched its broadband services unit and Enron Online, the company's website for trading commodities, which soon became the largest business site in the world. About 90 percent of its income would eventually come from trades over Enron Online.

By August 2000, Enron shares reached a peak of $90. That year, California learned what Enron had wanted from a deregulated marketplace. For years afterward, Enron employees would insist that the catastrophe was California's fault and that Enron had done nothing wrong. Government investigators discovered that Enron's dummy companies had traded natural gas and electricity among themselves, with each trade increasing in price, until the commodities were sold to California for several times their actual market value.

In August 2001, an Enron employee, Sherron Watkins, met Lay to alert him to her concerns about dodgy finance and accounting practices at the firm. Later, on October 16, Enron shocked the markets by announcing a $638 million loss for the previous three months, and write-offs worth $1.2 billion; three days later the U.S. stock market watchdog launched an inquiry into Enron's finances. A week later, CFO Andrew Fastow was replaced. On November 2001, rival firm Dynegy made an offer to buy Enron. Shortly thereafter, Enron announced even further losses and previously undisclosed debt. As Enron's share price fell below $1, Dynegy broke off the takeover talks. On November 8, 2001, Enron filed a Form S-K with the SEC, announcing that its failure to account properly for transactions with partnerships known as KLM Cayman, L.P. and Chewco Investments, L.P. required the company to adjust its financial statements for 1997–2001. The Securities and Exchanges Commission added accountancy firm Arthur Andersen, the auditor for Enron, to its investigation. In December 2001, Enron filed for bankruptcy protection, the largest bankruptcy in the United States history at that time. Thousands of employees were laid off.

In January 2002, Lay resigned. Arthur Andersen declared that its employees destroyed a "significant but undetermined" number of Enron documents. The transnational company was later fined for its actions. In October 2002, Fastow was arrested on the charges of fraud, money laundering, and other accusations. Enron defendants faced over 30 felony charges, including alleged violations of the Securities and Exchange Act of 1934. The charges stated that Enron knew and did not disclose actual earnings and hedges to the public. In May 2006, Lay and Skilling were found guilty of conspiracy, fraud, and other charges. The collapse of Enron raised new questions about the adequacy of U.S. corporate governance rules. The secret partnerships and deceitful accounting hurt Enron's shareholders, customers, and employees and tarnished the reputation of senior managers. The failure of Enron caused damage in the world of accounting that stretched far beyond Arthur Andersen. The Sarbanes-Oxley Act, a measure that attempted to improve the audit process for public companies in the United States, passed largely as a result of the Enron failure.

SEE ALSO: Deregulation; Energy; Natural Gas; United States, California.

BIBLIOGRAPHY. Sayan Chatterjee, "Enron's Incremental Descent into Bankruptcy: A Strategic and Organization Analysis," *Long Range Planning* (v.36/2, 2003); Brian Cruver, *Anatomy of Greed: The Unshredded Truth from an Enron Insider* (Carroll & Graf Publishers, 2002); C.C. Steven and M.J. Epstein, "The Fragility of Organizational Trust: The Lessons From the Rise and Fall of Enron," *Organizational Dynamics* (v.32/2, 2003); Bethany McLean and Peter Elkind, *The Smartest Guys in the Room: The Amazing Rise and Scandalous Fall of Enron* (Portfolio, 2003); Jean-Luc Moriceau, "What Can We Learn from a Singular Case Like Enron," *Critical Perspectives on Accounting* (v.16/6, 2005).

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Environmental Accounting

THE FIRST ENVIRONMENTAL accounts were constructed by Norway in the 1970s and were slowly adopted by other nations. At the firm level, companies are becoming progressively more aware of the environmental and social liabilities pertaining to their operations and products, with associated financial effects. Uncertainties in measuring these financial effects can be addressed by using environmental evaluation and accounting techniques. Environmental accounting can support national income accounting, financial accounting, or internal business managerial accounting. It is an effective tool for a company's greener management practice. Moreover, the term *environmental cost* has at least two major dimensions: it can refer solely to costs that directly impact a company's bottom line, or it can also encompass the costs to individuals, society, and the environment for which a company is not accountable. Government involvement is a critical factor for corporate accountability for the environment. Corporate environmental accounting is also a strategic management tool for the improvement of corporate policies and decision-making practices.

The principal goal of environmental accounting is the identification of decisions that will enhance profitability and lead to environmental improvements. There are several major problems that occur when identifying and measuring environmental costs. For example, while it is feasible to value a forest in terms of its possible source as wood, no calculation can be made for that tree as part of a rainforest in which it is home for a rich ecosystem. Environmental costs are one of the many different types of costs businesses incur as they provide goods and services to their customers. Some critics argue that modern environmental accounting models have been developed based on procedural liberal frameworks that limit the proposals for reforms, namely concerning the role of the companies and their impact on nature.

SMART BUSINESS DECISIONS

Many environmental costs can be considerably reduced or eliminated as a result of business decisions. Environmental costs (such as wasted raw materials) may provide no added value to a process, system, or product. Uncovering and recognizing environmental costs associated with a product, process, system, or facility is important for good management decisions, and requires paying attention to current, future, and potential environmental costs. How a company defines an environmental cost depends on how it intends to use the information (for example, in cost allocation, capital budgeting, and process/product design). Moreover, it may not always be clear whether a cost is "environmental" or not: some costs fall into a gray zone or may be classified as partly environmental and partly not.

Whether or not a cost is "environmental" is not critical: the goal is to ensure that relevant costs receive appropriate attention. Costs incurred to comply with environmental laws are environmental costs. Costs of environmental remediation, pollution control equipment, and noncompliance penalties are all environmental costs. Other costs incurred for environmental safety are likewise clearly environmental costs, even if sometimes they are not explicitly required by regulations or go beyond regulatory compliance levels.

Environmental accounting can be applied at different scales of use and different scopes of coverage. Companies will likely want to assemble cross-functional teams to implement environmental accounting. Because environmental accounting is not solely an accounting issue, and the information needed is split up among all of these teams, open communication is necessary between teams. This can require, for example, pulling some environmental costs out of overhead and allocating those environmental costs to appropriate accounts. By allocating environmental costs to the products or processes that generate them, a company can motivate affected managers and employees to find pollution prevention alternatives that lower those costs and enhance the benefits. Proposals to integrate environmental costs and benefits into national accounts can also only be evaluated by considering them in the context of their likely policy use.

ECONOMIC IMPLICATIONS

Effective environmental management is based not only on an understanding of the volume of pollution and material use, but also on an understanding of the economic implications. Even if the value of the environment is immeasurable, a figure can be placed on the cost of environmental destruction. Therefore, it is possible to use accounting to help the environment. For example, the full cost of transportation systems should be assessed; not just the cost of building roads, but how trucks and cars impose a burden on the country's environmental health (such as air pollution, loss of arable land, and runoff). Also, there should be an examination of how subsidies damage the environment. For example, with a shortage of water, should a country continue to grow agricultural products using water-intensive agriculture? Most often, the corporate goals of companies are fundamentally in conflict with sustainability. The value of an information framework, combined with an understanding of accounting's role in corporate decision-making, highlights a set of considerations that guide the search for environmental accounting priorities.

SEE ALSO: Adaptive Management; Best Available Technology (BAT); Cost-Benefit Analysis; Decision Science; Ecomanagerialism.

BIBLIOGRAPHY. Patrick De Beer, "Environmental Accounting: A Management Tool for Enhancing Corporate Environmental and Economic Performance," *Ecological Economics* (v.58/3, 2006); Rob Gray, "Environmental Accounting, Managerialism and Sustainability: Is the Planet Safe in the Hands of Business and Accounting?," *Advances in Environmental Accounting and Management* (v.1, 2000); Glen Lehman, "Social and Environmental Accounting: Trends and Thoughts for the Future," *Accounting Forum* (v.28/1, 2004); G.A. Swanson, "A Systems View of the Environment and Environmental Accounting," *Advances in Environmental Accounting and Management* (v.3, 2006).

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Environmental Determinism

THE AVERAGE SWEDE will live 80 years while the average person in Malawi will live half as long. Why do Scandinavians live longer than residents of Malawi by a factor of two? A proximal reason is that European countries have more productive economies, higher incomes and better healthcare, which all contribute to increased longevity.

The more complex task is to explain why some countries are rich and others poor in the first place. Recently, scholars have reprised a "geography is destiny" argument that concludes that the natural environment ultimately determine a region's eventual level of economic prosperity. This essay explores the 19th century origins of environmental determinism as an explanation for 21st century socio-economic disparities.

Environmental determinism attributes economic inequalities to natural laws, and the uneven distribution of land and temperate climates. The notion that some countries have natural advantages over others is ascribed to German geographer Friedrich Ratzel, who was influenced by the concept of *social Darwinism*. British philosopher Herbert Spencer promoted social Darwinism as an altered interpretation of the theory of evolution, which Charles Darwin outlined in his 1859 book *Origin of the Species* (Livingstone 1992). Hence, this essay first explores Darwin's theory of evolution as the inspiration for social Darwinism, which in turn will be explained as the theoretical precursor to environmental determinism.

SOCIAL DARWINISM AS PRECURSOR

Darwin argued that species evolve over generations through the natural selection of physical traits and competition between species for scarce resources. Organisms undergo spontaneous genetic mutations that might, for example, enhance their ability to compete for food. Better nutrition will improve the chances an organism has to reproduce and transmit the improved trait to future generations. A mutation that hinders the animal's ability to compete will likely not be "naturally selected" for future generations because the animal will not survive long enough to reproduce.

Darwin's emphasis on biological competition inspired Herbert Spencer to promote "social Darwinism" as a socio-political counterpart to British economic philosophy. In 1776, Adam Smith outlined the philosophical foundation for Britain's unrivalled 19th century economic prosperity. He argued in *Wealth of Nations* that capitalism worked best when guided by the "invisible hand" of a marketplace comprised of individual buyers and sellers acting out of "enlightened self-interest." The state should stay out of the marketplace so that it does not disrupt the natural competition between individuals needed for a healthy market. Seen in this light, social Darwinism appears to be a natural theoretical extension of Smith's "invisible hand" and Darwin's "natural selection."

British economist David Ricardo extended the notion of competition between individuals to explain trade relations between nation-states. Writing in 1817, Ricardo articulated a theory of comparative advantage that justified why countries should eliminate governmental barriers to trade. Countries should instead engage in free trade, even if one trading partner is more productive and technologically advanced than the other. Thus both Adam Smith and David Ricardo promoted *laissez-faire* or "leave us alone" capitalism that emphasizes free markets devoid of government interference.

Herbert Spencer wanted to develop a political theory to complement *laissez-faire* economic theories. Spencer borrowed from Darwin's theory of evolution, based as it was on biological competition, to argue that society was a competition between individuals for scarce resources such as income and political power. As in any competition, there is going to be winners and losers. Society should accept social inequality as a natural outcome of a process he was the first to describe as "the survival of the fittest."

By framing social inequality as a natural process, Spencer could use the scientific trappings of Darwinism to argue against government intervention to help society. The implication is that people succeed or fail entirely because of their own hard work or personal failings. Congenital infirmity, gender, or class origins can be conveniently overlooked as factors contributing to one's social status. This rhetoric ultimately served to maintain the status quo conditions of social inequality expressed through class, gender and racial divisions. The rhetoric of "naturalized" competition between individuals was extended to explain success and failure in the business world. Industrialist John D. Rockefeller cited "survival of the fittest" to explain the economic success of Standard Oil during the Gilded Age of late 19th century America.

IMPORTANCE OF GEOGRAPHY

Environmental Determinism can be simply defined as the territorial manifestation of social Darwinism. Herbert Spencer made the biological analogy that society is a living organism governed by natural laws. Friedrich Ratzel went one step further to argue in his 1897 book *Political Geography* that nation-states were analogous to living organisms. Like any organism, a healthy nation-state could expect its population to grow as long as it had access to adequate natural resources and room to expand. When territorial or resource limits are reached, Ratzel argued that a country must expand its *lebensraum,* or "living space," to survive. The finite supply of land means that countries must compete with each other for territorial supremacy. As with any competition, there will inevitably be winners and losers, with "higher forms of civilization [expanding] at the expense of the other."

Ratzel echoes Spencer to imply that when one country expands at the expense of another, it is nothing more than a spatial expression of "survival of the fittest." Territorial realignments resulting from interstate rivalries and wars are "environmentally determined" by natural laws akin to natural selection.

Environmental determinism is geopolitically significant because it allowed Europeans to justify colonial and imperial land grabs as merely being the outcome of objective natural laws. This excused them from viewing colonialism and imperialism through the moral lens of Judeo-Christian values. Instead, they could see their actions through the amoral lens of the marketplace, where natural or environment laws determine social and regional inequalities. From this perspective, the question of why some countries are rich while others are very poor is beside the point because inequalities result from natural laws.

SEE ALSO: Capitalism; Darwin, Charles; Evolution.

BIBLIOGRAPHY. John Agnew, David Livingstone and Alisdair Rogers, *Human Geography: An Essential Anthology* (Blackwell Books, 1999); James Blaut, *The Colonizer's Model of the World* (Guilford Press, 1992); Jared Diamond, *Guns, Germs, and Steel: The Fates of Human Societies* (Norton, 1997); Richard Hofstader, *Social Darwinism in American Thought* (Beacon Press, 1992); David Landes, *The Wealth and Poverty of Nations: Why Some Are so Rich and Some Are so Poor* (Norton, 1999); David Livingstone, *The Geographical Tradition: Episodes in the History of a Contested Enterprise*. (Blackwell, 1992); Louis Menand, *The Metaphysical Club: A Story of Ideas in America* (Farrar, Straus, Giroux, 2001); Christopher Merrett, "Debating Destiny: Nihilism or Hope in *Guns, Germs, and Steel*," *Antipode* (35 (4)); Kevin Phillips, *The Politics of Rich and Poor: Wealth and the American Electorate in the Reagan Aftermath* (Harper Perennial, 1999); Robert Putnam, *Bowling Alone: The Collapse and Revival of American Community* (Simon and Schuster, 2000); U.S. Census 2006, International Programs Center, International Database (IDB), IDB Aggregation–Table 010, www.census.gov. (cited May 2006).

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Environmental Impact Statements (EIS)

ENVIRONMENTAL IMPACT STATEMENTS (EIS) are written, multidisciplinary scientific-technical reports whose goal is to predict and evaluate the environmental effects of a proposed project. EIS allows to compare the state of the environment *with and without* the project in order evaluate the changes that would happen in a certain location if the project was carried out. In such studies often the term *environment* is used to refer to *both* the physical-natural system and the social-economic-cultural one.

EIS are decision-making tools to be used by resource managers, land planners and many other elected officials and appointed staff whose mission is to take care of the environment and their elector's quality of life as well as lead the sustainable development process of nations worldwide.

Since the appearance of the Green Revolution in the 1970s, the ecologist movements and the concepts of conservation and sustainable development as key issues in most parts of the western world, EIS have become one of the most efficient and necessary tools to achieve sustainable development goals, as established by the United Nations Conference on Environment and Development (Earth Summit), held in Rio de Janeiro in 1992.

APPLYING AN EIS

EIS come into the scene whenever a new project appears, either if this project has a large scale, for instance the construction of hydroelectric plants or mining projects, or if it has a more punctual scale (construction of buildings, landfills, pulp mill, petrochemical or any other type of industrial plants). When the investor (whether a private company, the State or a single individual) decides to go on a project, in most countries legal framework requires that he first prepares and then presents an EIS to the government planning office as a way of controlling what kind of impacts are going to occur on the environment.

An EIS document's common structure is composed of the following items: an executive summary, project description and alternatives, legal framework, environmental diagnosis or baseline, environmental impacts, mitigation measures, environmental management plan (emp), closure plan, organizations consulted and bibliography, and conclusions and recommendations.

The executive summary provides a summary of the main results of the study, that is, the major impacts the project would provoke as it is proposed, the mitigation measures proposed by the group that elaborated the EIS, the cost of such measures, and the improvements their implementation would provoke in the environment.

The project description includes all the data relevant to the construction and operation activities, with all investments costs, the workforce involved and the facilities description. The project alternatives are critical: they show the different locations considered for the project, the different technologies evaluated, the different transportation routes considered and the best one selected.

The legal framework must include regulations at all jurisdictional levels related to the impacts the project could provoke. For instance, in a petrochemical plant the EIS must consider the hazardous wastes local regulations and soil and quality regulations.

The environmental baseline must include both the up-to-date description of the socio-economic (economy, employment, education, health, transport, infrastructure, services, housing, poverty) and physical-natural (natural resources, biology, fauna, flora, geology, hydrogeology, air, soil and water quality) aspects of the place where the project will be developed. The idea is having the best description of the area involved in a zero moment, before the project is carried out, so as to evaluate how would the project change such area.

The environmental impacts section must provide a detailed prediction of both positive and negative impacts the project will cause, often being showed in a matrix (the most known models are Leopold's and Batelle's ones). Then, mitigation or remediation measures are proposed to diminish the negative impacts. Also measures to encourage positive aspects should be proposed. The EMP includes those measures and also monitoring plans so that the authority can keep a control during the whole lifetime of the project. The closure plan is performed in order to assure that once the project has finished, for instance a mining one, all the facilities used for it will not be abandoned but instead will receive the necessary treatment to avoid pollution of the environment's resources.

EIS are not reports done on the desk and then delivered. They often require considerable fieldwork for technicians, public consultation with local residents of the area affected to know their points of view and concerns—a process that can last months or years, all depending on the scale of the project and the public disputes that arise. That is because EIS are often very controversial as the conclusion and evaluation of impacts are not "objective," but rather have a bias toward the interest of one of the parts.

These kinds of studies receive different names worldwide, but they all refer to the same thing and have similar goals. For instance, the United States version is the Environmental Impact Statement (EIS), while in England, they are called Environmental Impact Assessment (EIA). Moreover, even within the United States there are different names for it; for instance in California, they name it Environmental Impact Report (EIR).

EIS are a legal requirement in many countries before any project is carried out. For instance, in the United States and according to the National Environmental Policy Act (NEPA), whenever the Federal government or any private company takes a "major Federal action significantly affecting the quality of the human environment," it must first consider the environmental impact in an EIS document. Although EIS are mostly performed by consultation companies, they are also conducted by universities and public research centers, which makes such studies more reliable and accountable for the public as the profit is not the sole engine of their motivation.

SEE ALSO: Environmental Accounting; Green Revolution, National Environmental Policy Act (NEPA).

BIBLIOGRAPHY. Jacob I Bregman & Kenneth Marsh Mackenthun, *Environmental Impact Statements* (Lewis Publishers, 1992); Charles H. Eccleston, *Environmental Impact Statements: a Comprehensive Guide to Project and Strategic Planning* (John Wiley & Sons, 2000); Diori L. Kreske, *Environmental Impact Statements: a Practical Guide for Agencies, Citizens, and Consultants* (John Wiley & Sons, 1996); Emmett Burris Moore, *The Environmental Impact Statement Process and Environmental Law* (Battelle Press, 2000); James A. Roberts, *Just What is EIR?* (Global Environmental Management Services, 1991); U.S. Environmental Protection Agency (EPA), National Environmental Policy Act (NEPA) www.epa.gov (cited April 2006).

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Environmental Organizations

THE MANCHESTER ASSOCIATION for the Prevention of Smoke may be the earliest environmental organization on record. Yet the group's establishment in 1843 precedes the modern application of the term *environmental* by much more than a century. Despite the lack of such an overarching category during that formative time, the United Kingdom would lay claim to a number of other local and national environmental groups in the subsequent decades of the 19th century, including the Commons, Open Spaces and Footpaths Preservation Society (1865) as well as the short-lived colonial Natal Game Protection Association (1883). The only other country to substantially contribute to this new phenomenon during this time period was the United States. There were some tentative initial steps, including an unsuccessful first attempt at establishing an Audubon Society (1886–89), as well as the 1887 establishment of the Boone and Crockett Club by Theodore Roosevelt and his patrician colleagues (more of a club than an environmental group). The "archetypal" environmental group would appear nearly a decade before the century ran out: the Sierra Club.

In 1890, conservationist John Muir celebrated the designation of Yosemite as the first national park. During the campaign, the idea of establishing a promotional organization had been considered, but the idea would not reach fruition until 1892. That year, with Muir at its helm, the Sierra Club was established with the tripartite mission of fostering enjoyment of the outdoors, providing information about the Pacific Coast's mountain regions, and advocating for their protection. Over the course of the 20th century, the Sierra Club would come to be mostly associated with the latter conservation mission—albeit with a far greater geographic encompassment than the mountain ranges of California.

Since those early initiatives, the number of environmental organizations has expanded dramatically, particularly during and after the birth of the new environmentalism in the 1960s. One assessment found approximately 10,000 environmental organizations in 1990 in the United States alone. Extrapolating how many environmental organizations work at an international level is also daunting, and it is worthy of note that whereas approximately 1,400 nongovernmental organizations (NGOs) were accredited to attend the 1992 Earth Summit in Rio de Janeiro, 20 years later over 3,200 organizations attended the 2002 World Summit on Sustainable Development in Johannesburg, South Africa. However, these NGOs were not necessarily environmental organizations.

A WIDE VARIETY

Environmental organizations range from small neighborhood groups with a handful of members and no budget, to international bureaucracies with membership in the millions and budgets in the tens of millions of dollars. One of the few well-known examples of a smaller environmental organization is the Love Canal Homeowners Association, created in 1978 by Lois Gibbs in response to health problems arising from a toxic waste dump that had been converted into a housing and school development in Niagara Falls, New York. The group's efforts would lead to a federal home buyout of the area, as well as passage of one of the most significant U.S. environmental laws since the early 1970s. In regard to the larger environmental organizations, perhaps most emblematic were the members of the Group of Ten, a now defunct coalition of large and relatively well-funded national environmental organizations—most of them based in Washington, D.C.—that ranged from the National Parks and Conservation Association and the Wilderness Society to the Natural Resources Defense Council and the Environmental Defense Fund (now Environmental Defense).

Despite their tremendous diversity on so many fronts, environmental groups are typically separated into one of two camps in terms of their general focus. On the one hand are the "brown" organizations that focus primarily on human health issues; on the other are the "green" organizations that focus on issues relating to biodiversity conservation.

Many chafe at this distinction, and countless organizations explicitly emphasize the critical and inextricable ties between humanity and biodiversity. Nonetheless, the strategic focus of most groups can still be tied to one or the other of these two categories.

FROM RADICAL TO MAINSTREAM

Environmental organizations' missions, goals, and strategies range from radical to mainstream. From a vantage point based on these polar opposites, social theorists have identified two divergent strategic approaches adopted by agenda-driven organizations emanating out of civil society. On the one hand, organizations can adopt a "fundamentalist, expressive" approach that directly protests the practices and ideology of the dominant authority—whether that authority consists of a particular government or, more broadly, generally held beliefs and values embedded throughout society. On the other hand, they can take a "pragmatic, instrumental" approach that attempts to change authoritative societal structures (including those widely held beliefs and values) from within the system.

But environmental groups use a wide variety of tactics that span the reality lying between these two nonexclusive strategies: Identifying, framing, advocating, and lobbying on particular environmental issues; building constituencies over environmental issues; mobilizing public opinion through the use of media and grassroots channels; influencing planning by government agencies and citizen groups; engaging in innovative problem solving; gathering information and consulting on scientific issues; conducting independent monitoring and reporting on environmental conditions and initiatives; seeking legal recourse for environmental protection through the judicial system; implementing new policies; organizing boycotts, public protests, and demonstrations, and conducting civil disobedience; and building coalitions with other environmental groups and with other sectors of civil society.

These tactics have been applied in domestic and international arenas. In the latter arena, environmental organizations have added a number of additional tactics that include: lobbying governments to enter into environmental conventions, monitoring the enforcement of conventions, democratizing international negotiations over environmental issues, directly protecting valuable habitats, and educating domestic public audiences on the need for international environmental protection.

Although such international approaches are often traced to the 1972 Stockholm Conference on the Human Environment, environmental organizations have been working at an international level since at least the dawn of the 20th century. Many of them have been explicitly created for just such purposes. Two early examples are the North American Fish and Game Protective Association, which held its first meeting in 1900 in Montreal, and the 1903 establishment of the Society for the Preservation of the Wild Fauna of the Empire in the United Kingdom (now Flora & Fauna International). In the United States, environmental organizations became more active in international issues during the 1970s when they started building alliances with groups from other countries, particularly as the links between international economic and political forces were becoming more obvious in light of environmental problems such as ozone depletion, climate change, and tropical deforestation. Two of the largest U.S. environmental organizations focusing on international work are Conservation International and the World Wildlife Fund.

FROM A DUBIOUS HISTORY

In reviewing the historical development of environmental organizations over the last few decades, the noted biologist Edward O. Wilson recalled that the role of environmental organizations "was basically that of evangelists and beggars" when he joined the global conservation movement in the early 1970s. By the 1990s, however, "the major global NGOs had grown strong enough to initiate direct action on their own toward the salvaging of forests and other threatened natural environments." With large memberships, articulate voices, and political acumen, environmental groups have attained an anticipated and well-respected voice in domestic and international debates over environmental policy. Environmental groups have created a "world civic politics" within which they act as the principal intermediary "agents of change" for individuals and governments.

GROWTH AND EFFECT

This literature remains rife with debate over exactly how effective environmental organizations have been in changing the course of international environmental affairs. Yet the debate is largely over degree, and only a few observers from the realist camp of international relations would contend that environmental organizations have had a negligible effect. This is particularly the case in light of the growing number of environmental transnational advocacy networks (TANs) that address: broad global issues such as ozone depletion or climate change; project-specific environmental controversies, many of them associated with World Bank financing for large development projects such as dams; and environmental issues across transborder regions, such as ongoing deforestation in the nine-country Amazon Basin or the loss of large carnivores in the Yellowstone to Yukon region of Canada and the United States. Although some researchers have argued that participation of environmental organizations in such networks represent little more than extensions of domestic policy concerns, rather than a fundamental concern over international environmental protection per se, the number and size of these networks have blossomed in the past two decades.

At the same time that many credit environmental organizations for achieving environmental protection, there are many barriers that limit their effectiveness. Principal among these are a perpetual dearth of financial resources and a recurrent unwillingness to coordinate their efforts amongst each other (despite the existence of TANs).

Wavering public support for environmental organizations also remains a challenge; at least in the United States, membership in environmental organizations has fluctuated largely in response to broad governmental policies on the environment. For example, membership declined during the pro-environment years of the Carter administration, but grew substantially during the Reagan administration, which was widely seen as hostile to environmental policies.

In addition to these barriers, critics of environmental organizations have arisen on the political left and right. For different reasons, both ends of the political spectrum have expressed concern over the cooptation of environmental groups by either governments or corporate actors. And as with organizations rooted in other social movements, many environmental organizations have followed a classic pattern in which they originally coalesce as volunteer-driven assemblages of like-minded people, but over time inevitably transform into bureaucratic and professionally staffed interest groups. Given the rapid growth in this professionalization of the environmental movement, it is not surprising that some have criticized the large annual salaries that have been granted to many of the leaders of large environmental organizations. In addition, many environmental organizations spend large portions of their budgets on fundraising and either own or rent expensive office spaces—the costs of which, critics argue, do not justify their benefits.

TANs have addressed many international issues, such as the loss of large carnivores in transborder regions.

LACK OF DIVERSITY

Lack of racial and gender diversity has also been seen as a problematic characteristic of most environmental organizations. It was not until 2005 that the first African American was hired as an executive director of a large U.S.-based environmental organization (the National Wildlife Foundation, est. 1936). This stereotype is somewhat belied by the growing number of groups under the aegis of the environmental justice movement, one count holding their number in the United States at over 7,000. Because of their roots in both the civil rights and environmental movements, these smaller organizations have arguably been more effective than the larger organizations in protecting urban and poverty-stricken populations from environmental threats. Yet despite the stated willingness of the larger U.S. environmental organizations to adopt an environmental justice agenda, critics still see a wide divide between these newer groups and the old guard.

No small number of friends and foe alike have denounced the practice of shrill doom and gloom mass mailings from environmental organizations—mailings that not only consume resources, but that allegedly rely on incomplete, exaggerated, and/or inaccurate information in an attempt to scare potential donors into writing checks. The focus on recruiting new members through mass mailings has also been associated with a decline in the social capita that only comes with engaged participation in environmental activities. As social critic Robert Putnam has put it, this type of approach provides "neither connectedness among members nor direct engagement in civic give-and-take, and they certainly do not represent 'participatory democracy.'" Citizenship by proxy is an oxymoron."

Although Putnam is careful to note that such practices are not necessarily immoral, other critics have expressed strong reservations about the growing influence of environmental organizations as a potentially antidemocratic form of institutional exclusivity. At the other end of the political spectrum, a number of critics more friendly to an environmental agenda believe that such antidemocratic tendencies are manifested in the lackluster performance of environmental organizations in drawing attention to electoral politics—or to be more exact, in getting out the vote for the environment. With a few exceptions such as the Sierra Club and the League of Conservation Voters, the critics argue, most large U.S. environmental organizations have been overtly apolitical largely in order to maintain a noncontroversial reputation for purposes of fundraising appeal. Accordingly, some recent research has indicated that environmental legislation is more associated with grassroots protests than with the activities of environmental groups per se. Overall, a common refrain in the United States holds that the larger environmental organizations have lost touch with the grassroots—and that this loss of connection to a wider audience has dramatic consequences, including the purported death of environmentalism.

INTERNATIONAL CONCERNS

Many of these domestic concerns are reflected internationally, but with the added complexities of defining sovereign control over natural resources, and the role of foreign environmental organizations in exerting undue influence over domestic policy-making. Most notably, Western environmental organizations working in Africa have been accused of participating in the continent's history of paternalistic European treatment of wildlife resources. Whereas the early colonial power structures simply marked off territory as game reserves and banned native peoples from subsistence hunting, but not wealthy Caucasians from trophy hunting, critics accuse contemporary environmental organizations of attempting to impose conservationist policies without full local input in how those policies are determined and implemented.

Similar claims have been made in regard to how international environmental organizations operate in Asia and Latin America, and Western green aid to eastern Europe has also had reportedly mixed effects. In Russia, for example, the number and visibility of environmental groups have been much strengthened through foreign aid since the demise of the Soviet Union, but apparently it has not been met with a concomitant rise in either public interest in environmental issues or, most importantly, in the actual protection of the environment.

The wide range of interests, capabilities, and perspectives between different environmental organizations makes it difficult to generalize about the phenomenon. At the most critical end of the spectrum, environmental organizations serve as mere institutional flourish draped over the power and influence of power-hungry individuals. This is an extreme point of view, but environmental organizations are nonetheless human institutions. From the other end of the spectrum, the critics can be reasonably accused of neglecting the broad practical implications of institutional persistence and legitimacy that has been achieved through the growth and maturity of environmental organizations worldwide. The rise of environmental groups over the course of the 20th century has mirrored and led the growing importance of civil society in domestic and world affairs—and so while numerous NGOs can be found in other issue arenas such as human rights and labor, their rise to influence has perhaps been most notable in the environmental sector.

SEE ALSO: Institutions; Long Term Ecological Research Network (LTER); Movements, Environmental; Non-Governmental Organizations (NGOs); Policy, Environmental; United Nations Environment Program (UNEP); World Conservation Union (IUCN); World Wildlife Fund; Worldwatch Institute.

BIBLIOGRAPHY: Mark Dowie, *Losing Ground: American Environmentalism at the Close of the Twentieth Century* (MIT Press, 1995); R.E. Dunlap and A.G. Mertig, *American Environmentalism: The U.S. Environmental Movement, 1970–1990* (Taylor & Francis, 1992); J.A. Fox and L.D. Brown, *The Struggle for Accountability: The World Bank, NGOs, and Grassroots Movements* (MIT Press, 1998); M.E. Keck and Kathryn Sikkink, *Activists Beyond Borders: Advocacy Networks in International Politics* (Cornell University Press, 1998); Thomas Princen and Matthias Finger, *Environmental NGOs in World Politics* (Routlege, 1994); R.D. Putnam, *Bowling Alone: The Collapse and Revival of American Community* (Simon & Schuster, 2000); Michael Shellenberger and Ted Nordhaus, *The Death of Environmentalism* (Grist, 2005); E.O. Wilson, *The Future of Life* (Alfred A. Knopf, 2002).

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Environmental Protection Agency

THE U.S. ENVIRONMENTAL Protection Agency (EPA) was established under President Nixon's Reorganization Act 3 of 1970. The creation of the EPA was part of a sweeping transformation of American environmental regulation that is often credited to the social movements that evolved around growing public and scientific awareness of environmental crises. The publication of *Silent Spring*, the burning of the Cuyahoga River in Ohio, and the Santa Barbara oil spill are often cited as significant events, which crystallized mainstream opinion around the need for a strong federal regulatory hand in ensuring environmental quality.

Strong federal environmental roles were minted in landmark laws such as the National Environmental Policy Act (1969), the Clean Air Act (1970), the Clean Water Act (1972), and the Endangered Species Act (1973). The EPA was created as an independent agency to administer many of these laws: few believed that the Department of Commerce, for example, could fairly and firmly regulate polluting industries that it was simultaneously promoting and protecting through trade policy.

Another narrative concerning the federalization of environmental regulation puts less stress on the achievements of environmental social movements, pointing to the fact that these movements were still nascent—and drowned out by antiwar and other social movements—at the time of these laws' passage and the EPA's founding. Regulated energy industries, which faced a welter of individual state-level regulations, also called for federal environmental regulation. These industries felt that the best long-term strategy would be to use their established influence with politicians, like Senator Edwin Muskie, to proactively shape the environmental debate and the ultimate form of federal environmental regulation. This would give regulated industries a single target, rather than 50 different targets, when attempting to influence environmental regulation. It has also been suggested that the founding of the EPA was the result of competition between President Nixon and Democrat senators with their eyes on the 1972 presidential election, over who would be perceived as "more environmentalist." Because no political benchmarks concerning environmentalism existed, Nixon and his competitors continued to try and out-do each other.

MAJOR TASKS

The EPA is charged with executing many of the major environmental laws and programs including (but not limited to) the Clean Air Act, the Clean Water Act, the Ocean Dumping Act, the Comprehensive Environmental Response Compensation and Liability Act (CERCLA—also known as "Superfund"), the Resource Conservation and Recovery Act, the Toxic Substances Control Act, the Federal Insecticide, Fungicide and Rodenticide Act, the Safe Drinking Water Act, the Emergency Preparedness and Community Right-to-Know Act, and the Solid Waste Disposal Act. Although executing many of these laws entails regulatory duties and the ability to ensure compliance and pursue enforcement, the EPA has also developed broad nonregulatory programs in education, information provision, and the delivery of federal money to state, tribal, and local environmental programs. As the political enthusiasm for environmental enforcement has waned with the growth of the Wise Use and Sagebrush Rebellion movements, the EPA's regulatory and enforcement activities have been deemphasized at the expense of such grants and voluntary programs. The administration of the Toxic Release Inventory, which provides information to the public on sources of toxins in their locales, and the $15 million in grants given each year to develop state-level wetland protection programs, are popular examples of nonregulatory EPA programs.

The EPA was pieced together largely through the transfer of staff and existing programs from other areas of the executive branch, such as the Departments of Health, Education, and Welfare (which had regulated air pollution, water hygiene and solid waste), and the Food and Drug Administration (which had regulated pesticides). From the beginning, the EPA was divided organizationally into six areas: air, water, toxics, solid waste, research and development, and enforcement. The current organizational structure still reflects indecision as to whether to organize by medium (air and water) or by regulated substance (solid waste and toxins).

Each of the 12 headquarters offices and 10 regions are headed by a politically appointed assistant administrator, with one politically appointed deputy and one career deputy. The EPA is thus rather thickly invested with political appointees relative to its size. This is perhaps because many of the environmental laws it executes are potentially quite powerful and disruptive to the economy and industry. The deep penetration of political appointees ensures that agency actions are considered in the light of (and often constrained by) political policy considerations. The fact that policy decisions are made at the headquarters level under relatively close political supervision has produced an enduring tension between the regions (often staffed by career environmental scientists) and headquarters (where staff are largely lawyers and policy specialists).

The influence of political decisions was evident in the notorious incident in which President Reagan's appointed EPA administrator, Anne Burford, was charged with contempt of Congress. She and many other EPA appointees resigned after refusing to provide a congressional investigation with documentation relevant to potential conflicts of interest in administration of the Superfund toxic cleanup program. Although the respected first administrator, William Ruckleshaus, was brought back to the post in an attempt to restore the reputation of the agency, the Burford legacy has persisted as a deep cynicism among environmentalists concerning the political nature of EPA regulatory activities. Staff members, often sympathetic to environmental causes, have occasionally leaked sensitive documents to journalists or environmental nonprofits, and the regional staff has an often-contentious relationship with the headquarters management in Washington. In both Democrat and Republican administrations, it has been common for the EPA to use its regulatory and enforcement powers only lightly or selectively, often waiting until a lawsuit from an environmental advocacy organization forces it into more direct compliance with its regulatory mandates.

The EPA is a standalone federal agency, unaffiliated with any department, and this isolated institutional position has been both a strength and a challenge. On the one hand, it is beholden to no constituency in the way that the Department of Commerce must both serve and regulate industry, or that the Department of the Interior must both serve and regulate resource extraction. However, within the hierarchy of the executive branch, the EPA's lack of affiliation and lack of powerful civil-society constituents puts it at a disadvantage in budget and allocation decisions.

The EPA is a popular target for cuts and lacks private-sector interests who will argue for Congressional augmentation of a spare White House proposed budget. However, as its regulatory duties have been muted in recent administrations, its role as a distributor of federal money to state environmental programs has grown, and the EPA has used its alliances outside the federal government to aid its political position within the executive branch. Nonetheless, the institutional culture of the EPA is one of caution, consultation, and networking: rapid unilateral or aggressive action is the exception. This is arguably inimical to the goal of achieving the dramatic environmental improvements sought in the laws the agency executes.

SEE ALSO: Environmentalism; Management, Environmental; Policy, Environmental.

BIBLIOGRAPHY. Tristan Boyer Boyer Binns, *EPA: Environmental Protection Agency* (Heinemann, 2002); Robert W. Collin, *The Environmental Protection Agency: Cleaning up America's Act* (Greenwood Publishing Group, 2005); Environmental Protection Agency website, www.epa.gov (cited February 2007).

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Environmental Racism

ENVIRONMENTAL RACISM IS intentional or unintentional racial discrimination in environmental decision-making, systematic exclusion of people of color from the mainstream environmental movement, negligent enforcement of environmental protections, laws and regulations along racial lines, and disproportionate distribution of environmental burdens on racial and ethnic minorities where they live, work, and play.

Environmental racism has been endemic throughout U.S. history as a parallel story deeply rooted in the ideological constructions of race, nature, and society. Environmental racism can be traced to colonial dispossession of Native American homelands to their expulsion from national parks and wilderness areas for the benefit of 19th century white, middle-class tourists and environmentalists, such as John Muir. For the African-American community, slavery's expropriation of environmental knowledge, reconstruction-era land loss, and consequent rural exodus to segregated urban centers, forcibly reconfiguring the community's relationship to the natural world. In the 20th century, racial and ethnic minorities have faced increasing environmental hazards as they represent large percentages of the urban working class exposed to the toxic threats of industrial society in the workplace to neighborhoods yet excluded from the mainstream environmental movement.

Within these larger trends in American history, key moments further refined the meaning of environmental racism as part of the contemporary movement for environmental justice. In the 1960s and 1970s, the United Farm Workers' Union (UFW), led by César Chávez, mobilized the first labor movement to address an environmental injustice—the hazards of pesticide exposure of Latinos and Filipinos in the fields of California. By the early 1970s and early 1980s, waste-facility siting controversies rose to national attention as the Love Canal incident transformed the question industrial contamination and toxics into a political issue. But in 1982, popular protest and mobilization against the planned hazardous waste dump for 40 thousand cubic yards of polychlorinated biphenyls (PCB)-contaminated soil in Warren County, a predominantly African-American community in North Carolina, is widely viewed the transformative event in the environmental justice movement.

During the Warren County struggle over the planned waste dump, church activists and the nationally recognized civil rights leader Reverend Dr. Benjamin F. Chavis, Jr. drew widespread attention to the unequal burden of African Americans to hazardous waste storage sites and the community's marginalization in environmental decision-making. As a direct result of grassroots mobilization in Warren County, Dr. Chavis commissioned the United Church of Christ Commission on Racial Justice (UCCCRJ) to examine race and location of toxic waste sites. The groundbreaking report *Toxic Waste and Race in the United States* (UCCCRJ 1987) was the first national study to document the strong correlation between race and hazardous landfill locations at a national level. Moreover, Dr. Chavis first articulated the term *environmental racism* for a national audience during the presentation of the UCCCRJ report at the National Press Club in Washington D. C.

EXPANDING THE SCOPE

Since the first use of the term *environmental racism* by Chavis, activists and scholars have expanded the meaning and scope of the term. Initially, "environmental racism" only addressed explicit racist acts in hazardous wastes storage unit locations and the consequent distributive inequities of environmental burdens and toxic exposures. Over the past decade, the grassroots environmental justice movement and academic community, to a lesser degree, have expanded the application of "environmental racism" to include institutional discrimination in decision-making process and procedure of environmental policy making. In 1991, grassroots activists led the First National People of Color Environmental Leadership Summit. The Summit resulted in the acceptance of 17 Principles of Environmental Justice that expanded claims of communities of color to participate as equal partners in environmental planning, policy implementation, and enforcement. Moreover, the Summit broadened the scope of environmental justice to include concerns from all vulnerable groups—such as women, children, and the poor.

Social science has explored environmental racism in research since the early 1990s, marked by the seminal publication of Robert Bullard's *Dumping in Dixie* (1990). Drawing from strong quantitative and geospatial approaches, social scientists have attempted to "prove" statistically racial discrimination. However, critics have strongly underscored the "racial pitfalls" of highly empiricist approaches that assume racism and discrimination are discrete, overt acts or social artifacts that can be measured through quantitative analysis. Critics argue that this position belies any attempt to examine racism as an ideology operating in a particular political economic system. Recent academic study and mobilization against environmental racism has begun to address how environmental racism operates at the global scale, paying particular attention to toxic trading, global electronics industry, and climate change.

SEE ALSO: Justice; Bullard, Robert; Native Americans.

BIBLIOGRAPHY. W. Bowen, "An Analytical Review of Environmental Justice Research: What Do We Really Know?" *Environmental Management* (v.29, 2002); R. Bullard, *Dumping in Dixie: Race, Class and Environmental Quality* (Westview Press, 1990); C. Merchant, "Shades of Darkness: Race and Environmental History," *Environmental History* (v.8, 2003); D.N. Pellow, *Garbage Wars: The Struggle for Environmental Justice in Chicago* (MIT Press, 2004); L. Pulido, *Environmentalism and Economic Justice: Two Chicano Struggles in the Southwest* (University of Arizona Press, 1996); L. Pulido, "A Critical Review of the Methodology of Environmental Racism Research," *Antipode* (v.28, 1996); United Church of Christ Commission on Racial Justice, *Toxic Waste and Race in the United States: A National Report on the Racial and Socio-Economic Characteristics of Communities with Hazardous Waste Sites* (United Church of Christ Commission on Racial Justice, 1987).

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Environmental Refugees

Since this term first appeared in the mid–1970s, discussions have focused around three broad concerns that are raised by the phenomenon. These are: what are environmental refugees, what are the causes of their plight, and how might these causes be removed, or reduced in impact?

First, in terms of definitions, it is important to recognize that the term *environmental refugee* (or *ecological refugee*) is not a legal designation. The 1951 International Convention on the Status of Refugees defines *refugees* in strictly political terms. According to that Convention, a *refugee* is an individual who has fled his or her country because they fear persecution on the grounds of their race, religion, nationality, political beliefs, or membership in a social group. Such a definition is one that highlights the erosion of civil and political rights of the individual; it pays no heed to their economic or environmental rights, nor to the circumstances that might lead to a deterioration of those rights.

Since the integrity of a region's environment or the viability of the local economy are as important in any individual's ability to maintain their quality of life, however, many critics have come to argue that the definition of *refugees* should be expanded to include *environmental refugees*—defined as individuals who are obliged to flee their homelands because deterioration in their local environment has made it dangerous, unhealthy, or impossible for them to continue to support themselves and their family in that region.

Critics of the term have pointed to many problems with such a definition. Are only natural calamities to be considered (such as volcanic eruptions) or are human-induced environmental disasters to be included (such as the Chernobyl nuclear power plant disaster in Ukraine)? Is the time scale of the event relevant to claims of refugee status—for example, is the slow salinization of soils any less relevant than the effects of a massive tsunami? Is permanent displacement required or are temporary movements of concern as well? Some scholars even debate whether the term *environmental migrant* might not be a more useful term to use as the term *environmental refugee* is so imprecise, and devoid of rights under international treaty.

Political opposition and the fear of being inundated with an ever-expanding number of migrants makes it highly unlikely that the 1951 Convention can ever be amended to include the category of "environmental refugees." However, this lack of legal meaning need not detract from the general usefulness of the concept as it places their plight firmly on the agendas of policymakers and researchers.

At an international level, the interconnectedness of the global environment means that the plight of environmental refugees is ultimately part of everyone's concern, and—as a corollary—whatever action occurs to protect the global environment will also help ease their situation. Therefore, treaties to mitigate the consequences of global warming not only alleviate the toll on the earth's entire ecosystem, but also enable local environments to support individual populations. Through such agreements, the predicted flooding of the Maldives and several small Polynesian island states by the middle of this century may yet be abated, and one of the most dramatic examples of future environmental refugee flows could be prevented.

The recent advances in human security and disaster research have been very useful to this discussion as they have clearly shown why environmental deterioration produces environmental refuges in certain circumstances but not in others. This growing body of work has shown how poverty is often the root cause of such movements. Richer communities are able to withstand repeated floods or crop losses; economically deprived or more "vulnerable" communities simply cannot and must seek alternatives elsewhere. Therefore, according to this approach, the root causes of many environmental refugee movements lie not only in the deterioration of the environment, but in the social and economic structures of the region's society and, in particular, in those institutions that create or sustain local poverty.

It follows from this research that any broad strategy to combat the plight of environmental refugees needs to focus on local economic development, and on the creation of community resilience, as much as it does on the more immediate consequences of environmental change.

SEE ALSO: Chernobyl Accident; Dust Bowl; Floods and Flood Control.

BIBLIOGRAPHY. D.C. Bates, "Environmental Refugees? Classifying Human Migrations Caused by Environmental Change," *Population and Environment* (v.23, 2002); Richard Black, "New Issues in Refugee Research: Environmental Refugees–Myth or Reality?" www.unhcr.ch (cited January, 2006); E. El-Hinnawi, *Environmental Refugees* (United Nations Environment Program, 1985); Thomas Homer-Dixon and Jessica Blitt, *Ecoviolence: Links Among Environment, Population and Security* (Rowman and Littlefield, 1998); Norman Myers, "Environmental Refugees: A Growing Phenomenon of the 21st Century," *Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences* (v.357, 2002); Alan Nash, "Environmental Refugees: Consequences and Policies From a Western Perspective," *Discrete Dynamics in Nature and Society* (v.3, 1999).

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Environmental Services

ENVIRONMENTAL SERVICES HAS become a central concept in environmental management. Environmental services are functions of ecosystems that are valuable to society. They include carbon storage by vegetation, water, and soil; water filtration and flood control by wetlands and upstream slopes; the provision of wildlife habitats, genetic diversity, scenic beauty, and recreational opportunities by forests and other ecosystems; and the production of useful materials. *Ecosystem services* is also used to describe these environmental services.

For many private, government, and international environmental agencies, conservation of environmental services is replacing protection of endangered species and wilderness as a policy focus. Ecosystem services is the central organizing idea in the 2005 Millennium Ecosystem Assessment. As a representation of scientific and policy consensus about the biosphere, the assessment is the successor to the influential 1987 Brandt Commission Report, *Our Common Future*.

The assessment warns that humans are overusing or undermining ecosystem services so much that we are "living on borrowed time," and defines four categories of ecosystem services: Provisioning services, such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services, such as soil formation, photosynthesis, and nutrient cycling.

The idea of environmental services promotes recognition of the myriad ways in which individuals, communities, and economies depend upon the "life-support functions" of ecosystems, both nearby and distant. It draws attention to the fact that most of these services remain external to economic calculations: they are provided at no monetary cost to those who depend upon them or profit from them. The measuring and mapping of ecosystem functions can help to clarify what will be lost or gained as a result of different land use decisions and conservation regulations. Environmental and ecological economists estimate the economic values of ecosystem functions so as to provide a more informed and rational basis for these social choices.

MARKETING OF SERVICES

Some carry this idea further, arguing that the world's natural environment can best be safeguarded by the privatization, monetary pricing, and market exchange of environmental services. The premise of this "conservation by commercialization" strategy is that it will foster more efficient resource use and the greatest conservation gains for the least cost. Environmental services markets are already established in industrialized countries. New, global green markets are being designed to link local ecosystem service providers with government agencies, nongovernment organizations, and private investors worldwide.

The such largest markets involve carbon emissions reduction credits. They permit the buyer, such as a power company, to continue emitting CO_2 or other greenhouse gasses into the atmosphere in excess of the amount allowed by law or promised by the company. The funds paid by the buyer of these credits, also called *offsets*, are meant to finance activities to reduce emissions by another firm or create new carbon sinks in another community or country. For example, they might fund a tree plantation in the tropics or pay landowners not to cut existing forests. Markets in offsets for damage to biodiversity and other ecosystem services are also being developed.

These markets are highly controversial. Their advocates of say they offer "triple-win" solutions for buyers, for sellers (such as the owners or stewards of forests), and for nature, with no significant sacrifices by anybody. Others maintain that, while the concept of ecosystem services is a useful aid to decision making, market prices cannot encompass the full values of nature or the different benefits of ecosystems to people who depend on them for survival and people who admire them from a distance. Even strong advocates of environmental services markets debate whether they can simultaneously foster conservation and "reward the poor," which is the stated goal of many international environmental services projects. Some critics contend that putting a monetary price on ecosystem services lays the groundwork for expropriating them from poorer people and weaker countries, enabling the world's wealthy to "own" and determine the fate of the planet's ecosystems.

In any case, the environmental services concept—particularly when linked to the idea that ecosystem functions should be commodified—is not epistemologically innocent. Environmental services trading requires new ways of representing nature, new methods of measuring nature's values, and new institutions to standardize and reproduce those representations and methods.

The increasing prominence of environmental services markets in the policies of governments and international agencies makes them an important frontier in the re-regulation of socionature. A critical question is: in whose interests will this re-regulation it be carried out?

SEE ALSO: Carbon Trading; Ecosystems; Environmental Accounting.

BIBLIOGRAPHY: Millennium Ecosystem Assessment, *Ecosystems and Human Well-being: Synthesis* (Island Press, 2005); Stephen C. Farber, Robert Costanza and Matthew A. Wilson 2002 "Economic and Ecological Concepts for Valuing Ecosystem Services" (*Ecological Economics* 41, 375-392, 2002); Sven Wunder, *Payments for Environmental Services: Some Nuts and Bolts* (Center for International Forestry Research, 2005); Natasha Landell-Mills and Ina T. Porras, *Silver Bullet or Fools' Gold? A Global Review of Markets for Forest Environmental Services and their Impact on the Poor* (International Institute for Environment and Development, 2002); Friends of the Earth International, *Nature for Sale: The Impacts of Privatizing Water and Biodiversity* (FOEI Amsterdam, 2005).

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Environmentalism

ENVIRONMENTALISM IS A social and political movement emerging in the mid-20th century in various Western countries like Germany, Sweden, and the United States. Environmentalism is not just a mere concept for the defense of the environment; rather, environmentalism argues that the protection of nature is more important than economic matters, industry, corporations, governments, and private interests. In other words, creating new jobs for a future nuclear power plant would be meaningless for environmentalists if it also brought pollution, hazardous waste, and industrial risks to a region. Therefore, environmentalism implies bringing environmental concern into a political sphere.

Environmentalism promotes environmental consciousness and cries for a social change on varied issues such as deforestation, desertification, global warming, greenhouse gases, nuclear hazards, and genetically modified organisms.

Some observers see environmentalism as a democratic mode of civic participation—*civic environmentalism*—while other scholars perceive it as an ideology with a coherent worldview, or even as a kind of religion, as argues environmental historian Thomas Dunlap in his 2005 book *Faith in Nature: Environmentalism as Religious Quest*.

Because it carries more values than just the respect of the protection of natural resources and land management, environmentalism is often linked with other ideologies or political movements not necessarily related with the environment, such as antiglobalization, anticapitalism, counterculture, and even anti-Americanism. As a consequence, corporations and their lobbyists who seek to legitimize industrialization are often the targets of environmentalists and social activists. On the other side, most groups that promote environmentalism usually emerge from civil society.

The main ideas of environmentalism—respect for nature, protection of wildlife, and green energy production—have historic roots that have been passed through the generations as many environmentalists advocate for the preservation of natural resources, even beyond their own life spans, for the benefit of future generations. Specifically, advocacy groups like the Sierra Club (founded in 1892 by John Muir), the World Wildlife Fund, Friends of the Earth, and Greenpeace are now global organizations using and adapting some of the strategies of public funding and advertising in order to bring their messages to a large public audience. These organizations use the media in various ways in attempt to influence public opinion on debated issues such as the defense of wildlife, global warming, and air and water quality.

In many cases, environmentalist movements are the result of a strong reaction to major events that are seen as a threat to health, wildlife, landscapes, or security. For example, when U.S. biologist Rachel Carson (1907–64) published her book *Silent Spring* in 1962, it created a whole movement against the use of DDT, a now illegal toxic insecticide that was ini-

Many environmentalists advocate for the preservation of natural resources for the benefit of future generations.

tially used to control mosquito populations in battle against malaria. Typically, average citizens are converted to environmental activists when they believe that their governments do not act in order to protect their land against pollution, or when they feel there is no one else who would care as much as they do about the future of nature. For instance, a large international network of environmental groups such as Friends of the Earth was founded in 1969 in the United States by David Brower to promote a fair use of nature. Similarly, Greenpeace was a pacifist organization created in 1971 to oppose the United States nuclear testing in the Pacific region.

IMPORTANT DISTINCTIONS

Environmentalism should not be confused with all environmental movements, since there are many degrees and perspectives. Other ecological movements, such as deep ecology and ecological radicalism, take a more radical perspective on the environment stating that the preservation of nonhuman nature is even more important than the interests of human beings, and therefore nature and wildlife must be protected and defended as such against abusive human activity. Because environmentalism carries a will to advocate a form of social change, it is not a synonym for environmental education, and it should also not be confused with sustainable development, which promotes industrialization in harmony with the environment.

Sociologist Steven Yearley, a leading expert on environmental issues, has explained that environmentalism can be interpreted either as a social construction or as a characteristic of anxiety over environmental risks in contemporary Western societies. Yearley also sees these networks of environmental groups and nongovernmental organizations (NGOs) as competitive with each other in their common quest for legitimate causes, new members, funding, and media exposure.

Because environmentalism opposes itself to official discourses from corporations and governments, the counter-discourses get a high level of credibility from their members, even about debated issues such as global warming. Most citizens are not scientists; therefore, their opinions do not rely on their own observations, measures, and evaluation of scientific data, but rather on their beliefs and sometimes the contradictory testimony of scientific experts. In that sense, environmentalism can be similar to an ideology that is in conflict with other ideologies in the public sphere.

Countless films related to environmentalism and similar issues have been produced. In recent decades, some documentary films have brought the ideas of environmentalism to a wide audience such as former U.S. Vice President Al Gore's 2006 film *An Inconvenient Truth*, which focused global warming. Also well known is Peter Watkins's 1987 film *The Journey*, which shows not only how the environmentalist movements work, but how many activists are perceived and often rejected by some members of the media in Canada, Scotland, Norway, Japan, Australia, and the United States.

SEE ALSO: Film, Representations of Nature in; Greenpeace; Non Governmental Organizations; World Wildlife Fund (WWF).

BIBLIOGRAPHY. *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It*, Directed by Davis Guggenheim with Albert Gore Jr., (Paramount Home Video, 2006); Rachel Carson, *Silent Spring* (Houghton Mifflin Company, 1962); Thomas R. Dunlap, *Faith in Nature: Environmentalism as Religious Quest* (University of Washington Press, 2005); Albert Gore Jr., *An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It* (Rodale Press, 2006); *The Journey*, Directed by Peter Watkins, Produced by Swedish Peace & Arbitration Society (SPAS and the National Film Board of Canada, (Facets Multimedia, 1987); Yves Laberge "Peter Watkins' *The Journey*," *Encyclopedia of Documentary Film*, ed. Ian Aitken (v.2, Routledge, 2006); Andy Reynolds, *A Brief History of Environmentalism* (Channel 4, September 2002), www.channel4.com (cited December 2006); United States Environmental Protection Agency, "From Ecology To Environmentalism," www.epa.gov (cited November 2006); Steven Yearley, "The Sociology of the Environment and Nature," *The SAGE Handbook of Sociology* (Sage Publications, 2005).

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Environmentality

ENVIRONMENTALITY IS A neologism (or newly invented word) devised to describe a novel set of political processes in and through which the environment is being governed and controlled. The types of political practice discerned within work on environmentality were first described in the pioneering work of Michel Foucault. In a series of lectures, partly given at the Collège de France between 1978–79 and later in the United States, Foucault outlined a history of the changing objectives and technologies associated with state power (or to use Foucault's term, *governmentality*).

GOVERNANCE OF EACH AND OF ALL

Within these lectures, Foucault revealed that the practices of governments were not universal or unchanging, but were marked by a shifting set of rationalities concerning what the purpose of states actually was. According to James Faubion, Foucault's account of governmentality was an attempt to explore the links between the government of the self and the government of a national population, or to put it another way, the governance *of each and of all*. At the heart of Foucault's history of state power was a desire to show how the reason, rationality, or *mentality* of government had shifted in the modern era from being one devoted to securing the sovereign power of a government over its territory, to one committed to establishing the *right disposition of things* in order to assure continued wealth, power, and prosperity. According to Foucault, securing the right disposition of things is most effectively achieved by governing the conduct of the individual while anticipating the needs and likely productivity of the whole of society. The key to both of these goals was an effective knowledge of the society to be governed and the deployment of disciplinary tactics to guide the activities of the population at an individual level. It was in this context that Foucault equated the practices of the modern state with "the head of a family over his household and his goods." Consequently, just as the head of a household knows and controls her/his family, the state knows and controls its population through the complex webs of surveillance and disciplinary tactics it deploys.

The notion of environmentality embodies an attempt to understand how this new mode of modern government applies to the political control and management of the environment. The word *environmentality* was first used by Timothy Luke and reflects a hybridized summation of Éric Darier's notion of *environmental governmentality*. While a concern with the governmentalization of the environment is implicit within Foucault's own account of governmentality (particularly in his discussion of the *ensemble of objects* that make up a territory), he does not outline the significance of his theory for studies of the environment directly. It is in this context that writers such as Luke, Darier, Michael Goldman, Paul Rutherford, James Scott, and Arun Agrawal have worked assiduously to reveal the different ways in which the environment has been governmentalized. According to Darier, studies of environmentality should focus primarily on political interventions within the environmental field, which have occurred since the early 1970s. Darier chooses to focus on this historical period because it is only at this point that we see—through the establishment of environmental ministries, policies, and acts of legislation—the emergence of the environment as a distinct arena for government intervention. Darier asserts that the object of environmentality is not to develop a history of how the environment has been governmentalized, but rather to study how the notion of the environment inserts itself into the longer history of the practices associated with governmentality.

Through a detailed study of Canada's 1990 *Green Plan,* Darier argues that the governmentalization of the environment is achieved through the collation of knowledge about the national environment and the establishment of new systems of environmental citizenship and education, which govern the conduct of individuals' environmental conduct.

The work of Michael Goldman and Timothy Luke has extended the application of environmentality from a study of national environmental governance to consider the government of the environment at a global level. Through studies of the transnational activities of the World Bank and the government of the United States, respectively, Goldman and Luke show how a sensitivity toward the practices of environmentality reveals the increasing up-scaling of environmental power from a national to a global level. According to Luke, the global and interconnected nature of contemporary environmental threats means that in order to secure the right disposition of things within a given territory, a state must also work to protect the functioning of transnational ecological systems. It is in this context that Luke interprets the policies of sustainable development currently being pursued by the United Nations and the environmental policies of Clinton-Gore administration in the United States as attempts to secure national forms of socioeconomic productivity through the governmentalization of the total setting of the global environment.

Most prominently, Arun Agrawal's research has revealed the way decentralized institutions of forest governance, specifically in India, have led to a system of management that transforms local people, as subjects, to become concerned about forest protection. This work has most clearly and empirically demonstrated that changes in governance can lead to a actual changes in the identities of people, as political subjects, as they encounter and relate to state institutions. Whether it is used to analyze the ways in which social conduct toward the environment is being changed or how the global environment is being governed, it is clear that theories of environmentality are having a profound affect on contemporary understandings of the links between state power and the environment.

SEE ALSO: Clinton, William Administration; Globalization; Political Ecology; Policy, Environmental; Sustainable Development; United Nations; World Bank.

BIBLIOGRAPHY. Arun Agrawal, *Environmentality: Technologies of Government and the Making of Subjects* (Duke University Press, 2005); Éric Darier, "Environmental Governmentality: The Case of Canada's Green Plan," *Environmental Politics* (v.5, 1996); Michel Foucault, "Governmentality" (lecture given to the Collège de France), reproduced in Michel Foucault, *Power—Essential Works of Foucault: 1954–84,* Vol. 3, James D. Faubion, ed. (Penguin, 2002); James D. Faubion, "Introduction," in Michel Foucault, *Power—Essential Works of Foucault: 1954–84,* Vol. 3, James D. Faubion, ed. (Penguin, 2002); Michael Goldman, "Eco-Governmentality and Other Transnational Practices of the 'Green' World Bank," in Richard Peet and Michael Watts, eds., *Liberation Ecologies: Environment, Development, Social Movements* (Routledge, 2004); Timothy W. Luke, "Environmentality as Green Governmentality," in Éric Darier, ed., *Discourses of the Environment* (Blackwell, 1999); Timothy W. Luke, "On Environmentality: Geo-Power and Eco-Knowledge in Discourses of Contemporary Environmentalism," *Cultural Critique* (Fall 1995); James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press, 1998).

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Epidemic

IN EPIDEMIOLOGY, AN epidemic is defined as a disease that appears as new cases in a given human population, during a given period of time, at a rate that substantially exceeds "normal," based on recent experience. However, the definition of *epidemic* can be subjective depending on what is "normal." For example, a few cases for a very rare disease like rabies may be classified as an epidemic, while cases of a common disease, as the common cold, would not.

Epidemics can be categorized based on the size or the intensity of appearance of cases of a new disease. For example, an epidemic may be restricted to one locale (an outbreak), more general (an epidemic) or even global (*pandemic*). Also, when diseases occur at a constant but relatively high rate in the population, it is termed as *endemic*. An example of an endemic disease is malaria in some parts of Africa (for example, Liberia) in which a large portion of the population is expected to get malaria at some point in their lifetimes.

Epidemics can also be classified by their pattern of transmission. The disease can be transmitted by a vector, from person to person, or from a common source such as contaminated water.

Some of the famous examples of epidemics include the bubonic plague epidemic of Medieval Europe known as the Black Death, the Great Influenza Pandemic concurring with the end of World War I, and the current AIDS epidemic, which some also consider to be of pandemic proportions.

The Bubonic Plague, or Black Death, was a devastating pandemic, which first struck in China. This plague traveled to Europe by rat-infested Italian ships trading goods across the Mediterranean Sea. The plague reached England by the late 14th century and within 4 years (1347–51) it had killed over a million people, one-third of Europe's entire population. Including Middle Eastern lands, India, and China, the Black Death killed at least 75 million people, taking the form of the most dangerous pandemic ever to be known in the history of epidemics. In addition to its massive effect on mortality, the Black Death irrevocably changed Europe's social, economic and cultural structure. The deaths changed the size of the civilization, which further led to changes in trade, the church, art, and music. The disease was completely eradicated in Europe only at the beginning of the 19th century, but survives in other parts of the world (Central and Oriental Africa, Madagascar, and Asia).

GREAT INFLUENZA PANDEMIC

The Great Influenza Pandemic during the World War I killed more people than the war itself, somewhere between 30 and 40 million people. The origin of this influenza is not precisely known. It is thought to have originated in China and the war is believed to have accentuated its spread to take the form of a catastrophic pandemic. The pandemic affected everyone. With one-quarter of the United States and one-fifth of the world infected with the influenza, it was impossible to escape from the illness. The influenza virus had a profound virulence, with a global mortality rate at 2.5 to 5 percent compared to the previous influenza epidemics, which were less than 0.1 percent. The age specific death rate for the age group 15 to 34 years due to influenza and pneumonia were 20 times higher in 1918 than in previous years. The Great Influenza Pandemic was the most calamitous infectious disease pandemic in U.S. history, which killed around 28 percent of the U.S. population. The effect was so severe that the life expectancy in the United States was decreased by 10 years. Like many other pandemics, this influenza pandemic also had profound influence on socioeconomic status of the people. According to John Barry, author of *The Great Influenza: The Epic Story of the Deadliest Plague in History*, even though it killed at least 40 million people in less than a year, the 1918 influenza pandemic's most alarming consequences may have been that it nearly extinguished the basic humanitarian impulses that bind civil society together.

AIDS

At the beginning of the 21st century, Human Immunodeficiency Virus (HIV), which causes the Acquired Immune deficiency Syndrome (AIDS), has killed more than 25 million people since it was first detected in 1981. Nearly twice that many, 40 million, are living with the virus. Without some major breakthroughs, most of these people are expected to die during the next 10 years or so. Despite recent, improved access to anti-retroviral treatment and care in many regions of the world, the AIDS epidemic claimed between 2.8 and 3.6 million lives in 2005, of which more than half a million were children. Interestingly, over 90 percent of people infected with the HIV live in the developing world. The Joint United Nations Program on HIV/AIDS (UNAIDS, 1999) expects that this "proportion will continue to rise in countries where poverty, poor health systems, and limited resources for prevention and care fuel the spread of the virus." Sub-Saharan Africa remains by far the worst-affected region, with 23.8 million to 28.9 million people living with HIV at the end of 2005. Just under two thirds (64 percent) of all people living with HIV are in sub-Saharan Africa. South and southeast Asia is the second most affected region with 15 percent. If the current trends of HIV infection and mortality due to AIDS continue to hold, the HIV/AIDS epidemic will develop into a devastating pandemic. It will then dictate the size, growth, and age-sex structures of entire populations around the world.

SEE ALSO: Acquired Immune Deficiency Syndrome; Black Death; Disease; Influenza.

BIBLIOGRAPHY. John M. Barry, *The Great Influenza: The Epic Story of the Deadliest Plague in History.* (Viking, published by the Penguin Group, 2004); Karen A. Stanecki, "The AIDS Pandemic in the 21st Century,"

International Population Reports and U.S. Census Bureau, WP/02-2 (U.S. Government Printing Office, 2004); Stéphane Barry and Norbert Gualde, "The Biggest Epidemics of History," *La plus grande épidémie de l'histoire, in L'Histoire* (2000).

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Epidemiology

EPIDEMIOLOGY IS A population's health science. It utilizes a population approach for the study of the distribution (person, place, and time) and determinants (biological, social) of health and disease in defined populations of varying characteristics, and how to use the information for the prevention and control of various health problems.

The term *epidemiology* is of Greek origin and can be roughly translated as the study among or upon people. The origins of epidemiology can be traced back to the era of Hippocrates, when the idea that environmental factors (seasons, winds, hot, cold) can influence disease occurrence was in circulation. However, epidemiology's development into a full-fledged discipline excelled in the 19th century with the work of John Snow, on which identified the relation between drinking water supplied from a certain company and the risk of death from cholera. Although epidemiology originated from the study of communicable diseases, it eventually developed a more comprehensive scientific approach to studying various health-related states including noncommunicable diseases, disability, accidents, quality of life, and others.

An epidemiologist is a scientist who uses epidemiological methodology to investigate various phenomena related to the health of the population. An epidemiologist should also have some knowledge of other public health disciplines, statistics, and social and medical sciences. An epidemiologist's range of functions includes practical applications, such as outbreak investigation and field epidemiology, in addition to applications such as formulating and testing epidemiological hypothesis and developing study designs. However, in all efforts, the epidemiologist aims to use epidemiological thinking and methods to contribute to disease prevention and health promotion.

Traditionally, epidemiology has been classified by type of discipline or disease and physiology. Examples of epidemiology discipline classifications include: environmental, social, pharmacoepidemiology, nutritional, genetic, molecular, and clinical and surveillance. Examples of disease and physiology–based classification include: reproductive epidemiology, epidemiology of aging, cancer epidemiology, and injury epidemiology.

Epidemiology attempts to answer various questions regarding the distribution of diseases and the determinants of health, such as: How many people developed the disease? What is the disease burden in a certain population? Why a specific group of the population developed the disease while the others did not? What are the factors associated with disease? What are the different stages of disease? What is the prognosis? Is there a causal relation between a certain factor (exposure) and the disease? Are the interventions used to prevent or control the disease effective? What are the public policies that should be formulated and the regulations to be applied to safeguard the health of the population?

ANSWERING THE QUESTIONS

In its attempt to provide scientifically sound answers to theses questions, epidemiology adopts two main approaches. Descriptive epidemiology focuses on studying the occurrence of disease, disability or any other health-related phenomenon. It observes and describes the relation of the disease with the basic population characteristics such as age and sex. The person, place, and time triad is the cornerstone of descriptive epidemiology. It does not aim to tests hypotheses, for example to prove or disprove a causal relation. In contrast, analytical epidemiology usually studies causal relations, tests hypotheses, and measures the association between exposures and outcomes.

Measuring and comparing the occurrence of diseases and death is achieved by using various measurements of morbidity and mortality. *Prevalence* refers the total number of persons with the disease or health related event during a defined period or point in time, and the *prevalence rate* is calculated by dividing this total number of cases or persons with the disease by the population at risk of having this event. *Incidence* refers to the new events or cases in a defined period only and the incidence rate is calculated by dividing the new cases by the population at risk at the same period, and can be expressed as person-time. Comparing the occurrence of disease among groups of people with different exposure status (exposed vs. unexposed) is useful to show the effect and to calculate the risk of being exposed to a certain factor (exposure) on a health outcome (disease). Both absolute (risk difference) and relative (risk ratio) comparisons of risk are available. Various measures can be used to assess mortality such as the crude mortality rate, which is calculated by dividing the number of deaths in a defined period by the average total population in the same period. Other measures of mortality include age-specific and age-adjusted mortality rates, which allow comparison of rates among populations with different age structures.

EPIDEMIOLOGICAL STUDY DESIGNS

Answering these different epidemiological questions requires the use of suitable epidemiological study designs, which are classified into observational and experimental studies. Experimental studies involve an intervention introduced or eliminated by the researcher/epidemiologist, while the observational studies are based on observation and measurement only. Examples of observational studies include ecological, cross-sectional, case-control, and cohort studies. A cross-sectional study can be used, for example, to determine the prevalence of diabetes mellitus in a certain population. Experimental studies include the randomized controlled trial, which is considered the gold standard of epidemiological designs, field trials, and community trials. An example of experimental study application is the use of a randomized controlled trial to study the effect of a new oral hypoglycemic drug on controlling blood glucose in persons with diabetes mellitus. Epidemiological studies vary in their characteristics such as the capacity to study causal relations, the cost of conducting a study, the duration, the required sample size, and other characteristics. These characteristics affect the choice of a certain epidemiological study over the other.

Epidemiological study errors that can affect the accuracy of collected information include random error, systematic error (bias) and confounding. Minimizing the effects of those errors is an important component of epidemiological study design and analysis.

SURVEILLANCE

Another important aspect of epidemiology is surveillance, which involves a continuous systematic process that involves data collection, analysis, interpretation and dissemination of results. Data collected include information on diseases, risk factors, complications, and health practices. Surveillance objectives include detecting epidemics, monitoring disease trends, identifying risk factors and the emergence of new diseases and microbes.

Outbreaks are usually marked by an unexpected rise in the incidence of a certain disease above the base-line level. Outbreak investigation classically originated from communicable diseases outbreaks such as typhoid. In the modern age, different types of outbreaks have been identified including outbreaks due to environmental factors such as contamination with chemicals. An example of an environmental pollution epidemic is the Minamata Bay-Japan case, where methylmercury accumulated in fish due to the release of chemicals containing mercury from a nearby factory. This caused severe poisoning among fishermen and their families who consumed fish as a main food item. Epidemiology played a crucial role in identifying the cause of and in controlling such epidemics.

SEE ALSO: Disease; Drinking Water; Epidemic; Health; Sexually Transmitted Deseases.

BIBLIOGRAPHY. John Last, *A Dictionary of Epidemiology* (Oxford University Press, 2000); D. Coggon, Geoffrey Rose, D. Barker, *Epidemiology for the Uninitiated* (BMJ Publishing Group, 2003); R. Beaglehole, R. Bonita, T Kjellstrom, *Basic Epidemiology* (World Health Organization, 1993); Leon Gordis, *Epidemiology* (W.B. Saunders Company, 2004); Raj Bhopal, *Concepts of Epidemiology* (Oxford University Press, 2002).

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Equatorial Guinea

THE NATION OF Equatorial Guinea is located in west central Africa. The total land area is 10,811 square miles (28,000 square kilometers) and includes the mainland region as well as the islands of Bioko, Annobon, and others. In 2006, the estimated population of the country was 540,000, and it was one of the last African countries to gain independence (in 1968, from Spain). Continental Equatorial Guinea rises from a wide coastal plain to the hilly terrains of the interior. The Mbini River Basin covers much of this region, which is home to about 80 percent of the population. The islands are volcanic and present altitudes above 9,840 feet (3,000 meters) in Annobon. The climate is hot with abundant rainfall throughout the year. About two-thirds of the continental portion is covered by tropical rain forest.

Since 1995, Equatorial Guinea has become one of the largest oil producers and exporters of Sub-Saharan Africa. Oil fields were discovered in the islands in the early 1990s and large-scale production began in 1995. In 2004, the country was producing nearly 400,000 barrels/day (the third-highest rate among African nations, after Nigeria and Angola), with estimated reserves of 1.3 billion barrels. Because of oil operations, the country ranks third in Africa (after Angola and South Africa) in U.S. investments. The contribution of oil to Equatorial Guinea's Gross National Product (GNP) rose from 7 percent in 1992 to 83 percent in 2000. Booming oil prices in 2004, 2005, and 2006 induced sharp increases in the country's GNP, which attained double digits during these years. However, oil revenues have not been directed to development, and there are serious accusations of misappropriation of oil money by the government. Meanwhile, Equatorial Guinea remains one of the poorest countries in Africa, with much of the population subsisting on $1 a day or less and health indicators among the worst of the region (life expectancy is around 50 years and the infant mortality rate is 111 per 1,000). Malaria has taken a heavy toll, especially among the young, and waterborne diseases are also widespread, as only 45 percent of the population have access to potable water in urban areas (42 percent in rural areas).

Deforestation has become widespread during the last decades. Originally, the tropical rain forest covered about 96 percent of the country. By the year 2000, this area had been reduced to 62 percent. Before the oil boom of the 1990s, timber (okume and ebony) was the main commodity produced in the country. About 3.2 million acres (1.3 million hectares) are susceptible to timber production. In 1993, about 1.4 million acres (600,000 hectares) had been authorized for exploitation, but the devaluation of the currency in 1994 prompted an increase in the number of concessions (mostly to Chinese and Russian investors) to the point that by the end of the 1990s, all productive forests had been organized in some 80 lots and were regularly exploited. One large Chinese company controls virtually half of the timber produced in Equatorial Guinea. In 2003, about 16 percent of the land was protected, although there are concerns about the growing illegal traffic of plants and animals. In the late 1988 there were accusations that the waters surrounding the island of Annobon were used to dump toxic and nuclear wastes produced in Western countries.

SEE ALSO: Deforestation; Drinking Water; Infant Mortality Rate; Life Expectancy; Malaria; Petroleum; Poverty; Timber Production.

BIBLIOGRAPHY. Randall Fegley, *Equatorial Guinea* (ABC-CLIO, Incorporated, 1992); USA IBP, *Equatorial Guinea: A Spy Guide* (International Business Publications, USA, 2005); Jan Vansina, *Paths in the Rainforests: Toward a History of Political Tradition in Equatorial Africa* (University of Wisconsin Press, 1990).

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Equilibrium

EQUILIBRIUM IS A term from general systems theory that has been a central concept in ecology for several decades. In general systems theory, equilibrium is a steady state (homeostasis) that the system achieves due to negative feedback, causing changes in the system to quickly return to the initial state. In terms of ecology, equilibrium occurs when a biotic community maintains a constant species composition and abiotic nutrients and energy are cycled through food webs such that the amount of energy and nutrients entering the biotic community are balanced by output of these abiotic components. Equilibirium is considered to be reached in late stages of ecosystem development when high biodiversity across all trophic levels and a high degree of niche specialization result in all available environmental resources being cycled through the foodwebs, such that no excess nutrients are available for new species to become established. Equilibrium is closely tied to the hypothesis that high biodiversity conveys ecosystem stability, and has been a fundamental concept behind modern conservation design.

A FUNCTION OF HIGH BIODIVERSITY

Equilibrium occurs as a function of high biodiversity across all trophic levels due to intertrophic and intratrophic competition. Within a trophic level, interference competition between individuals of different species for the same resources causes these species to sort into specialized niches through competitive exclusion. With high biodiversity within a trophic level, species become competitively specialized into very narrow niches with each species having a higher efficiency in resource utilization within that niche, such that all of the resources in question are consumed at that trophic level. Across trophic levels, greater specialization among predators for their prey assures that predator populations are controlled by the individual numbers of their prey species; the predator population fluctuated with that of its prey, and neither becomes extinct. Populations of species are thus controlled from the lowest trophic levels, and species composition is maintained, as no single species is able to consume another into extinction without becoming extinct itself. This encourages greater specialization, thus ensuring available environmental resources are cycled, and maintaining a constant species composition in the ecosystem, which is in a state of equilibrium. The stability of these ecosystems also require sufficient time to pass for competition to sort species into their various niches, in which disturbances do not occur that upset the balance of species.

The equilibrium theory of island biogeography proposes that ecosystems are maintained in a state of dynamic equilibrium. For a given ecosystem, the overall number of species will remain relatively constant over time, although species turnover (the replacement of locally extinct species with new immigrants) occurs. As a study of island environments, the theory asserts that immigration rates into an island are inversely proportional to distance from the nearest continent, extinction rates are inversely proportional to area of the island, and that the equilibrium number of species occurs at the point the two curves are equal. Although originally formulated for predicting biodiversity on oceanic islands, the theory has been widely applied in conservation ecology, with isolated mountaintops and habitat patches within a heterogeneous landscape viewed as functional islands.

Within conservation ecology, the implications of equilibrium have far reaching implications for

In the Equilibrium Theory of Island Biogeography, ecosystems are maintained in a state of dynamic equilibrium.

human–environment interaction. An equilibrium view of nature is one in which species are free to interact and coevolve into stable assemblages over long periods of time. To do so, these systems must be free of disturbance. With disturbance seen as an aberration to these systems, humanity is viewed as having no place in these environments. This scientific view of the environment is rooted in Western ideals regarding the separateness of humanity and nature. Furthermore, these equilibrium perspectives suggest that reserves must have sufficiently large area to prevent extinctions and maintain viable populations of species.

Ecological equilibrium as a model for ecosystem and biodiversity management has been criticized in recent years. First, disturbance has been observed to be a natural and frequent occurrence in ecosystems, such that several terrestrial ecosystems have been identified as functioning within a particular disturbance regime.

Fire ecology is an example of one of these disturbance regimes, whereby midlatitude grasslands and Mediterranean ecosystems, among others, have been identified as being adapted to relatively frequent burnings, such that periodic burning is necessary for proper ecosystem function. Disturbances are seen to occur frequent enough that ecosystems are now often viewed as being in a constant state of flux in terms of species composition and nutrient cycling. Equilibrium is viewed more as an unstable property that an ecosystem may possess at any given moment, rather than as a teleological endpoint that the system naturally gravitates toward. Ecosystems are more frequently described as being in disequilibrium, or nonequilibrium, within the ecological literature.

Second, equilibrium models have been criticized from within conservation ecology itself on philosophical and political grounds. Although equilibrium models provide a politically defensible approach to conservation (an ecosystem's integrity can only be maintained by being set aside and left undisturbed by people), and there is a tendency to maintain these equilibrium discourses as a result, conservationists criticize equilibrium approaches for encouraging a natural ontology in which nature will return to its natural balance if left alone, and obscures the need for increased human intervention into ecosystems to preserve biodiversity.

Finally, the equilibrium perspective has been used to justify the removal of people from landscapes targeted for conservation reserves. Social and environmental justice concerns have been raised over ecological equilibrium as a result.

SEE ALSO: Biodiversity; Conservation; Predator/Prey Relations; Disequilibrium; Ecology; Ecosystem; Nutrients.

BIBLIOGRAPHY. Daniel Botkin, *Discordant Harmonies. A New Ecology for the Twenty First Century* (Oxford University Press, 1991); William Cronon, ed., *Uncommon Ground: Toward Reinventing Nature* (W. W. Norton and Company, 1995); Robert H. MacArthur and Edward O. Wilson, *The Theory of Island Biogeography* (Princeton University Press, 1967); Eugene P. Odum, "The Strategy of Ecosystem Development," *Science* (v. 164, 1969); Michael E. Soulé and Gary Lease, eds., *Reinventing Nature? Responses to Postmodern Deconstruction* (Island Press, 1995); Karl S. Zimmerer, "The Reworking of Conservation Geographies," *Annals of the Association of American Geographers* (v. 90, 2000).

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Equity

EQUITY REFERS TO the distribution of wealth or power and is closely related to notions of justice, fairness, and equality. The concept permeates several disciplines of social thought, including prominent roles in economics, geography, and political philosophy. Equity concerns have become inextricably bound to environmental quality. This intrinsic relationship between equity and the environment takes many forms across space and at different scales, yielding the paired concept of environmental equity.

Empirical trends in world economic development, such as uneven resource exploitation and disparate vulnerability to environmental harms, underscore the prevalence of environmental inequities among nations, economic classes, and cultural groups. These inequities have coalesced into at least three interrelated topics pursued by environmental equity activists and scholars: environmental justice, natural resource access, and intergenerational equity.

Environmental justice exposes inequalities in the incidence of environmental harms across differences in race, gender, economic class, or national economic development. The disposal of toxic and hazardous waste near areas inhabited by racial minorities in the United States sparked an environmental justice movement that has become embedded in local, national, and international environmental politics. Global climate change provides a vivid and complex example of the environmental equity and justice notions that shape contemporary policy debates. In the early 1990s, global climate change emerged onto the international environmental agenda, spawning proposals to curb anthropogenic greenhouse gas emissions.

Such policy responses could impose an inequitable burden on developing countries by restricting their ability to exploit the same sources of energy used by richer nations to develop economically. In 1997, the Kyoto Protocol amendment to the United Nations Framework Convention on Climate Change attempted to accommodate such environmental equity concerns by acknowledging that developed countries, such as the United States and Japan, bear the primary responsibility for current and historical emissions of greenhouse gases. The Kyoto Protocol took force in 2005 without United States approval, and it stipulates a "common yet differentiated responsibility" that excludes some developing countries from emission reduction requirements.

Equity also exists centrally in natural resource access issues. For example, the richest 20 percent of society consumes 17 times more energy resources than the poorest 20 percent, and this pattern applies to many other natural resource and environmental harms. The disparities in resource access and consumption can be gleaned by evaluating the eco-footprint of citizens from different countries. Eco-footprint analysis portrays the amount of land and water needed to accommodate per capita consumption of resources and the disposal of associated waste. While the United States, Canada, and countries of western Europe have an ecofootprint of 12.35 to 24.7 acres per person (5–10 hectares), China's per capita ecofootprint lies between 2.47 and 4.94 acres (1–2 hectares). An important corollary to uneven resource exploitation stems from inequalities in the generation and disposal of environmental waste, such as toxic and hazardous materials. The disproportionate burden of that waste on poorer segments of society underscores the primary concerns of the environmental justice movement. European colonial history adds an important dimension to resource access issues due to the well-documented record of exporting natural resources from resource rich colonies in Africa, South America, and south Asia to the former ruling nation states, such as France, Spain, and Great Britain. This colonial legacy influences contemporary resource access debates, especially as the nation states forged from former colonial territory confront resource exploitation limits imposed by international environmental agreements and economic development funding arrangements. The resource development paths once available to many contemporary economic powers have proven untenable for developing countries required to pursue more efficient technologies.

COLONIAL INFLUENCE

The persistence of colonial influence in natural resource access and economic development suggests the primacy of intergenerational equity considerations in environmental discussions. Intergenerational equity considers the implications of current resource access and pollution for future generations. These issues have infused environmental policy debates with concerns over sustainability and sustainable development. Permanent biodiversity loss from habitat conversion associated with current levels of resource extraction and pollution demonstrates the basic concern of intergenerational equity: diminished environmental quality bequeathed to future generations as a consequence of current or historic resource consumption patterns.

Due to long-term natural variability in many indices of environmental quality, intergenerational equity impacts often defy rigorous evaluation and quantification. In other words, it is difficult to separate the environmental impact of human resource consumption patterns from the environmental changes wrought by natural variability. Despite the moral and political challenges associated with issues of environmental justice, natural resource access, and intergenerational equity, the equity dimensions of human-environment interactions remain a focal and growing concern in environmental policy and society.

SEE ALSO: Colonialism; Development; Ecological Footprint.

BIBLIOGRAPHY. J. Agyeman, R.D. Bullard, and B. Evans, *Just Sustainabilities: Development in an Unequal World* (Earthscan Publications, 2002); Gabriela Kütting, *Globalization and the Environment: Greening Global Political Economy* (State University of New York Press, 2004); M. Wackernagel, et al., "National Natural Capital Accounting with the Ecological Footprint Concept," *Ecological Economics* (v.29, 1999).

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Erie, Lake

LAKE ERIE IS the fourth largest of the five Great Lakes and the 12th largest freshwater lake in the world. The history of Lake Erie is complex. Approximately 2 million years ago, a basin, or lowland, in the present-day Erie basin served as the valley of a once east-flowing Erigan River. This drainage system was destroyed by the first of several major glacial advances that deepened and enlarged the basin. The problem for geologists was that each successive glacier destroyed the evidence of the preceding one, making a complete and thorough history virtually impossible.

A more detailed history of Lake Erie can be traced as far back as the retreat of the Wisconsinan—the last Pleistocene glacier—some 14,500 years ago. Scientists using radiocarbon-dated sentiments, detrital transport, hardwater, inorganic carbon contamination, postdepositional compaction, and other sampling procedures have added considerably to our understanding of Lake Erie's evolution.

In its present form, Lake Erie is relatively young according to geologists, with a lifespan of less than 4,000 years. Lake Erie has an elevation of 571 feet (174 meters) above sea level, a surface area of 9,940 square miles (25,745 square kilometers), a length of 241 miles (388 kilometers), and a breadth of 57 miles (92 kilometers) at its widest point. Its maximum depth is 210 feet (64 meters), its water volume is 116 square miles (484 square kilometers), and its residence time—the time lake water takes to renew itself—is 2.6 years. Its primary source is the Detroit River and primary outflow is the Niagara River into Lake Ontario.

Lake Erie has a number of interesting characteristics. Its basin is comprised of Devonian shale in the east and limestone and dolomite (Silurian and Devonian carbonates) in the west, which are more resistant to erosion. Hence, the lake is shallow in the west (averaging less than 25 feet) and much deeper in the east (reaching 210 feet) where glacial ice was able to remove the limestone. The basin is also shallow at its most southerly points (where it averages less than 25 feet) because that is where the glacial ice was thinnest pending its retreat. When glaciers flow over resistant bedrock, they leave scratches in the surface known as striations, which are produced by grinding stones caught between the ice and the bedrock. Striations of up to three feet are found commonly in Bass Island's hard Silurian limestone in western Lake Erie. Waves in shallow water also tend to be steeper than those in deep water, and thus Lake Erie is known for choppy waters during storms.

Lake Erie's ecology and hydrology also have some unique features. Because Lake Erie (like the other Great Lakes) is relatively young, its water contains relatively few species of fish. The food chains are short, relatively simple, and easily disrupted, such as when spectacular changes in lake levels result from tilting or imbalance of the lake surface produced by winds and changing barometric pressures. Consequently, Lake Erie has risen for hours or days over an appreciable area by as much as 8.4 feet. The lake also has small tides called *seiches*, which can be measured in inches rather than feet, that can last for days. Another unique feature of the Great Lakes including Lake Erie are seasonal thermoclines (often called *thermal bars*), which are horizontal interfaces that separate the warmer water at the surface, or *epilimnion*, from the colder deeper water, or *hypolimnion*. These thermoclines form during the spring and break up during the fall.

Like other lake ecosystems, Lake Erie was significantly transformed from its original state through a number of processes largely consequential of human activity. Oxygen depletion and eutrophication, namely the rapid aging and filling in of the lake caused by algal growth, increased sediment influx, and contamination with toxic materials are major dangers confronting the lake since the 1960s and 1970s. Eutrophication has resulted in the decomposition of algae, which has led to extensive seasonal anoxic areas in the lake (often called *dead zones*). In 1972, Canada and the United States entered into an agreement to reduce the runoff and dumping of phosphorus into the lake. Both governments and, in particular, the U.S. Environmental Protection Agency (EPA) are monitoring this problem. Lake Erie has also been impacted by a long list of invasive species: rainbow smelt, white perch, common carp, and alewife. Other additions affecting Erie include quagga and zebra mussels that have populated the entire Great Lakes ecosystem, pushing energy flow through the food web away from the pelagic zone and into the benthic zone.

Commercial fishing on Lake Erie is extensive and management of the fishery is conducted by consensus of all agencies with a shared interest in the resource: the Canadian province of Ontario, and the states of New York, Pennsylvania, Ohio, and Michigan. Commercial fishing is most active in Canadian communities, and the Ontario fishery is intensively managed with individual transferable quotas (ITQs). It also features the mandatory reporting of daily catches and intensive auditing of the catch system.

SEE ALSO: Canada; Environmental Protection Agency (EPA); Eutrophication; Fisheries; Geology; Glaciers; Lakes; United States, Midwest.

BIBLIOGRAPHY. William Ashworth, *The Late, Great Lakes: An Environmental History* (Collins, 1986); John J. Bukowczyk, Nora Faires, David R. Smith, and Randy William Widdis, eds., *Permeable Border: The Great Lakes Basin as Transnational Region, 1650–1990* (University of Pittsburgh Press, 2005); Susan L. Flader, ed., *The Great Lakes Forest: An Environmental and Social History* (University of Minnesota Press, 1983); Michael C. Hansen, "The History of Lake Erie," www.ohiodnr.com/geosurvey/lakeerie/lefact1.htm (cited December 2006); Jack L. Hough, *Geology of the Great Lakes* (University of Illinois Press, 1958); P.F. Karrow and P.E. Calkin, eds., *Geological Association of Canada Special Paper 30: Quaternary Evolution of the Great Lakes* (Johanns Graphics, 1984).

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Eritrea

ERITREA, LOCATED IN the Horn of Africa, covers 121,320 square kilometers It shares boundaries with Sudan in the north and west, Ethiopia in the south, and Djibouti in the southeast. Topography is dominated by highlands, descending in the east toward a coastal desert plain, in the northwest to hilly terrain, and in the southwest to undulating plains. Altitude ranges from sea level to approximately 3,000 miles above sea level. The capital is Asmara. Eritrea's climate is categorized into semi-desert, arid, and moist lowlands, sub-humid zones, and arid and moist highlands. The climate is characterized as bimodal. The main rains, from June to September, affect the highlands and western lowlands. Short rains occur from November to March and affect the coastal, eastern, and southern escarpments. Average annual rainfall varies between less than 200 millimeters in the semi-desert and 900 millimeters in the sub-humid zone. Mean annual temperature varies between 18 degrees C in the highlands and 28 degrees C in the semi-deserts.

Eritrea was awarded to Ethiopia as part of a federation by the United Nations in 1952. Ethiopia's annexation of Eritrea as a province 10 years later sparked a 30-year struggle for independence that ended in 1991 with Eritrean rebels defeating government forces; independence was approved in 1993. Only five years later, tensions with Ethiopia sparked over economic policies and border disputes, which resulted in war, costing many lives and displacing more than a quarter of the Eritrean population. Eritrea has suffered damages to its weak infrastructure and economy, from which it has yet to recover. In 2000, Eritrea and Ethiopia signed a peace agreement, but the border continues to be disputed and Eritrea's relations with Ethiopia remain tense. Eritrea has become isolated internationally, mainly due to the totalitarian military regime.

The country has a population of nearly 4.8 million, with an annual growth rate of three percent in 2006. Eritrea is one of the poorest countries in the world, with more than half of the population surviving on less than $1 per day. Population density is highest in the highlands, where 60 percent of the population occupies 19 percent of the area. About 84 percent of the population lives in rural areas where the main sources of livelihood are subsistence agriculture, pastoralism, and fishing. The agricultural sector employs 80 percent of the population; but only contributes 17 percent to the gross national product. Eritrea's main exports are coffee, cotton, meat, and hides. In 2002, economic growth of two percent was contrasted with an inflation rate of 15 percent. Eritrea is largely reliant on external support, especially through remittances from Eritreans living abroad; foreign investments are low because of political instability.

Shrublands and grasslands cover around 64 percent of the land, while woodlands make up 11 percent and cultivated land nine percent. Grasslands are exposed to wind erosion during the dry season, and to water erosion at the onset of the rains. Reliance on natural resources and increasing population is leading to the expansion of cultivation into areas that are marginal for agriculture, resulting in land degradation. Even in years of sufficient rainfall, Eritrea only produces about half of its food requirements, thus, relying heavily on food aid. Food security is a national priority, but options to expand agricultural land are limited. Reliance on subsistence agriculture has made Eritrea vulnerable to droughts and locust invasions. Moreover, depletion of scarce natural resources has led to deforestation, overgrazing, and desertification. Due to lack of investment, the potential for livelihood diversification into non-natural-resource-based sectors remains limited.

SEE ALSO: Ethiopia; Poverty; Subsistence.

BIBLIOGRAPHY. D. Connell, *Against All Odds: A Chronicle of the Eritrean Revolution* (Red Sea Press, 1997); G. Kibreab, "Displaced Communities and the Reconstruction of Livelihoods in Eritrea," in T. Addison, *From Conflict to Recovery in Africa* (Oxford University Press, 2003); T. Negash and K. Tronvoll, *Brothers at War: Making Sense of the Eritrean-Ethiopian War* (James Curry, 2000); J. Nyssen, et al., "Human Impact on the Environment in the Ethiopian and Eritrean Highlands: A State of the Art," in *Earth-Science Reviews* (v.64, 2003); R. Srikanth, "Challenges of Environmental Management in Eritrea: A Case Study," in *AJEAM-RAGEE* (v.6, 2003).

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Estonia

FOR MUCH OF its history, Estonia has been dominated by larger neighboring nations. Toward the end of World War II, for instance, Estonia was unwillingly incorporated into the Soviet bloc but gained its independence in 1991 after the breakup of the Soviet Union. Since joining the European Union (EU) in 2004, Estonia has been on the road to economic recovery and is making significant environmental progress.

The topography of Estonia is varied, with marshes in the lowlands, plains in the north, and hills in the south. Bordering on the Baltic Sea and the Gulf of Finland, Estonia has 2,464 miles (3,974 kilometers) of coastline and is home to more than 1,500 islands. The maritime climate produces wet, moderate winters and cool summers. Flooding is common in the spring of the year, increasing the potential for environmental damage.

Estonians enjoy the benefits of an economy based on strong electronics and telecommunications sectors and on strong economic ties to Finland, Sweden, and Germany. While nearly 70 percent of the population live in urban areas, 11 percent of the workforce are engaged in the agricultural sector. Estonia's rich natural resources include peat, phosphorite, clay, limestone, sand, dolomite, arable land, and sea mud. Estonia also has the largest usable deposits of oil shale in the world. With a per capita income of $16,400, Estonians enjoy a comparably high quality of life, and the United Nations Development Program (UNDP) Human Development Reports ranks Estonia 38th of 232 countries on overall quality-of-life issues.

Major environmental problems of the 21st century concern water polluted by untreated wastewater and air pollution resulting from the northeastern oil shale-burning power plants that release sulfur dioxide into the air. Progress is being made in both areas, and sulfur dioxide emissions have fallen 80 percent from 1980 levels. Likewise, water pollution has dropped to one-twentieth of 1980 levels in response to the erection of water purification plants. In addition to polluted seawater, the Estonian government is concerned about the potential for agricultural pollution of the country's 1,400 lakes. Because of heavy urbanization and a rate of 296 cars per 1,000 people, Estonia experiences carbon dioxide emissions of 11.7 metric tons per capita.

ENVIRONMENTAL IMPACT

The Soviet occupation of Estonia left an enormous impact on the environment, including the aftermath of hundreds of thousands of tons of jet fuel that were dumped in Estonia. At an air base near Tapa, for instance, it has been estimated that about two square miles (six square kilometers) of land were covered by a layer of fuel, and about four square miles (11 square kilometers) of water were contaminated. The Soviets also created an environmental nightmare by improperly disposing of toxic chemicals and dumping explosives and weapons in inland waters. Additionally, a uranium plant in Sillamäe discharged 1,200 tons (1,089 metric tons) of uranium and 750 tons (680 metric tons) of thorium into the Gulf of Finland. Overall, the Ministry of Environment estimated cleanup costs at nearly $300,000 (3.5 billion EKR).

With a new commitment to environmentalism, the Estonian government has protected 11.8 percent of its land. Of 65 species of mammals endemic to Estonia, four species are threatened. Bird species fare better, with only three of 204 species in danger of extinction. Improved environmental policies are due in large part to public awareness raised through the work of such groups as the Estonian Nature Conservation Society and the Green Movement.

Within the Estonian government, the Ministry of Environment oversees four units that consist

Exceptional National Parks

Estonia, the northern-most of the Baltic Republics, has a diverse natural history and has established five national parks which, because of the country's remoteness, have extensive unspoiled natural environments for flora and fauna.

The first and most well-known national park in Estonia is the Lahemaa National Park, which was established in 1971 and is located in the northern part of the country, 50 miles east of Tallinn, the capital. Until independence it was the only national park in the country, and it covers 1878 square miles (725 square kilometers), including 651 square miles (251 square kilometers) of sea. The park has a charter which calls for the preservation, research, and promotion of North Estonian landscapes, ecosystems, biodiversity, and natural heritage. Some 8 percent of the park is only accessible to scientists.

The Lahemaa National Park was chosen as a national park for its uniquely Estonian natural and cultural features, with 838 plant species—34 of them rare—found in the park, along with 37 mammals including the brown bear, the lynx, and the European mink, along with 213 species of birds and 24 different types of fish. In the middle of the park is the restored manor and parkland of Palmse where wealthy German barons once lived.

The Soomaa National Park, located in the southwest of Estonia, is nicknamed the "Land of Bogs" and contains five extensive swamps that are located in the catchment area of the Parnu River, one of the longest rivers in the country. In 1997 it was included in the nature protection areas of Europe, becoming a CORINE biotope area. It has also been a member of the Ramsar List of Wetlands from 1997, and in the following year moves were made to nominate it as a UNESCO World Heritage Site.

The other national parks in the country are the Karula National Park, the Matsalu National Park, and the Vilsandi National Park.

of administration, management, international cooperation, and nature conservation and forestry. In 1990, the Estonian Parliament passed the comprehensive Nature Protection Act and the Act on Sustainable Development to provide a framework for environmental legislation. Subsequent supplementary legislation includes the Public Health and Packaging Acts of 1995; the Energy, Chemicals, and Environmental Supervision Acts of 1997; the Ambient Air Protection and Waste Acts of 1998; and the Pollution Charges and Environmental Monitoring Acts of 1999. In 2000, Estonia adopted the Environmental Impact Assessment aimed at coordinating all environmental plans and programs.

The Ministry of Environment is also in charge of environmental research and development centers and the works closely with 15 county environmental departments. At the international level, Estonia participates in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Sulfur 85, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Endangered Species, Hazardous Wastes, Ship Pollution, Ozone Layer Protection, and Wetlands.

SEE ALSO: Carbon Dioxide; Endangered Species; Pollution, Air; Pollution, Water; Sulfur Dioxide.

BIBLIOGRAPHY. CIA, "Estonia," *The World Factbook*, www.cia.gov/cia (cited March 2006); Country Studies, "Environmental Issues: Estonia," www.country-studies.com/estonia (cited March 2006); Economic Commission for Europe, "Second Environmental Performance Review of Estonia," www.unece.org (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Environment, "State of Environment in Estonia," www.nfp-ee.eionet.eu.int (cited March 2006); UNDP, "Human Development Reports: Estonia," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Estonia," *Little Green Data Book*, www.worldbank.org (cited March 2006).

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Estuaries

ESTUARIES ARE KNOWN by many different names: bays, coves, inlets, harbors, sounds, and lagoons. Simply put, they are places where rivers meet the sea. Estuaries are, however, far more complex than merely areas where seawater is mixed with fresh. They are also ecotones, places where different ecosystems meet and boundaries overlap: terrestrial and aquatic, freshwater and marine, inland and offshore. They are dynamic regions of transformation, high productivity and species diversity. Estuaries act as buffers and filters, protecting upland habitats from storm surges and, preventing sediments and pollutants from reaching coastal waters. Estuaries contain diverse habitats: sandy beaches, rocky shorelines, mudflats, fringing salt marshes and mangroves, and provide critical habitats for many species.

Diverse definitions of estuaries have been proposed, emphasizing various sets of attributes, delineating landward and seaward ranges differently, but there is general agreement that estuaries are semi-enclosed bodies of water with freshwater inputs and some open connection to the sea, allowing for dilution and tidal exchange. The proximity of barrier islands, reefs, bars or peninsulas protects them from the full force of the ocean. Several geophysical processes give rise to estuaries and, as a result, estuaries exhibit different forms. Several types of estuaries have been delineated, encompassing those of glacial origin, known as fjords, those of tectonic origin, those formed from river deltas, flooded river mouths and bar-built estuaries where barrier islands or peninsulas form from sand bars, protecting river mouths from the ocean.

Environmental conditions in an estuary may be highly variable, unpredictable and extreme. Considerable variation can exist even within a given estuary. Due to tidal fluxes, river flows, topography, and weather conditions, estuarine waters experience dramatic changes, both regular and irregular, affecting salinity, sediment load, oxygen concentrations, and temperature. Salinity fluctuates, varying from brackish to almost fresh and in some arid areas, hypersaline. Waters may be well-mixed, or strongly stratified, with water layers of different salinities and densities, called a salt wedge.

Environmental conditions in an estuary may be highly variable, unpredictable, and extreme.

These physical extremes present physiological challenges for organisms, but species have adapted to the rigors of the estuarine environment. Estuarine productivities are among the highest in the world, due to high nutrient loads in water and sediments. Estuaries are critically important in the life histories of many species, including recreationally and commercially valuable species. Some species, particularly benthic invertebrates, live their entire lives within the bounds of the estuary. These include species of oyster, clam, and scallop. Some spend only a portion of their lives in the estuary, using them for reproduction, larval, and juvenile rearing. Other species, notably shorebirds, waders and wildfowl, utilize these areas for feeding. Salmon use estuaries as nurseries for juveniles and migrate through them as adults on their way to freshwater tributaries in which they spawn.

Humans settled around estuaries because they provided subsistence opportunities, good harbors, direct linkages between rivers and the sea, facilitating transportation and commerce. Settlements became cities and now several of the world's largest cities are found along estuaries. Estuaries are also considered attractive places to live for recreational and aesthetic reasons. In the United States, over 50 percent of the human population lives along the coast, which constitutes less than 10 percent of the lower 48's land. Globally, coastal density is approximately 40 percent. In either case, human populations are increasing in estuarine areas and, as a result, the ecological footprint of humans on the estuarine environment is significant and growing.

Some estuaries habitats and species have declined significantly. Eelgrass (*Zostera marina),* an aquatic flowering plant that provides habitat for many aquatic species, has declined dramatically, due to dredging, impacts with boat propellers, reduced water quality and clarity. More recently, dieoffs of salt marsh grass *(Spartina alterniflora),* an important primary producer in the highly productive foodweb of many estuaries, have been observed. The phenomenon, called Sudden Wetlands Dieback, may be caused by various factors such as pollution, drought conditions, elevated water temperatures, increasing sea levels as well as a non-local strain of *Fusarium*, a pathogenic soil fungus, acting alone or in combination.

Anthropogenic impacts such as pollution, habitat destruction and degradation, resource extraction, and the spread of invasive species are negatively impacting estuaries worldwide. Estuarine pollution comes in many forms and from many different sources, including both point and nonpoint source discharges. Pollutants encompass organic substances and nutrients from sewage outfalls as well as diffuse sources, which can create eutrophic conditions. Oil, synthetic organic compounds, heavy metals, radioactive substances, pathogens, large debris as well as excess heat, produced from electrical generating plants, also contribute to estuarine pollution. Upland land conversion, water diversions, dredging, beach defenses and modifications constitute some of the habitat changes impacting estuaries. Estuaries also provide sites for aquaculture and mariculture operations, with attendant releases of pollution, pathogens, and escapees. Invasive species threaten endemic species via increased predation and competition. Resource extraction occurs as both a directed and incidental activity. Subsistence, recreational and commercial harvesters take shellfish, fish, seaweeds, and various bird species from estuaries and harvest estuarine-dependent species in other areas, depleting reproductive stocks. Estuarine animals are killed by impingement and entrainment through cooling water intake during the operation of power plants.

However, the most serious threat facing the world's estuaries may be global climate change and its attendant increases in storm frequency, intensity and sea level. Although new estuaries will form at higher elevations, the rate and magnitude of change is critical. At high rates of sea level rise, newly flooded habitats may not be able to form and retain the fringing marshes and mangrove swamps, the various bioscapes that are so important to maintaining productivity and providing habitats for the diversity of organisms that currently utilize the world's estuaries.

SEE ALSO: Ecotones; Oceans; Rivers.

BIBLIOGRAPHY. Donal S. McLusky and Michael Elliott, *The Estuarine Ecosystem: Ecology, Threats and Management,* 3rd ed. (Oxford University Press, 2004); Karl F. Nordstrom and Charles T. Roman, Editors, *Estuarine Shores: Evolution, Environments and Human Alterations* (John Wiley & Sons, 1996); Michael J. Kennish, *Ecology of Estuaries: Anthropogenic Effects* (CRC Press,1992); Mark D. Bertness, *The Ecology of Atlantic Shorelines* (Sinauer Associates, Inc., 1999); Stephen A. Bortone, Editor, *Estuarine Indicators* (CRC Press, 2005); Carl J. Sindermann, *Coastal Pollution: Effects on Living Resources and Humans* (CRC Press, 2006); F. John Vernberg and Winona B. Vernberg, *The Coastal Zone: Past, Present and Future* (University of South Carolina Press, 2001) Bostwick H. Ketchum, Editor, *Ecosystems of the World, Volume 26: Estuaries and Enclosed Seas* (Elsevier Scientific Publishing Company, 1983).

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Ethics

GROWING EVIDENCE OF human-induced environmental damage has raised popular awareness that we ought to act and think differently about nature. The bad effects of fossil fuel emissions, marine pollution, deforestation, urban sprawl, and unchecked population growth have raised a set of ethical questions. Is technology the answer to environmental problems, or should we transform our consumption patterns and production processes? Is population growth or unequal resource distribution a greater cause of land degradation? Are societies morally obligated to ensure the resource needs of future people? Do nonhuman entities have value beyond their usefulness to humans? Do animals and plants have moral standing and therefore rights?

In response to these and other questions, scholars and activists since the 1970s have forged the distinct and growing field of environmental ethics. This branch of philosophy reflects on society's conception and treatment of nonhuman nature in moral terms, offering both ideal codes of conduct and policy guidelines. It seeks to craft theories that explain the motivations and consequences of human actions on earthly life, and it proposes what ought to be done.

Environmental ethics took root in the 1960s, a decade of transformational politics and social consciousness. Frequently cited as a wakeup call to the world about the ruin of nature, Rachel Carson's *Silent Spring*, published in 1962, documented how industrial technologies—particularly the use of DDT—have harmed the planet's ecosystems and have jeopardized human well-being. Slightly later, Paul Erlich's *The Population Bomb* (1968) alerted the public to what he described as an impending crisis caused by unsustainable population levels at the global scale. While scholars in the United States, Australia, and Norway laid the foundations for environmental ethics in academia and political movements, key concepts—such as the virtue of sustainable resource use or wilderness protection—were articulated by earlier economists, naturalists, foresters, and artists, people like: George Catlin, Thomas Malthus, David Ricardo, John Stuart Mill, Ralph Waldo Emerson, John Muir, Gifford Pinchot, and Aldo Leopold. Leopold, especially, laid the cornerstones of an explicit "land ethic" in his *Sand County Almanac*, published in 1949. For him, the extending the concept of community to land involves an extension of morality beyond the purely human realm: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." In addition to the problem of how humans should understand "community" (should we consider the concept holistically, ecologically?) scholars have deliberated on the moral standing of other sentient beings. The subject of animal liberation today constitutes an important subfield of environmental ethics. Debate on the question of animal rights draw on diverse ethical theories, including utilitarianism, a view that weighs and seeks to balance good and bad effects, or costs and benefits, and deontology; a theory that privileges questions of right and wrong rather than good and bad.

TWO THEORETICAL POLES

Generally speaking, environmental ethics spans two theoretical poles. One situates humankind within the biosphere and puts human interests on equal footing with the interests of other animate beings. The other subordinates the elements of the biosphere—"natural resources"—to the interests of humankind. The first perspective embraces holism or "biocentrism." The second is anthropocentric in that debates about environmental ethics tend to center on how our acts upon nature may enhance or worsen human life. At each extreme, thinkers propose ways in which to value the natural environment, and the terms *environment* and *nature* themselves reflect philosophical preferences. Anthropocentric ethics gauge the instrumental value of the environment, while the recognition of nature's "intrinsic value" suits holistic viewpoints.

Efforts to theorize intrinsic value reflects some scholars' dissatisfaction with existing moral categories and principles, which they find too limited in applicability or conceptual content. Regarding the conventional understanding of morals and ethics, for example, some argue that human practices upon the earth not only affect the living conditions of present and future people but also present and future nonhuman creatures. The concept of morality therefore must extend to include other species. Moral extensionism seeks to broaden the range of moral considerability beyond humans to plants and animals, beyond individuals to entire species, or even beyond species to ecosystems.

Conceptual limitations of existing categories include the idea of nature's instrumental value. Some ethicists argue that plants, animals, soils, waters, and forests possess value that is not solely derived from their usefulness to humans (including uses such as aesthetic appreciation or spiritual inspiration). They also possess an intrinsic value, a goodness in and of themselves without regard to their effect on other entities. Intrinsic value serves as a core principle of "deep ecology," a movement begun in Scandinavia by Norwegian philosopher, Arne Naess. Naess' term, *biospheric egalitarianism,* represents one of the key guideposts for deep ecology. In a similar vein, key issues of environmental ethics have inspired often politically subversive, intellectual movements. For example, feminist analyses have been brought to bear on environmental issues and have illuminated patriarchal patterns and effects in the human domination of nature. Also focusing on the negative effects of unequal social relations and power, Marxist-inspired environmental perspectives include the subfields of social ecology, which focuses on the problem of humanity's alienation from nature, as well as the expanding field of political ecology, which focuses on the effects of capitalism on nature and humanity, and on the effects of environmental change on social structures.

SEE ALSO: Animal Rights; Deep Ecology; Environmental Racism; Values, Environmental.

BIBLIOGRAPHY. M. Bookchin, *Toward an Ecological Society* (Black Rose Books, 1980); A. Brennan, *Thinking About Nature* (Routledge, 1988); A. Brennan (ed.), *The Ethics of the Environment* (Dartmouth Publishing Company, 1995); Rachel Carson, *Silent Spring* (Hamish Hamilton, 1962); Paul Erlich, *The Population Bomb* (Amereon Limited, 1976); Joesph R. Des Jardins, *Environmental Ethics: An Introduction to Environmental Philosophy* (Wadsworth, 1993); Eric Katz, *Nature as Subject: Human Obligation and Natural Community* (Rowman and Littlefield, 1997); A. Leopold, *A Sand County Almanac* (Oxford University Press, 1997);

Andew Light and Holmes Rolston, eds., *Environmental Ethics* (Blackwell Publishers, 2002); Arne Naess, *Ecology, Community, Lifestyle* (Cambridge University Press, 1990); Paul Robbins, *Political Ecology: A Critical Introduction* (Blackwell Publishers, 2004); Alison Stone, "Introduction: Nature, Environmental Ethics, and Continental Philosophy," *Environmental Values* (v.14, 2005); Richard Sylvan and David Bennet, *The Greening of Ethics* (The White Horse Press, 1994); Karen Warren, *Ecofeminist Philosophy: A Western Perspective on What It Is and Why It Matters* (Sagebrush Press, 2000).

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Ethiopia

DURING COLONIAL TIMES as European powers steadily exploited the resources of most African countries, the Ethiopian kingdom—situated in the Horn of Africa—maintained its independence except for a brief Italian occupation during World War I. The last emperor was replaced with a socialist military junta in 1974, setting the stage for two decades of fighting marked by massive famine. By the mid–1990s, Ethiopian rebels had overthrown the government and established the Federal Democratic Republic of Ethiopia. When Eritrea won its independence in 1993, Ethiopia lost access to the Red Sea.

Agriculture has a long history in Ethiopia, and scholars have traced the origin of coffee, grain sorghum, and castor bean to the ancient kingdom. While the constant threat of drought has frequently played havoc with Ethiopian crops, the region has a long history of prosperity and profitable linkages in pre-modern global trade.

Recently, however, a dramatic collapse of civil society, governance, and the regional economy has taken place. Less than 16 percent of the population is urbanized and 80 percent of the work force is engaged in agriculture and animal husbandry, which provide 50 percent of Gross Domestic Product and 60 percent of export revenue. Coffee has traditionally been the chief crop, but low prices and political unrest has resulted in a collapse in that sector. As a result of economic downturn and military conflict, Ethiopia has become the ninth poorest country in the world, with a per capital income of only $800. In 2001, Ethiopia was approved for participation in the International Monetary Fund's (IMF) Highly Indebted Countries initiative and had its IMF debt forgiven in 2005. Half of the population of Ethiopia lives in abject poverty, and 46 percent are severely undernourished. The United Nations Development Program UNDP Human Development Reports rank Ethiopia 170 of 232 countries on overall quality of life issues.

Although landlocked, Ethiopia has 7,444 square kilometers of inland water sources. Lake Tana in Northwest Ethiopia is particularly important because the Blue Nile, considered the chief headstream of the Nile River by water volume, rises there. Ethiopia shares land borders with Djibouti, Eritrea, Kenya, Somalia, and the Sudan. Ethiopia's terrain is marked by high plateaus with a central mountain range that is divided by the geologically active Great Rift Valley. Over time, rivers have cut deep gorges into the mountains. Ethiopia is subject to both earthquakes and volcanic eruptions. Elevations range from 125 meters at the Denakil Depression to 4,620 meters at Ras Dejen. The climate of Ethiopia is tropical monsoon with great variations according to topography. Natural resources are limited to small deposits of gold, platinum, copper, potash, natural gas, and hydropower.

Ethiopia's current population of 74,700,000 is undergoing great changes as Ethiopians return from the Sudan and refugees from the Sudan, Somali, and Eritrea leave Ethiopia and return to their homelands. Ethiopia is vulnerable to a number of the diseases of poor African nations. Suffering from a 4.4 HIV/AIDS rate, 120,000 people have died, and 1.5 million are living with the disease. Less than a fourth of the population has sustained access to safe drinking water, and only 6 percent of the entire population has access to improved sanitation. Consequently, Ethiopians have a very high risk of contracting food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A and E, and typhoid fever and the respiratory disease, meningococcal meningitis.

Ethiopians are also vulnerable to contracting rabies from contact with infected animals and schistosomiasis from contact with infected water. In some areas, there is high risk of contracting vectorborne diseases such as malaria and cutaneous leishmaniasis.

Consequently, Ethiopians experience low life expectancy (49.03 years) and growth rates (2.31 percent) and high infant mortality (93.62 deaths per 1,000 live births) and death rates (14.86 deaths per 1,000 population). On the average, Ethiopian women give birth to 5.9 children. The abysmally low literacy rates (35.1 for females and 50.3 for males) combine with low school enrollment (36 percent overall) to make it difficult for officials to disseminate information on health and environmental issues.

In addition to problems with environmental health, Ethiopia's fragile environment has been seriously damaged by massive deforestation, resulting in the loss of 80 percent of forests as trees are cut for use in construction and fencing and for fuel use. The loss of so many trees combined with the leeching tendencies of the eucalyptus trees has created severe soil erosion and desertification. In some areas, agricultural mismanagement has led to severe water shortages and soil degradation. The agricultural sector has further degraded the soil and polluted air and water through indiscriminate use of fertilizers and pesticides. Some estimates place Ethiopia's stockpile of banned pesticides at 3,000 ton. In urban areas, industrial and domestic waste has produced extensive water pollution.

In 2006, scientists at Yale University ranked Ethiopia 129 of 132 countries on environmental performance, far below the comparable income and geographic groups. The lowest score was predictably in the area of environmental health, but low scores were also received in the areas of biodiversity and habitat and the production of natural resources. During the civil wars, four national parks were taken over to be used as ranger camps. The government has since protected 16.9 percent of land area. Of 277 mammal species identified in Ethiopia, 35 are endangered, as are 16 of 262 bird species.

Since the late 1990s, the Environmental Protection Authority has worked with the Ministry of Economic Development and Cooperation to implement Ethiopia's Environmental Policy and conduct regular environmental assessment impact studies. Current policies focus on promoting sustainable development through the employment of organic agriculture and responsible land management. The Rural Development Plan of 2002, for instance, incorporates environmental rehabilitation into the development process. By drawing local communities into the process, the government has succeeded in formulating policies that ensure protection of essential ecosystems and biodiversity.

Band Aid and Live Aid

In 1984 the Irish singer Bob Geldof was so concerned about the famine in Ethiopia that he organized Band Aid, along with Midge Ure, performing the song *Do They Know It's Christmas?* as well as other British and Irish singers.

After Geldorf viewed a report by British Broadcasting Corporation journalist Michael Buerk on starving children in Ethiopia, he immediately asked Midge Ure about the possibility of putting together a recording, which took place on November 25, 1984, and was released on December 3, going straight to No. 1 in the charts for record singles in the United Kingdom. In fact, it outsold all the other recordings on the chart put together, with one million sales in the first week.

This was so successful that it was followed in 1985 by Live Aid, a multi-venue rock music concert that was held on July 13, 1985. It was attended by 72,000 people who packed the Wembley Stadium in London, and by 90,000 who were at the JFK Stadium in Philadelphia. Acts were also performed elsewhere, including some in Sydney, Australia, and the Soviet capital of Moscow.

The concert started at Wembley Stadium on 12:00 GMT (7 am Eastern time), and just under two hours later started at the JFK Stadium. Altogether the concert lasted for 16 hours. In the United States, ABC was largely responsible for the broadcast, with the BBC providing the coverage in Europe. Paul McCartney, one of the surviving members of the Beatles, also took part, as did Bob Dylan, Mick Jagger, and other famous performers.

Altogether, Live Aid raised £150 million ($283.6 million) to provide money to alleviate the worst problems faced by the Ethiopians suffering from famine.

Ethiopia participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, and Ozone Layer Protection. Agreements on Environmental Modification and Law of the Sea have been signed but not ratified.

SEE ALSO: Coffee; Eritrea; Pesticides.

BIBLIOGRAPHY. Central Intelligence Agency, "Ethiopia," *World Factbook,* www.cia.gov/cia (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Environmental Protection Authority, *Environmental Policy* (Federal Democratic Republic of Ethiopia,1997); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC—CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (Jefferson, North Carolina: McFarland, 1993).

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Ethology

ETHOLOGY IS THE study of animal behavior. It is a branch of zoology that focuses mainly on the role of anatomy and physiology in determining behavior, rather than analysis of psychology. The field emerged toward the end of the 19th century and was greatly expanded upon in the 20th century as a scientific study drawing on the parsimonious approach to explain animal behavior, which aims to find the simplest motivation for behavior and, thus, avoid anthropomorphizing animals. The nature of the behaviors explored depends on the animal concerned, its sophistication and structure, and the motivations it has to act in particular ways. Consequently, the ethology of simple animals with a low number of cells is significantly different from the behavior of primates, which involves sophisticated and complex social relationships.

One influential ethologist was Konrad Lorenz (1903–89), an Austrian zoologist who jointly won the Nobel Prize for Physiology or Medicine in 1973. Lorenz spent many years closely observing different types of animals, especially birds, and analyzing and describing that behavior. In his work with young geese and ducks, Lorenz observed that the young birds began to imitate their parents (or substitute parents) through a process he termed imprinting. This involved both visual and audio stimuli provided by the parents, which were mimicked by the young animals. It was possible for replacement parents to be used, and the young creatures would imitate a creature of quite another species. Lorenz also noted the adaptive and evolutionary behavior of animals, specifically with reference to changing behavior to survive in difficult or shifting environments. This led him to understand that aggression in human beings is also an innate form of behavior that exists for evolutionary survival purposes, and which may be changed with behavior modification techniques.

Ideas such as this have made ethology controversial to those people who religious beliefs inform them that humans are unique and distinct from animals. One of the joint Nobel Prize winners with Lorenz was Nikolaas Tinbergen, whose work focused on developing the issues of causation, development, evolutionary history, and function of animal behaviors and the ways they change. Sir Julian Huxley developed the ideas emerging from ethology to consider the future of human evolution and the cultural factors that he believed would influence its course. Again, his work was based on the scientific method and on the careful accumulation of observations and data.

Modern ethologists have adopted more concepts from other scientific disciplines, including sociobiology, comparative psychology, and ecology. This has enabled ethologists to take a more holistic approach. One of the most notable scientists workers in this field is Richard Dawkins, whose book *The Selfish Gene* outlines the ways that genetic programming causes behavior in animals, including humans, which is aimed at the long-term survival of the species. This means that there are occasions on which individual members of a particular species might behave in a manner that is personally self-destructive, but that is necessary for the species as a whole. Dawkins argues that humans are uniquely placed among all living creatures in being able to understand this genetic prerogative and may be able to escape from it through behavior modification techniques or through technological enhancement. While this form of ethology is aimed at humans and the higher primates, the lower forms of animals still offer many lessons for ethologists, particularly with respect to adaptation to changing environments, which may offer important lessons in dealing with global climate change and environmental degradation.

SEE ALSO: Adaptation; Animals; Lorenz, Konrad.

BIBLIOGRAPHY. Richard W. Burkhardt, Jr., *Patterns of Behavior: Konrad Lorenz, Niko Tinbergen, and the Founding of Ethology* (University of Chicago Press, 2005); Richard Dawkins, *The Selfish Gene* (Oxford University Press, 2005); Julian Huxley, *Evolutionary Humanism* (Prometheus Books, 1992); Konrad Lorenz, *Man Meets Dog* (Routledge Classics, 2002); Desmond Morris, *Primate Ethology* (Anchor Books, 1969).

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Eucalyptus

THIS GENUS OF trees and shrubs, with more than 700 species, dominates the tree flora of Australia. There are also a number of native species growing wild in New Zealand, Indonesia, New Guinea, and the Philippines, with many plantations established recently in Vietnam.

The word *eucalyptus* derives from the Greek, meaning "well-covered." In Australia, the trees are generally known as gum trees, or sometimes because of the fact that the bark seems to "peel" in the summer, they are referred to as *stringybark trees*. Although they grow wild, they are also common as trees providing shade in parks, on sides of roads and in the gardens of houses, as well as being planted in forestry plantations.

The leaves of eucalyptus trees are leathery because the tree often has to survive in areas of low moisture or water shortages. They hang either obliquely or vertically with the modified petals falling off as the flower opens and the woody cup-shaped fruits, called gumnuts, open at one end to release minute seeds.

The eucalyptus tree grows quickly and can achieve great heights, with some reaching 300 or more feet, and sometimes can have a circumference of up to 25 feet. Most of these very large eucalyptus trees survive in national parks. One peculiar aspect of the eucalyptus is that they tend to only have branches toward the top of the tree, partly because of their great height and partly because they can grow close to each other; lower branches have become superfluous.

During hot periods of the summer, the eucalyptus trees shed much of their bark and many of their leaves, allowing piles of dry leaves to form fuel for bush fires, which also happen during the summer. However, once the fire has gone through an area of eucalyptus trees, burning away all the undergrowth, the trees drop seeds that find fertile soil on the forest floor. The ferocity with which the leaves burn may have been one of the contributing factors to the Oakland Hills fire in California in 1991, as many eucalyptus had been planted in the area, close to housing.

Because the eucalyptus trees have to survive in dry climates, they have very deep roots, and this also allows them to generally survive the fires well. It was for this reason that many eucalyptus trees have been planted in Vietnam in areas affected by defoliants, because the much deeper roots can often penetrate soil that has not been as badly polluted by the chemicals as the soil closer to the surface.

Throughout Australia, eucalyptus has been used as fuel, but is also used for building, especially sheds and fencing. Joseph Banks, a botanist on the 1770 voyage of Captain Cook to Australia, took back some eucalyptus saplings, and there are now some eucalyptus trees growing in places with similar climates such as California, and also Galicia in Spain, Portugal, South Africa, and parts of Brazil, Morocco, and Israel.

The proverbial "gum tree," however, remains very much a part of the Australian identity, appearing in many paintings of Australia, and also in books, including the titles of many stories, and also in folk songs and poems.

Despite the importance and success of the species in its home range, the introduction of eucalyptus for environmental remediation and afforestation around the world has led to unforeseen negative consequences. The tree can tap deep aquifers and compete with other native species for groundwater, and it can grow aggressively in some contexts and compete for light. Some caution is now exercised before the species is recommended for plantation outside of Australia. Nevertheless, the remarkable adaptive qualities of the gum tree are widely recognized for a reason.

SEE ALSO: Australia; Fire; National Parks.

BIBLIOGRAPHY. Ian Brooker and David Kleinig, *Eucalyptus: An Illustrated Guide to Identification* (Reed, 1996); John J. Coppen, *Eucalyptus: The Genus Eucalyptus* (Taylor & Francis, 2002); Dean Nicolle, *Eucalyptus of Victoria and Tasmania* (Bloomings, 2006).

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Eugenics

THE EUGENICS MOVEMENT emerged in the late 19th century as a social philosophy advocating for the improvement of human genetic traits through social and political intervention. Although its purported goals were to benefit humanity and save society's natural resources, the theory ultimately justified racism and state-sponsored discrimination. Selective breeding, forced sterilization and birth control, and genocide are examples of the types of social control that were advocated by early eugenicists. Eugenics relies on the belief that intelligence is associated with social class and that humanity benefits by maintaining racial purity. These beliefs were widely held by academics, doctors, professionals, and politicians up until the early 20th century. Today, these views are widely discredited due to advances in the understanding of genetics and greater recognition of human rights. The legacy of eugenics continues to pervade political debates, however, concerning the causes of poverty and overpopulation and their effects on the environment.

Sir Francis Galton coined the term *eugenics* in 1883 in his book *Inheritance of Human Faculties,* which made assumptions from the recent work of Charles Darwin and the theory of natural selection. Galton assumed that human traits such as intelligence and talent were genetically determined and therefore could be improved if proper breeding selection occurred among the most-fit humans—primarily the upper classes. According to this belief, any effort to aid the poor and underprivileged is at odds with natural selection and therefore is a disservice to all of humanity. He concluded that the poor were genetically inferior, and therefore dismissed the social and political questions of why poverty exists and how it can be alleviated.

The most notorious application of state-sponsored eugenics was in Nazi Germany during Hitler's attempts to create a pure German race. Forced sterilization and genocide were grossly carried out in the name of eliminating inferior races, while economic benefits were offered for Aryan women to produce more children. The Nuremberg Trials, which indicted these actions as war crimes, raised international attention to this form of eugenics and scientific racism. The second-largest eugenics movement occurred in the United States. In 1910, the Eugenics Record Office opened with a mission to collect family pedigrees and document unfit citizens, primarily from economically and socially poor backgrounds. This was an attempt to bolster the belief that classes were hereditary traits rather than social constructs. The U.S. Immigration Act of 1924 limited entry of people considered as coming from inferior stock, meaning people from certain parts of Europe that were not as "racially pure." In addition, states had rights to sterilize any citizens that were seen as unfit, such as the disabled. During the Cold War, eugenicists suggested that any political radical was "inferior" in an attempt to discredit socialism or other forms of political and social equality.

The worldwide attention that focused on these human rights violations—especially in Nazi Germany—began to discredit eugenics ideology. Politically motivated eugenics principles manifested in other ways, however, and began to focus on the environmental effects of overpopulation and common property ownership of natural resources. In a 1968 essay, Garret Hardin, a biologist and population control advocate, put forth a thesis known as the Tragedy of the Commons that relied on a population-centered logic that has bolstered some eugenic thinking. For example, Hardin concluded that large populations (typically of the poor) make excessive claims on public resources and that society should try to curb the fertility of poorer, high population nations.

The Tragedy of the Commons thesis thus argued that the poor degrade the public stock of natural resources. It has been used by less scrupulous thinkers to further argue for specifically racial and national population control. Ultimately, the Tragedy of the Commons argument combines current concerns of environmental degradation with issues of population that make it vulnerable to the legacy of eugenics by concluding that the only way to prevent the "tragedy" of overuse is to promote preferential distribution of rights to natural resources and reproduction. Although most scholars recognize eugenics as invalid, caution must be taken to ensure that contemporary policy debates that focus on ways to conserve nature or limit population growth do not employ the racist or classist undertones endemic to previous eugenics movements.

SEE ALSO: Hardin, Garrett; Property Rights; Population; Poverty; Race; Tragedy of the Commons.

BIBLIOGRAPHY. Edwin Black, *War against the Weak: Eugenics and America's Campaign to Create a Master Race* (Four Walls Eight Windows, 2003); Stephen Jay Gould, *The Mismeasure of Man* (Norton, 1981); Eric Ross, *The Malthus Factor: Poverty, Politics, and Population in Capitalist Development* (Zed Books, 1998).

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European Union

THE EUROPEAN UNION (EU) is a union of 25 independent states joined to increase economic integration and cooperation. The EU was established by the Treaty on European Union, agreed between 12 member states on November 1, 1993. The Treaty on European Union, or Treaty of Maastricht, was ratified by Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, and the United Kingdom (UK). In 1995 Austria, Finland, and Sweden joined the EU, and in May 2004, a further 10 countries became members: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia. The member states have set up common institutions to which they delegate some of their sovereignty so that decisions on specific matters of joint interest can be made democratically at the European level.

The EU is commonly understood as an economic and political bloc, synonymous with the project of European integration, and Europe itself, when the question of European identity is raised. The Treaty on European Union grants European citizenship to citizens of each member state. Customs and immigration agreements allow European citizens freedom to live, work, or study in any of the member states. A single European currency was introduced in 2002 when the euro replaced the national currencies of 12 EU nations. Denmark, Sweden, and the UK have not joined the single currency, and national currencies are still in use in the country members that took up membership in 2004.

The EU predecessor was the European Community (EC), an organization composed of the European Coal and Steel Community (ECSC), the European Economic Community (EEC, often referred to as the Common Market), and the European Atomic Energy Commission (Euratom). The three institutions merged and created European Community in 1965 (effective from 1967) and established headquarters in Brussels.

INSTITUTIONS AND LEGAL FRAMEWORK

The institutions of EU are: the European Commission, the European Parliament, the Council of Ministers, European Council and the Court of Justice.

The European Commission makes policy proposals and presents them to the Council of Ministers, represents the EU in economic relations with other countries or international organizations, and manages EC funds and programs. It works as the executive body of the EU.

The European Parliament is the only body of the EU whose members are directly elected by the citizens of its member states. It meets in Strasbourg, though most of its committee work is done in Brussels and the secretariat is based in Luxembourg.

The 732 seats are allotted based on the population of each member state. In 2004 Germany had the largest representation with 99 seats, the United Kingdom had 78, and Ireland had 13.

The Council of Ministers is the main legislative body of the EU. It is composed of Cabinet ministers from the member governments. Summit meetings among the top leaders of the member states are called at least once every six months by the country holding the presidency of the Council of Ministers. This meeting of heads of state and government is called the European Council. The Court of Justice is the final arbiter in legal matters or disputes among EU institutions or between EU institutions and member states.

The EU represents a desire for peace and cooperation among sovereign European states. It maintains close links with 71 countries in Africa, the Caribbean, and the Pacific region (the ACP countries), which are affiliated with the organization and receive preferential economic treatment through the Suva Convention (2000). In 2004, European leaders signed a new EU constitution in Rome. Its key points included the election of a permanent EU president to serve for a term of two-and-a-half years, replacing the current rotating presidency; the appointment of a foreign minister; a legally binding charter of rights; and the adoption of common defense policies (though each country will retain a veto). The constitution was designed to take effect by October 2006 after ratification by each member country. It had been approved by Austria, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Slovakia, Slovenia, Spain, and Luxembourg; however, in national referendums held in France and the Netherlands, voters decisively rejected the constitution, casting considerable doubt on its future implementation. Despite this setback, referendums continued and ratified the treaty in July.

ENVIRONMENTAL POLICY

The EU integrates environmental policy into all policies. The main policy body is the Environment, Public Health and Food Safety Committee. The European Parliament decided to set up an environment committee in 1973. It was the 12th specialist committee, added to those set up since the European Parliament first met in 1952. The demand to deal with the consumer concerns at a European level dates back to 1967, when the first member's written question pressed the European Commission to address the issue. The committee's first directive on motor vehicle emissions was issued in 1970, and the European environmental protection law was agreed to at a conference of heads of state or government in October 1972. The environment committee took on responsibility under cooperation procedure for a series of legislative proposals on consumer protection and food safety. The responsibility includes most areas of environmental, food safety, and public health under the 1999 Amsterdam Treaty. The Environment, Public Health and Food Safety Committee has oversight and political responsibility for the activities of the European Medicines Agency (EMEA), the European Environment Agency (EEA), the European Food Safety Authority (EFSA), the Food and Veterinary Office (FVO), and the European Center for Disease Prevention and Control (ECDC). It has established a multilayered network of political links with other European institutions and international organizations in the areas of environment, public health and consumer protection.

ENVIRONMENT 2010 PLAN

The basis of EU environmental action is "Environment 2010: Our Future, Our Choice," an action program that emphasizes confronting climate change and global warming; protecting the natural habitat and wildlife; addressing environment and health issues; and preserving natural resources and managing waste. The document serves as a strategic direction to the European Commission's environmental policy till 2010. It also acknowledge the importance of: enforcing existing environmental laws; taking the environmental impact into account in all relevant EU policies (e.g., agriculture, development, energy, fisheries, industry, the internal market, transport); closely involving business and consumers in identifying solutions to environmental problems; giving people the information they need to make environmentally friendly choices; and raising awareness of the importance of using land wisely in order to preserve natural habitats and landscapes and minimize urban pollution.

The EU rules, constantly updated, provide a framework for an equal level of protection throughout the union and policy that is able to take local circumstances into account. Recognizing the value of coordinated action to solve common problems, the EU has developed comprehensive policy measures across an extensive range of environmental issues.

The EU environmental policy is based on the "polluter pays" principle. The polluter may be required to pay through the investment needed to meet higher standards or by creating a system to take back, recycle, or dispose of products after use. The payment may also be a tax on business or consumers for using an environmentally unfriendly product, such as some types of packaging.

The document "Environment 2010: Our Future, Our Choice" clarifies EU strategy to combat climate change under the Kyoto Protocol. The EU has introduced the world's first emissions trading system. EU governments issue allocations to industrial and energy businesses authorizing them to emit carbon dioxide, the main greenhouse gas, up to a certain limit. Companies who do not use all their certificates can sell the surplus to firms that exceed their emissions ceiling. Firms that exceed their limits and do not have certificates to offset this face heavy fines. Obligations under the Kyoto Protocol run to 2012, but the commission has already launched consultation on post-2012 climate change policy.

In 2002, a single European currency was introduced when the euro replaced the currencies of 12 EU nations.

When environmental threats are potential rather than proven, the commission applies the "precautionary principle:" it recommends protective measures if the risk seems real even if there is no absolute scientific certainty. "The European Environment–State and Outlook 2005" document, a five-year assessment across 31 countries, points to challenges, with climate change being just one of them. Other areas of concern include biodiversity, marine ecosystems, land and water resources, air pollution, and health. The report says Europe's average temperature rose by 0.95 of a degree C during the 20th century. This is 35 percent higher than the global average increase of 0.7 of a degree C and temperatures will continue to rise. The EU has recognized this and set a target limiting the global temperature increase to 2 degrees C above preindustrial levels.

The European Commission provides funding for the several environmental institutions. Acknowledging that sustainable environment depends on individual citizens and public participation, it financially supports the European Environmental Communication Networks (EECN), where grassroots organizations get access to information. The eco-label scheme helps citizens make environmentally sound purchases of a score of goods and services and the companies and service organizations that want to demonstrate their high environmental standards participate in independently verified eco-management and audit registration scheme (EMAS). The European Environment Agency in Copenhagen monitors the state of the environment, provides early warning of coming problems, and supplies policymakers with information on which to base their decisions. It also promotes best practices in environmental protection and technologies and helps the European Commission to disseminate the results of environmental research. The aim of the European Environment Agency is to establish a seamless environmental information system and assist the EU in its efforts to integrate environmental aspects into economic policies.

SEE ALSO: Biodiversity; Global Warming; Green Consumerism; Greenhouse Gases; Health; Kyoto Protocol; Polluter Pays Concept; Pollution, Air.

BIBLIOGRAPHY. Tim Bale, *European Politics* (Palgrave, 2005); European Environment Agency, main website, eea.eu.int/ (cited May 2006); "European Union," Microsoft Encarta Online Encyclopedia, 2005, au.encarta.msn.com (cited May 2006); Silvio Funtowicz, Martin O'Connor, Iain Shepherd, "Science, Governance, Complexity and Knowledge Assessment," in Masashi Sekiguchi, ed., *Government and Politics*, Encyclopedia of Life Support Systems (EOLSS Publishers, 2004), www.eolss.net (cited May 2006); Jonathan Golub, *Global Competition and E.U. Environmental Policy* (Barnes and Noble: 1998); "Portal to the European Union," europa.eu.int/ (cited May 2006); Chris Rumford, *The European Union: A Political Sociology* (Blackwell, 2002).

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Eutrophication

EUTROPHICATION IS THE process by which a body of water, usually a lake, becomes over-enriched by nutrients. The nutrients may comprise nitrates, phosphates, and or ammonia. The result is often an increase in the photosynthesis and growth of aquatic plants, particularly algae, followed by a decrease in plant and animal diversity. In more severe cases, dissolved oxygen within lakes may decrease to the extent that fish and aquatic plants die.

Eutrophication can be a natural process that is associated with the aging of a lake. This occurs through the erosion of mineral-rich bedrock or soil into the water. However, many more causes can be attributed to human impacts and this is sometimes referred to as *cultural eutrophication*.

Cultural eutrophication stems from various sources; one of the main causes is intensive agricultural practices, where both inorganic and organic fertilizers may either drain or be leeched into a lake. Many inorganic fertilizers are high in nitrates, which is a particularly damaging cause of eutrophication. The drainage of organic manure is also a potentially damaging factor, particularly given the high level of waste that is associated with intensive farming.

One of the most prominent drivers of eutrophication in contemporary agriculture comes from intensive livestock production in confined animal feedlot operations (CAFOs). Here, large numbers of animals are kept in small facilities where wastes are sluiced to holding ponds or tanks, sometimes unlined, and frequently vulnerable to flooding. During major rain events, organic nutrients can overwhelm nearby watersheds, resulting in massive eutrophication and large-scale fish kills.

Human settlements may, either directly or indirectly, also contribute to eutrophication. This is primarily through an increase in wastewater from treated sewage. More indirectly, recreational activities such as boating can also contribute to eutrophication through increasing the turbidity of a lake and bringing polluted sediments into suspension. Industrial discharges may also lead to eutrophication.

There are severe economic and social consequences to eutrophication. Lakewater may become undrinkable by humans, which, in turn, may cause the depopulation or abandonment of settlements that have limited access to transportable water or access via a well to underground water. Cattle and other animals drinking tainted water may die, an occurrence that has been reported in both Africa and Australia. Toxic secretions from some algae may be absorbed by fish, particularly shellfish, which are consumed by humans and have caused fatal poisoning.

In addition to drinking and agriculture, many lakes are also used for recreational tourism, although the processes associated with eutrophication may lead to a decline in recreational activities. Boating, swimming, and fishing have been negatively impacted in various areas as water quality changes to a much less aesthetically pleasing appearance and or smell. Boating and fishing may be hindered by the associated excessive growth of aquatic plants. The decline in the diversity of fish species may negatively impact recreational fishing. The result of one or more of these has affected property prices and settlement patterns as tourism shifts to less-affected water sources.

One well-studied area where eutrophication has both occurred and subsequently combated is in the Norfolk Broads in eastern England. The Norfolk Broads are a system of very shallow lakes and interconnecting rivers that are surrounded by marshes and fens. The lakes themselves are artificial, created through the excavation of peat and then subsequent flooding of the ensuing depressions in the 14th and 15th centuries. Problems started to occur in the first half of the 20th century, when water weeds began growing in open water areas. Sediment cores from the area show that the increase in the phosphorous content in the Norfolk Broads correlates readily with increases in both local human populations and farming activity and resulted in the loss of invertebrate and fish diversity and a reduction in aquatic plant and bird populations. Measures to combat the increased phosphorous began in 1977. Major sewage treatment works were especially singled out so that on one river the amount of discharged phosphorous was reduced by 90 percent. However, downstream of these major sewage treatment works, levels were only reduced by 50 percent. This discrepancy is most likely because motor boats that use the river created waves that brought the phosphorous-rich sediment, which had accumulated during previous years, into suspension. Even with the phosphorous reduction, the Norfolk Broads did not convert back to the desired status before eutrophication.

The levels of land use required to get phosphorous to the required levels would not be sustainable. Therefore, other measures need to be incorporated into the process, such as the encouragement of grazing zooplankton through the partial and temporary removal of fish populations.

SEE ALSO: Fertilizer; Lakes; Nutrients (as contaminants of water); Recreation and Recreationists; Wastewater; Water.

BIBLIOGRAPHY. "Environmental Chemistry," www.mpdocker.demon.co.uk (cited December 2006); Andrew Goudie, The *Human Impact on the Natural Environment* (Blackwell Publishers Ltd., 2000); David Harper, *Eutrophication of Freshwaters* (Chapman & Hall, 1992); B. Henderson-Sellers and H.R. Markland, *Decaying Lakes The Origins and Control of Cultural Eutrophication* (John Wiley & Sons, 1987).

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Everest, Mount

MOUNT EVEREST IS the highest mountain in the world, at approximately 8,848 meters (29,028 feet) above sea level. The mountain is known in the Sherpa language as *Chomolungma* or *Qomolangma*, in Nepalese as *Sagarmatha*, and in Chinese *Zhumulangma Feng* or *Shengmu Feng*. The English name was proposed in 1956 by Andrew Waugh, the British surveyor-general of India, after his predecessor George Everest, and was officially adopted a few years later. Before that it was known by the British administration as Peak XV. The summit ridge is the border between Nepal and China. The first attempt to reach the summit of Mount Everest was by a British team in 1921. The first to reach the summit were the Nepalese Sherpa Tenzing Norgay and the New Zealander Edmund Hillary on May 29, 1953. Over 2,000 people have since reached the summit of Mount Everest, and close to 200 have died in the attempt.

Members of the Sherpa ethnic group (from *shar,* which means "east," and *pa,* which means "people") inhabit the Nepalese side of the Mount Everest region, locally known as Khumbu. Until the mid–1960s, most Khumbu Sherpa households were involved in trade, some in urban centers as distant as Tibet and northern India. However, that trade was undermined by Chinese policies in Tibet during the 1960s, and later gradually supplanted by cash-based formal markets. Tourism has since become the main component of the regional economy, and an important contributor to national gross domestic product. Climbing permits cost between $10,000 and $25,000 per person, and salaries for the crew go from $3,500 for a cook to $25,000 or more for a lead guide for each trek. In the Khumbu region, three-quarters of Sherpa households have at least one individual who is involved in trekking. Tourism has also had an economic impact beyond the region, since many of the construction workers, household servants, and agricultural workers are migrants. However, money has also brought with it more wealth differentiation, since not all households are able to take advantage of the influx of tourism, and trekking has brought with it a general increase in the price of foodstuff and energy.

The main environmental problems in the region are deforestation and the increase of litter by trekkers and Sherpa. In the late 1960s, the local forest management policies were abandoned because of the nationalization of the local forests and the implementation of less strict national policies toward forest use. After the creation of the Sagarmatha National Park in 1976, which contains the southern half of Mount Everest, deforestation slowed. Sherpas are now forced to obtain all timber to build their houses, except the beams, from outside the Sagarmatha National Park.

Also, since 1979, trekking groups are no longer allowed to use wood for cooking and bonfires; they must use kerosene stoves. However, tourist lodges and the Sherpa still use fuel wood. To reduce litter, trekkers are forced to bring gas canisters and to pay a tax, which is only returned if they return the empty canisters. Litter is the other major environmental problem in the Khumbu area. Since 1979, the Sagarmatha National Park regulations require trekkers to haul out their litter, but few follow these regulations, which has resulted in the continual accumulation of rubbish along the trails to Mount Everest. From the late 1990s, the Sagarmatha Pollution Control Committee has addressed the problem by establishing long-term disposal facilities along the major trekking routes.

SEE ALSO: Deforestation; Ecotourism; Mountains; Nepal.

BIBLIOGRAPHY. E. Douglas, *Chomolungma Sings the Blues: Travels Round Everest* (Mountaineers Books, 2001); S.B. Ortner, *Life and Death on Mt. Everest: Sherpas and Himalayan Mountaineering* (Princeton University Press, 2001); T. and J. Tenzing, *Tenzing Norgay and the Sherpas of Everest* (McGraw Hill, 2003).

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Sir Edmund Hillary

Edmund Hilary was born at Tuakau, south of Auckland, on the north island of New Zealand. He became interested in mountain climbing while on a school mountaineering trip when he was sixteen. During World War II, Hillary served as a navigator in the Royal New Zealand Air Force, and in 1951 was a member of the British Reconnaissance Expedition to Everest led by Eric Shipton. This led to Hillary being chosen for the 1953 Everest Expedition. The news of the climbing of Everest was announced in London on the same day as the Coronation of Queen Elizabeth II, and he was subsequently knighted in Britain and given many awards. He also appears on the New Zealand $5 note, the only living New Zealander to appear on any banknote.

After climbing Everest, Hillary continued with mountaineering, returning to the Himalayas in 1956, in 1960–61, and again in 1963–65. In 1958 he also was a member of the New Zealand section of the Commonwealth Trans-Antarctic Expedition, reaching the South Pole on January 4, 1958. In 1985 he joined astronaut Neil Armstrong landing a small ski plane on the North Pole, making Hillary the first person to stand at both poles and also climb Everest.

Hillary founded the Himalayan Trust to help the Sherpas, and has been involved in advancing education in Nepal. In 2003 he was made an honorary citizen of the country, the first foreign national to receive this honor.

In 1975 Hillary had taken part in the general election and this was seen as preventing his nomination as Governor-General. However, exactly ten years later he was appointed as New Zealand High Commissioner (Ambassador) to India, Nepal, and Bangladesh, resident in New Delhi. After four and a half years in India, he retired. Edmund Hillary has written extensively about aspects of his life. His son, Peter Hillary, is now a prominent mountaineer in his own right.

Everglades

FLORIDA'S KISSIMMEE RIVER flows south into Lake Okeechobee, an expansive and shallow body of water in the south-central area of the state. At its southern end the lake slowly gives up its water to the Everglades, a vast and flat area of grasses and animal life extending southward to the Florida Keys. During the warm months, the water from Lake Okeechobee slowly flows in what has been characterized as a "River of Grass," three feet deep at its extreme and up to 50 miles in width. In the dry season, water flow is diminished and multitudes of wildlife—birds, alligators, and large cats—seek refuge near pools of deeper water until the flow of water again begins in the spring. The Everglades is a truly unique landform, and its existence was in danger following the transformation of the land south of Lake Okeechobee to agriculture and to urbanization along the Atlantic coast.

FRAGILE ENVIRONMENT

Extensive areas of vegetables and sugar cane capture large volumes of the water that perennially flowed south to the Florida Keys. As population quickly grew along Florida's Atlantic coast, vast amounts of water were moved along canals directly from Lake Okeechobee to West Palm Beach and the nearly continuous line of cities south to the Miami metropolitan complex. Robbed of its natural flow of water, the Everglades would not have survived without widespread public concern over its possible demise; and a series of governmental actions began in the 1970s. In 1972, a series of laws were passed in the Florida legislature to protect the fragile environment of the Everglades. Among them was the Land Conservation Act, authorizing the purchase of recreation lands and areas deemed to be environmentally endangered. The Save Our Everglades program was launched in 1983, which brought together federal and state governmental agencies and the South Florida Water Management District in a large-scale effort to restore the entire region to what it was 100 years earlier. Included in the program were the Kissimmee River Basin, Lake Okeechobee, the Everglades, and adjacent areas all affected by the diversion of waters from the ecosystem—the Big Cyprus Swamp; Florida Bay, the water body separating mainland Florida and the Keys; Biscayne Bay on the Atlantic coast south of Miami; and the Ten Thousand Islands, a mass of small islands off the Florida coast on the Gulf of Mexico.

Subsequent legislation created the Local Government Comprehensive Planning and Land Development Regulation, which was aimed at attaining sustainable state growth within a fully integrated planning process: local plans were required to be linked to the plans of adjacent communities and to fit well within comprehensive plans produced for the region and the state. An important plan emerged in 1987 aimed at the cleanup of polluted waters throughout the region. The Surface Water Improvement and Management Act of that year required every Florida water management districts to implement plans to ensure sustainable water quality throughout the region. As extensive as plans were through the 1980s, they paled by comparison to the scope of projects unfolding a few years later. A major redesign of the entire regional water management system was prepared for U.S. congressional approval in July 1999. The plan proposed the expenditure of $7.8 billion over a 20-year period to guarantee the life of the Everglades, the sustainability of Florida's economic growth, and a continued supply of fresh water to the burgeoning urban concentrations along the Atlantic coast.

An initiative entitled "Eastward Ho! Revitalizing Southeast Florida's Urban Core" in 1995 focused on ways to curb urban sprawl and to rejuvenate deteriorating sections of coastal cities. This initiative acts to slow down the continued loss of both wetland and valuable agricultural land to the spread of urbanization and to ensure the viability of the inner cities through gentrification programs. Perhaps no other natural region on the continent has received the degree of attention and the commitment of resources afforded to the Everglades. While experts have argued for the actual abandonment of large portions of the Great Plains, the Everglades has attracted billions of dollars in investment to maintain the unique "River of Grass" and its surrounding agricultural areas and the mighty cities along Florida's south coasts.

SEE ALSO: Land Use Policy and Planning; Swamp Lands Acts; United States, Gulf Coast South.

BIBLIOGRAPHY. Susan Cerulean, *The Book of the Everglades* (Milkweed Editions, 2002); Marjory Stoneman Douglas, *Everglades: River of Grass, Special 50th Edition* (Pineapple Press, 2003); Thomas E. Lodge, *Everglades Handbook: Understanding the Ecosystem* (CRC Press, 2004); Connie Bransliver and Larry W. Richardson, *Florida's Unsung Wilderness: The Swamps* (Westcliffe Publishers, 2000); National Park Service, *Everglades National Park Strategic Plan: 2001–2005* (Bureau of the Interior, 2001).

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Evolution

EVOLUTION IS A theory of the origin and transformation of life forms over time. Plants and animals exist on earth in an enormous abundance of forms or species. Evolution seeks to explain scientifically the origin and the development of new species from old species, as well as the beginning of life itself.

The existence of enormous numbers of older species, most of which are now extinct, is supported by the evidence of fossils. The rise of newer species is supported by a variety of evidences, including their living existence. Evolution seeks to explain with only natural evidences that these enormous numbers of species (both extant and extinct) originated eons ago in the Pre-Cambrian Era as single-celled life forms. It also seeks to show that over the last 600 million years (when life first appeared on earth), those life forms have changed. The claim that life has evolved, that is, that species have changed from one kind of species into a new species, has been the subject of enormous scientific, religious, and political controversy.

The theory of evolution is closely associated with Charles Darwin, who published *The Origin of the Species* in 1859. Darwin's publication was subsequently followed by many others. However, his earlier work, *The Voyage of the Beagle*, described the five years that he spent as a naturalist circumnavigating the world. It was a public version of the journal he kept during his journey.

Darwin's journey aboard the *H. M. S. Beagle* had been his first job after college. In *The Voyage of the Beagle,* Darwin described how he began the voyage as a person who accepted the view, like many others, that the world was of a relatively young age: between 6,000 and 10,000 years old. The theory estimating the age of the earth at 6,000 or more years had been propounded by Bishop James Usher (1581–1656), who derived his calculation by counting the generations of people in the Bible.

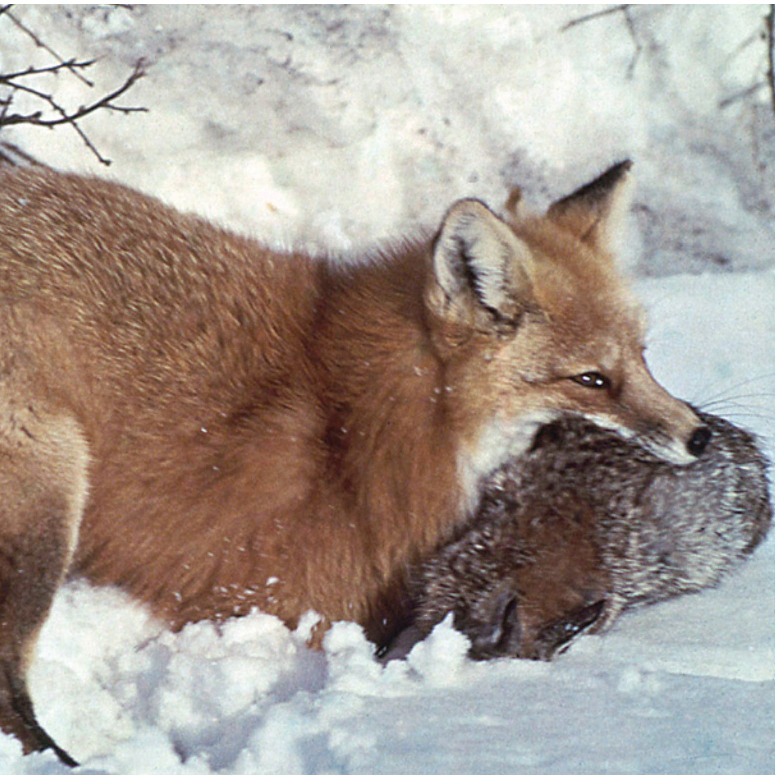
As the *Beagle* sailed south, it took Darwin on a journey that enabled him to see vast regions of the world, including much of South America in what was still pristine condition. Eventually, he was forced to extend the timeline for the age of the earth to make it longer and longer.

Darwin described how he saw thick beds of sea shells along the coast of Argentina and was unable to believe that these were the product of a single global flood. He visited older mountain ranges in South America and saw newer ranges, thus forcing him to conclude that it took enormous numbers of centuries for the natural phenomena that he was observing to have occurred.

While the crew of the Beagle was making soundings to create naval charts of the coasts of South America, Darwin as the professional naturalist explored inland in Brazil, Argentina, and Uruguay. He collected great numbers of specimens of birds, plants, animals, reptiles, and minerals. These were catalogued and shipped to England for analysis. There are warehouses today with this great collection of specimens available for comparison with the fauna and flora of the regions that Darwin first explored.

As Darwin traveled, he saw enormous geological formation and evidence of change. He was also exposed to a massive earthquake while visiting Chile. Afterward, he was able to see geological forces at work building mountains. His visit to the Galapagos Islands was crucial to the development of his theory of evolution. It led him to develop the idea that the species of plants and animals that populate the world are not fixed but change.

While preparing to publish, Darwin read Thomas Malthus's book, *Essay on the Principles of Population,* which postulates that populations grow geometrically while food supplies grow only arithmetically. The Malthusian principle is that life is a struggle for survival in the face of enormous competition for limited resources.



The natural selection in nature's struggle to survive was interpreted as the survival of the fittest.

In 1859, Darwin published his views on the mutability of the species. His theory was met with numerous responses. One reaction was ready acceptance of the idea, because the developmental philosophy (German Idealism) of G.F.W. Hegel had helped to prepare the way. Darwin's ideas influenced Karl Marx and his views on the development of world history and of human society. Using classes as his basic unit of analysis, he concluded that eventually the capitalist class would become extinct, and the proletarian class would take over the world.

In 1860, the theory of natural selection was applied to societies. The idea that people in societies struggle for survival was developed by Herbert Spencer. The natural selection in nature's struggle to survive was transformed into Social Darwinism and interpreted as the survival of the fittest. The fittest, it turned out, were the rich and successful. In America and elsewhere, Social Darwinism was used to justify numerous laws that were harmful to the poor.

A famous Supreme Court decision, centered on the evolution debate, was known as the Scopes Monkey Trial. The case pitted Clarence Darrow, a leading trial lawyer of the day, against populist champion, unsuccessful presidential candidate, and former Secretary of State William Jennings Bryan. The outcome of the trial was mixed.

The verdict went against Scopes for teaching evolution at school. However, public opinion went against Bryan and the opponents of evolution. The case was broadcast on radio and was the first electronic media event. Eventually being for or against evolution became a political litmus test, and the issue is one that is alive and well today.

Those who adhered to a strict creationist viewpoint won the battle, but lost the campaign. Other supporters have opposed evolution with the theory that the universe exhibits evidence of intelligent design, a scientific version of a teleological argument for the existence of God.

Darwin, along with his supporter Julian Huxley, engaged in a long debate over the nature of evolution. The idea was not completely new, as Darwin acknowledged in *The Origin*. At least the germ of the idea can be found in the metaphysical philosophy of the Greek philosopher-scientists, as early as five centuries before the birth of Christ. The Thales (624–548 B.C.) and Anaximande (588–24 B.C.), physical monists and members of the Miletian Schools, included developmental elements in their philosophies. The pluralist philosopher Empedocles (495–35 B.C.) saw fossils in the mountains of Sicily and suggested that life began in the sea along with others after them had espoused the idea.

The works of Aristotle were to give fodder to later opponents and supporters of the idea. From Aristotle, opponents took the idea of the fixity of the species and applied it to the Genesis account of creation. They interpreted the meaning of created "after their own kind" as an Aristotelian fixity of the species. However, during the Age of Discovery, so many new plants and animals brought new questions to help with understanding the enormous diversity of the species along with the idea of extinction.

In the 1700s, lawyer James Hutton applied the idea of uniformity to the development of species. In 1802, John Playfair published *Illustrations of Huttonian Theory of the Earth*. The idea of uniformitarianism was given further explication. Then Sir Charles Leyll published in 1832 *Principles of Geology,* which espoused inorganic evolution.

Inorganic evolution is the view that the inorganic world also has a biography that can be discovered and read. This view has been extended to the whole universe. The dominant theory today is the Big Bang Theory, which has a part of modern cosmology.

Organic evolution was espoused prior to Darwin by Jean Baptiste de Lamarck in *Philosophie Zoologique* (1809). He claimed that species adapted to life and then passed these adaptations on to their offspring. The Lamarckian theory seemed to apply nicely to the development of species. While this theory was also to heavily influence Social Darwinism, it was eventually to be refuted by the work in genetics of Gregor Mendel, a monk and a physicist. In order to help his fellow monks with their crops, he undertook crop experiments. With a mathematical eye to simple laws, he stated the conclusions of his experiments with breeding peas in a paper in 1865. Unfortunately, the paper was published in an obscure journal and was not widely read until 1900. By 1909, the term *gene* was invented to describe the hereditary particles that were described by Mendel in his paper.

EXPLAINING EVOLUTION

Darwin's theory explained that species show variation, which is a characteristic of all plants and animals. Darwin did not know that species undergo mutations, so he stressed slow incremental changes. He also observed that more individual organisms are born than there is food to support them, implying their struggle to survive in competition with each other and also against the vicissitudes of nature. In addition, the numerous variations presented by the members of different groups make it easier for some to survive and for others to fall by the wayside in the struggle for existence. The idea of the survival of the fittest therefore lies at the center of the process of natural selection. And as individuals survive, they are more easily able to pass these successful variations to their own offspring through succeeding generations.

The slight changes in the generations makes offspring better adapted to the changes in the environment that facilitate survival and propagation. Given enough generations, the changes can be significant enough that new species develop through the ongoing process of natural selection. The process of natural selection then can cause divides, so that one line develops characteristics that mark it as a different species from another line from the same parents that becomes a different species.

The intuitive appeal of Darwin's theory soon promoted its wide acceptance. It also continued to be rejected by others. One of the concerns addressed by some was that variations appear in many species that may be interesting but that have nothing significant about them. These variations neither help nor hinder the survival of the individuals with the characteristics nor enhance their survival. At the time of Darwin, this was a puzzle. Today, it is an accepted fact that these variations are simply non-adaptive differences controlled by genes.

Darwin's theory faced a different challenge after 1900, when the work of Mendel was discovered. Two corrections were made necessary by Mendel's theory of genes. The first was that to be useful for natural selection, genetic material must be inherited as a variation. Secondly, the fact of geographic or genetic isolation is necessary to prevent interbreeding.

The theory of evolution as espoused by Darwin did not include genetics; modifications were seen as evolutionary changes. However, the variations between living organisms that are caused by environmental actions are modifications, not permanent genetic changes that mutations in genes cause. For example, physical or chemical actions on an embryo may cause it to develop a congenital herniated diaphragm, a modification of the normal diaphragm. However, if the infant lived to reproduce that birth defect, it would not be transmitted to offspring. It is merely a modification of a physical feature that was probably caused by a chemical interference in the fetus' development. For each step in evolution to occur, an infant with a birth defect would have to have a line of descendants with the same defect.

Another feature of Darwin's version of the theory of evolution was that isolation was necessary for the members of a group to change so that a new species would eventually develop that could not longer breed successfully with other descendant of the original stock. Geographic isolation is the most common kind, and was what Darwin found in the Galapagos Islands as well as what primate researchers think is the source of the differences between chimpanzees and bonobos. Separated by the Congo River, they have followed different developmental tracks.

Another form of isolation is genetic isolation. If two isolated groups that were originally the same species are reunited and after breeding produce only sterile offspring, then genetic isolation has occurred. Ecological isolation can occur if the same species develops in close proximity, but in different local habits they may cease to interbreed. It may be due to such things as breeding at different times of the year as well. Darwin also assumed, erroneously, that variations were permanent.

Preadaptation, a theory of natural selection, recognizes that mutations occur randomly and does not have to be beneficial. It can be insignificant, or so harmful that it leads to a failure to survive. There are several types of mutations. Chromosomal mutations change the structure of the chromosome. Changes by addition or subtraction can produce polyploids that are larger and more robust than their parents. This feature of change has been used to produce bigger cultivated varieties of crops.

Darwin's visit to the Galapagos Islands was crucial to the development of his theory of evolution.

The theory of evolution is not without its difficulties, one of which has to do with prediction. It is virtually impossible to predict when genetic mutations or isolation events that will occur as the first step in the evolution of a new species. Another problem is that early evolutionists held to the idea that evolution was an almost deterministic straight-line path of progress, or *orthogenesis*. Investigators, especially paleontologists, have reported that the fossil record does not support this viewpoint. Rather, fossils show that orthogenesis is not normal and has probably never occurred. Species seem to flourish and then experience a massive extinction. The survivors of the few remaining species then repopulate and evolve a new set of species.

The late Stephen Jay Gould argued that the early understanding of evolution was deeply influenced by the idea of progress. This led to ideas that were rigidly deterministic and value-laden even when they appeared not to be. In fact, in the early 1900s, the idea of progress and racism were closely associated, and was assumed that progress was always from primitive to superior, which acquired a moral status: It was good, while the primitive was bad.

Another theory of evolution is *hybridization*. African bees bred with South American bees produce killer bees, a hybrid that is more aggressive and a better producer of honey than the gentler European honey bee. Whether this is a hybrid that will lead to future changes and new species of bees remains to be seen. If so, then it will support the idea that cross fertilization is what led to the development of the numerous species, at least in some cases.

At stake in the theory of evolution is the truth about the origin and development of life. Also at stake is the worth of people and of the world. If life is a mere cosmic accident, does that mean that there are only the values that the strongest impose? Or was life brought forth by divine fiat speaking the Word? If so, then humans created in the image of their creator are valuable and are worthy of respect. If not, perhaps anything goes in the survival of the fittest.

SEE ALSO: Adaptation; Biodiversity; Darwin, Charles; Extinction of Species; Genetic Diversity; Keystone Species; Malthus, Thomas; Marx, Karl; Mutation; Social Darwinism; Species.

BIBIOGRAPHY. Michael J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (Free Press, 2006); Charles Darwin, *The Origin of the Species: By Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life* (New American Library, 1958); Douglas Futuyma, *Evolution* (Sinauer Associates, Incorporated, 2005); Stephen J. Gould, *Wonderful Life: The Burgess Shale and the Nature of History* (W. W. 1989); Stephen Jay Gould, *Ever Since Darwin: Reflections in Natural History* (W. W. Norton, 1992): Stephen Jay Gould, *Rocks of Ages: Science and Religion in the Fullness of Life* (Ballantine Books, 1999); Stephen Jay Gould, *The Panda's Thumb: More Reflections in Natural History* (W. W. Norton, 1992); Phillip E. Johnson, *Darwin on Trial* (Intervarsity Press, 1993); Eli C. Minkoff, *Evolutionary Biology* (Addison-Wesley Publishing Co., 1984); Ralph O. Muncaster, *Dismantlling Evolution: Building the Case of Intelligent Design* (Harvest House Publishers, 2003); James Lawrence Powell, *Night Comes to the Cretaceous: Comets, Craters, Controversy, and the Last Days of the Dinosaurs* (Harcourt Brace & Co., 1998); Mark Ridley, *Evolution* (Blackwell Publishers, 2003); J. William Schopf, *Cradle of Life: The Discovery of Earth's Earliest Fossils* (Princeton University Press, 1999); Bernard Wood, *Human Evolution: A Very Short Introduction* (Oxford, 2005).

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Expertise

EXPERTISE COMES FROM the Latin *experiri,* which means to experience something. An expert primarily referred to someone who acquired skills or knowledge through experience. However, the meaning gradually changed to designate a specialist in a specific area.

These specific skills or knowledge defining an expert are usually ratified by a diploma. The role of experts is to provide support for decision-makers (whether in policy, business, or court) by calling on their knowledge to elucidate the consequences of actions in complex areas; for instance, the case for technical matters such as energy policy, health, or scientific policy.

The word *expertise* appeared in western European countries in the 14th century, first designating people called in front of court in order to help judges to decide on certain matters when common knowledge was not sufficient. This practice has led to what is known today as expert witnesses.

MODERN DECISION MAKING

Modern expertise as practiced during most of the 20th century appeared during the 19th century as the ground for rationally governing emerging nation-states. Impersonal bureaucracies covering different fields of competences were built up in order to manage all the knowledge and skills required in each specific field. Experts working for these bureaucracies had to have a diploma or training recognized by the state, allowing an expansion of state authority by setting the official trainings as standard and ensuring that all expertise throughout the territory would be practiced on similar ground. It also led to closer bonds between the scientific community and civil servants in need of expertise. Modern experts supported decision-making through evaluating possible consequences of decisions through models or scenario analysis in order to reduce uncertainty. Based on this, officials would decide. In most cases, however, the way expert reports would be framed strongly influenced the decision-makers.

In the second half of the 20th century, especially after the 1970, the position of experts in decision-making procedure was more thoroughly put into question. Groups of citizen started to argue that experts were withholding some topics from democratic decision-making, giving thus the sense that one was living in a technocracy.

Environmental concerns played a very important role in questioning the use of expertise in decision-making. The growing awareness of harms caused to the environment by new technologies and scientific applications lead to a mistrust of the public toward experts because they were perceived as the ones who were implementing these technologies and applications in everyday life. This mistrust was reinforced by social critics' considerations on how technocracy was dispossessing people from their own life. Another reason for this skepticism was the growing sense of failure of decision-making system relying exclusively on expert knowledge. By the end of the 20th century, in several areas that had strongly relied on expertise, policy outcomes were very different from what had been expected. One example for this was agricultural modernization, promoted by most governments and international organizations in the postwar era in industrialized as well as developing countries, which hoped to increase food production but led to soil pollution and impoverishment. Other factors included major environmental catastrophes in policy area dominated by or relying strongly on expertise, such as nuclear power production.

Along with the growing awareness of environmental problems there have been new challenges on expertise. On the one hand, experts have to respond to critics asking for more democratization, and on the other, they must cope with the increasing complexity and uncertainty when dealing with societies and ecosystems. Rather than suppressing expertise, these new challenges have contributed to a proliferation and diffusion of expertise. Questioning of expertise often happens after scrutiny of expert reports, revealing inconsistencies or errors, and comes along with founded alternative propositions. This generalized the practice of counter-expertise, which has become a standard in policy procedures. This does not denote a tendency toward obscurantism, but rather a diffusion of scientific knowledge in broader parts of society. This corresponds to what some authors have named a social distribution of expertise, which has been spreading since the end of the 20th century.

The complexity of some matters, such as ecosystem management, results in a rise of expertise because of the number of scientific disciplines involved in such projects. For instance, the restoration of wetland habitats requires the competences of civil engineers, botanists, or hydrobiologists, each of whom might provide very different insights on a same problem, thus opening room for democratic debates.

New practices of expertise also tend to go back to the former understanding of the word and rehabilitate experience. Accordingly, a greater place is given to lay knowledge (or *indigenous knowledge*, in the context of development aid) within decision making. Lay and indigenous knowledge are specific to particular contexts or practices. These inputs are increasingly integrated in expertise, either because they are considered as a part or as a counterpart of expertise. They enable covering aspects of a problem that are not tackled by scientific disciplines, such as the affective, religious, or symbolic value of a place affected by a project.

SEE ALSO: Land Use Policy and Planning; Nuclear Power; Science and Technology Studies (STS).

BIBLIOGRAPHY. Karin Bäckstrand "Civic Science for Sustainability: Reframing the Role of Experts, Policy-Makers and Citizens in Environmental Governance," *Global Environmental Politics* 3(4) (Massachussets Institute of Technology, 2003), Frank Fischer, *Citizens, Experts, and the Environment: The Politics of Local Knowledge* (Duke University Press, 2000.

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Exploration, Age of

EXPLORATION ENTAILED DISCOVERY of unknown lands by a certain culture and recognition of environments favorable for settlement or valuable resources for trade and, ultimately, a market for elaborated products of the metropolis. It normally implied contact with distinct and distant cultures and sometimes with organized political structures so that, depending on the attitude of both parts, the contact could derive into conflict, cooperation, or assimilation. Exploration also meant confronting harsh environments, storms, famine, thirst, diseases and scurvy in the seas, cold and dry regions, and tropical forests.

Exploration has been a key component in the configuration of empires and states, preceding or accompanying political expansion. The motivations were a combination of commercial, political, religious, and scientific interests. Discovery and exploration commonly brought parallel progress in the fields of the natural sciences—biology, geology, geography, and anthropology, and determinately influenced innovation and improvement of transportation and navigation systems. Newly collected information on the territories helped to improve geographical representation on maps and portolans, which in

The most striking discovery in the age of exploration was the Spanish expedition of Christopher Columbus in 1492.

turn favored initiating new explorations and territory reclamation. Portolans were specially decisive for safe navigation; they represented directions, marine routes, principal physical ocean features, and ports. Exploration meant great expenditures, which required private and state investments for supporting presumably long and uncertain journeys, to remunerate manpower and disburse for transportation and navigation resources.

The age of exploration designates a phase in the process of European territorial expansion from the 15th to 18th centuries. During this time, Europe had a leading role in geographical exploration, which determinately contributed to connect almost the whole world and shape the geography of lands and seas.

The seven expeditions of Cheng Ho, from 1405 to 1433, supported by the expansionist strategy of the Chinese emperor Cheng-tsu, represented an isolated initiative but with a patent exploration mission. Within a tradition of contact and exchange with the Indian Ocean, Cheng Ho led a venture noted for its magnitude as for the lack of continuity.

Portugal and Spain took initiative within Europe. First, both became interested in the surrounding seas and discovered the nearer Atlantic islands of the Macaronesia (Madeira, Canaries and Azores) by mid-14th century. This area, the Atlantic Mediterranean, eventually became the base for future explorations in Africa and America.

The Portuguese developed a planned program—conceived by Prince Henry of Portugal (1398–1460)—which included a school of navigators and cartographers in Sagres, the manufacturing of navigation instruments, a ship-building industry in Faro, and adopted the caravel as a ship for oceanic sailing. They pretended to gain access to the sources of gold and slaves in the western coast of Africa and to the Indian species through an eastern route. Bartolomeu Dias rounded the Cape of Good Hope in 1497–98 benefited by the sub-equatorial Atlantic wind system. It was Vasco da Gama, in an expedition in 1498–99, who reached India and established an alternative route to that ruled by Arabs through the Red Sea and gave the Portuguese an advantage over the Spaniards. The early diffusion of Islam contributed to the commercial integration of the western Indian Ocean up to Indonesia by the 13th century. When the Portuguese navigator Francisco Serrao reached the Moluccas by 1512, a Portuguese monopoly on spices started and changed the situation. Despite this progress, the interior of Africa remained rather unknown to the rest of the world until the 18th century.

CHRISTOPHER COLUMBUS

The most striking discovery in this age was the Spanish expedition of Christopher Columbus in 1492—followed by other three voyages in 13 years—searching for an alternative western route to the Indies. The encounter with America started the colonization of a whole continent by Europeans. Columbus was supported by Isabel, the Queen of Castile, and he used the Canary Islands as a platform to ride on the northeast trades to cross west and the westerlies to return. Columbus was followed by a rapid process of exploration, colonization, and settlement. Hernán Cortés conquered the Aztec empire and explored the New Spain (Mexico) from 1518 to 1536, and established the base of the Spanish Empire in America. South America was explored through the Pacific and Atlantic Oceans. By mid-16th century most of the subcontinent was roughly explored. Francisco Pizarro (1524–33) occupied the Northern Andes; the Southern Andes were explored by Pedro de Valdivia, who reached Chile in 1541; and Diego de Rojas went through the Chaco and Tucumán in 1543. The search for El Dorado, an imaginary land of fabulous wealth, stimulated the exploration of the inland South America. Francisco de Orellana explored the Amazon between 1541–46. From the Atlantic, Pedro Álvares Cabral initiated in 1500 the Portuguese exploration and colonization of Brazil.

The rivalry between Spain and Portugal led to periodical sovereignty conflicts in Brazil and the Moluccan Islands. The Treaty of Tordesillas (1494) was an attempt gained by the Pope Alexander VI to resolve the territorial disputes between Portugal and Spain, a world repartition, which divided the Earth into two hemispheres—western for Spain and Eastern for Portugal. The different interpretation by the two parties led to the continuation of the conflict until the Treaty of Zaragoza (1529).

A southerly Atlantic passage securing Spanish access to the Pacific Ocean in the continuous search for an alternative route to the Spice Islands was found by Fernão de Magalhães (Ferdinand Magellan) in 1520. The expedition traveled through the Pacific Ocean with a northwest direction until getting to the Philipines. Magalhaes was killed in 1521, and his pilot Juan de Elcano continued west to reach Spain through the Indian Ocean and the Cape of Good Hope, completing the first circumnavigation of the earth.

The exploration of northern America was initiated by the Norse in the 10th and 11th centuries discovering Greenland, Labrador, and Newfoundland. European exploration from the north was pursued by Giovanni Cabotto (John Cabot) in 1497–98, with the backing of the port of Bristol, and although he did not succeed to settle he placed England in a position of interest in the Northwest passage to trade with Asia, a route to the Pacific. Until 1819–20 the passage through this labyrintic frozen area was not completed by Robert McClure from the west in 1850 and William Parry from the East. The exploration of the southern part of North America was carried out by Álvar Nuñez Cabeza de Vaca between 1528–36, starting from Florida,

Henry the Navigator (1394–1460)

The man whose inspiration and energy was credited with starting the Age of Exploration was Henry "The Navigator" who was the third son of King John I of Portugal. In 1415 Henry, having been trained as a soldier, took part in the capture of the city of Ceuta in Morocco in 1415—an event now seen as the first establishment by a European power of an overseas colonial empire. Henry was appointed as governor of Ceuta, but left after seeing that it was well-defended. He returned three years later when he heard that Moors from the Kingdom of Granada in Spain were sending reinforcements to Morocco to try to seize the city.

It was in 1418 that Henry started to sponsor a few small voyages—the first were very modest and involved two of his squires sailing to Madeira, which had been "discovered" by sailors from Genoa many years earlier. When Henry returned to Portugal, he became governor of the Algarve and established his own court attracting sailors, adventurers, astronomers, and cartographers. In 1420, he was appointed Grand Master of the Order of Christ, the order which had taken over from the Knights Templar in Portugal. Using funds from them and from other sources, he sponsored voyages to Africa with the dual object of trade and of converting people there to Christianity. He was to be supported in this venture by his brother Prince Pedro who came across a copy of Marco Polo's *The Travels.* The result was a number of early expeditions to the ports along the Atlantic coast of Morocco.

The first great voyage was by Gil Eames who, in 1434, rounded Cape Bojador, with subsequent voyages reaching what later became the Spanish Sahara (now southern Morocco). At the same time, other Portuguese sailed to the Azores. The capture of the Moroccan port of Tangier followed, as did further expeditions to West Africa. One voyage in 1441 brought back both gold and slaves, with another expedition four years later reaching the Senegal River. Much of Henry's life was taken up by court intrigue in Portugal and although given the title "The Navigator" by English writers, the Portuguese point out that he never went on any voyages himself.

through Texas and northern Mexico. The exploration of the interior of North America was accomplished by British and French explorers, these particularly along the Mississippi River and Labrador. After 1776, the United States began its own exploration. The Lewis and Clark expedition (1804–05) was the first U.S. overland expedition to the Pacific coast to gain knowledge of the American west.

The exploration of the Pacific Ocean started with Magalhães finding the southern passage and continued with more Spanish expeditions, but none were able to return back through the Pacific Ocean until Andres de Urdaneta was able to navigate sufficiently north to find the North Pacific Current in 1565, which took him back to New Spain. Other European countries, namely England and France, became soon interested in the area, and completed the gaps in the discoveries made by the Spaniards. Sir Francis Drake was commissioned by the Queen of England to circumnavigate the earth, which he did between 1577–80, and Louis Antoine de Bougainville completed the first French circumnavigation from 1766–69. Exploration of the north Pacific mainly took place in the last half of the 18th century, based on a dispute for the control of the fur trade between Spanish, Russians and British. Two main geographical questions were resolved, the confirmation of the peninsula character of California and the Bering Strait. The identification of a separation by sea between America and Asia by Vitus Jonassen Bering (1728) and Aleksei Chirikov (1741) made the world aware of a lack of a passage in temperate latitudes.

Terra Australis Incognita was an obscure land for a long time, and drove many expeditions. Luis de Torres crossed in 1606 the strait that separates Australia from New Guinea; but still the question of the insularity remained until Abel Tasman revealed its nature in 1642–44, particularly the southern separation, preceded by the surveys of the Dutch East India Company. James Cook, with his three voyages from 1768 until his death in 1779, completed the whole picture of the Pacific Ocean, discovered the Hawaiian Islands, reached the Antarctica and mapped New Zealand, and epitomized the end of an era where the main discoveries where completed.

SEE ALSO: Colonialism; Columbian Exchange; Trade Winds.

BIBLIOGRAPHY. Carlo Cipolla, *Guns, Sails and Empires: Technological Innovation and European Expansion, 1400–1700* (New York, 1965); Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900-1900* (Cambridge University Press, 1986); Felipe Fernandez-Armesto, *The Times Atlas of World Exploration: 3,000 Years of Exploring, Explorers, and Mapmaking* (Harper Collins, 1991); *Oxford Atlas of Exploration* (Oxford University, 1997); John H. Parry, *The Age of Reconnaissance: Discovery, Exploration, and Settlement, 1450-1650* (University of California Press, 1982); John H. Parry, *The Spanish Seaborne Empire* (University of California Press, 1990).

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Externalities

AN EXTERNALITY, ACCORDING to economic theory, is a negative or positive impact of a market transaction on people not involved in that transaction (i.e., neither the buyer nor the seller). An example of a positive externality is the construction of a beautiful building that adds to the attractiveness of a city. Environmental issues usually involve negative externalities, however, including air and water pollution, waste disposal, degradation of ecosystems, depletion of natural resources, and adverse impacts on human health. The main impact of externalities may occur at the time of the transaction, or later, such as acid mine drainage from abandoned coal mines.

Many economists regard externalities as an exception in economic activity. However, environmentalists disagree, because virtually every economic transaction involves the manipulation of natural resources, which are eventually returned to nature as waste, with an increase in entropy. The primary response by economists to this problem has been the call for "internalizing externalities." If every resource is owned by someone, then all costs of economic production will be internalized. For example, if people own clean air, then polluters must pay them for polluting the air, the costs of air pollution will be internalized by the polluters, and passed on to consumers of the products they manufacture.

Furthermore, according to Ronald Coase, it does not matter whether people have the right to a clean environment or polluters have the right to pollute and must be compensated for not polluting—as long as such rights are assigned, negotiations between polluters and the polluted will lead to an economically optimum amount of pollution. This optimum exists when further reduction of pollution would cost more than the benefits (e.g., the dollar value of better health). According to this theory, the government should assign property rights in all natural resources and could then allow the market to determine the amount of pollution. However, a critical caveat is that transaction costs (such as costs of enforcing property rights) must be minimal for this theory to apply.

In the case of nonexcludable resources such as air and water, this is rarely, if ever, the case. Furthermore, Coase's theory assumes that willingness to pay is an accurate measure of the value of resources to people. This assumption is open to challenge both because poor people cannot pay much even for a resource they value highly, and because, as David Bolliers points out, few people are willing to pay anything for something they regard as stolen property.

Nevertheless, Coase's ideas have been used in efforts to control air pollution where tradable rights to pollute are given away or auctioned off by the government, leading to more cost-effective pollution control. The government still sets the total amount of pollution to be allowed and enforces compliance, while the market determines which companies invest in pollution control and which methods they choose, allowing costs of pollution reduction to be minimized.

Peter Barnes has proposed that internalizing externalities is a good idea, but that it *is* important who owns assets such as clean air. He has proposed that such resources be made into the common property of a nation's citizens and administered by a trust that charges polluters and pays out the proceeds equally to all citizens. An institutional model is provided by a trust in the state of Alaska that distributes some of the state's oil wealth to its residents. Such a solution would internalize at least some of the externalities associated with resource depletion or degradation, with reasonably low transaction costs.

The notion of internalizing externalities can also be criticized because many if not most externalities can not be quantified in dollar terms because they affect goods that are not traded (e.g., human health and biodiversity), because the magnitude of the impacts is unknown (e.g., how many cancers a toxic chemical may cause), or because the most serious impacts may occur only in the distant future. Furthermore, many externalities involve irreversible effects, such as species extinctions, which cannot be internalized by market mechanisms, and require the involvement of collective institutions such as the state.

SEE ALSO: Economics; Polluter Pays Concept; Pollution, Air; Property Rights.

BIBLIOGRAPHY. Peter Barnes, *Who Owns the Sky? Our Common Assets and the Future of Capitalism* (Island Press, 2001); David Bollier, *Silent Theft: The Private Plunder of Our Common Wealth* (Routledge, 2003); Ronald Coase, "The Problem of Social Cost," *Journal of Law and Economics* (v.3, 1960); Herman E. Daly and Joshua Farley, *Ecological Economics: Principles and Applications* (Island Press, 2004); Tom Tietenberg, "Lessons from Using Transferable Permits to Control Air Pollution in the United States," in Jeroen C.J.M. van den Bergh, ed., *Handbook of Environmental and Resource Economics* (Edward Elgar, 1999).

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Extinction of Species

AS LONG AS members of a species survive and reproduce themselves, they perpetuate themselves. However, if all the members of a species die, then the species becomes extinct. Extinction is local if a species disappears from a part of its range, but still exists elsewhere. A global extinction is the total disappearance of all the members of a species so that none are left alive on the earth.

Paleontologists have discovered millions of species of plants and animals that experienced extinction in the approximately 550–600 million years that life has existed on earth. The fossil remains of living creatures show clearly that life was teeming on the earth during the Cambrian Era. Many scientists believe that life probably emerged in the chapter of the biography of the earth called the Precambrian Era. However, these were probably soft bodied-fauna and flora. In the absence of shells, skeletons, or hard body parts, they have been lost to the fossil record. What is certain is that in the Cambrian Era, life forms exploded in number. New species seemed to have developed very rapidly.

Despite the presence of life and of numerous species, it is now known from the fossil record that massive deaths of whole species also occurred. Paleontologist, biologists, and other life scientists have estimated that extinction is a fact of biological life. It is estimated that at least 99.7 percent of all the species that have ever lived on earth are now extinct. The law of life is extinction.

MASS EXTINCTIONS

There have been an estimated five mass extinctions in the history of life on earth. Fossil evidence strongly suggests that massive dying of species occurred in the Ordovician, Devonian, and Permian geological eras. The most obvious example is the disappearance of the dinosaurs. These mass extinctions have been uncovered by paleontologists as they have examined the fossil record. The pattern has been the development of a few species, then an explosion in the numbers of new species, followed by a period of little change, followed by a deep dip in the number of species. The extinction-causing event is followed by a new period of at first slow development and then an explosion in numerous new species and then another massive loss.

Mass extinctions have been best seen in the fossil record of marine animals. The sedimentary record is clearer because better fossil specimens have been deposited in marine sediment than in other kinds of sediment, and show that the Paleozoic Era of the Cambrian Period was a time of rapid expansion, which was followed by massive extinctions in the Ordovician Era. Approximately 50 percent of the animal families disappeared. This massive die-off included many trilobites.

Species continued to diversify between 500 and 350 million years ago when the Ordovician extinction was followed by a Devonian extinction. At that time, about 30 percent of the species disappeared in animal families. Again many trilobites disappeared, along with many agnathan and placoderm species of fish.

In the Permian Era, about half of all animal families vanished. These included many of the new species that had not been found in the fossil record prior to the Devonian extinction. Swept away were 95 percent of marine species, great numbers of trees, amphibians, most bryozoans and brachiopods and all trilobites. The Triassic extinction occurred about 180 million years ago. It destroyed many reptiles, animal families and many marine mollusks. It is estimated that 35 percent of the animal families disappeared.

The fifth of the natural mass extinctions was the Cretaceous extinction. It was the most destructive and to date most widely known by the public. In the Cretaceous Era, which lasted for 165 million years, the dinosaurs were the rulers of the earth. Then, not slowly or gradually—but suddenly—all of the dinosaurs and most reptiles vanished into the Cretaceous Night. Gone were Tyrannosaurs Rex and all of his prey. Along with the dinosaurs, numerous other species aslo disappeared.

AT ODDS WITH EVOLUTIONARY THEORY

The disappearance of the dinosaurs from the fossil record was disturbing to many geologists, biologists, paleontologists, and others because it violated the idea of evolutionary uniformitarianism. This philosophy of science views evolution as a process in which development of species proceeds very slowly through the workings of natural selection. New species come as each generation breeds its offspring and then allows them to find ways to adapt to nature's changes.

In the history of geology and biology, the idea of evolution as stimulated by catastrophes became repugnant very early. Eventually, the prevailing scientific orthodoxy became the evolutionary theory of uniformitarianism. The fact of a sudden disappearance suggested a catastrophe for evolution theory, which was resisted by many who felt they had much to lose. Scientific revolutions occur when the anomalies, or data that does not fit the accepted model, become so great that a new model of explanation is needed.

Evolutionists have historically proposed that species have slowly developed through a process of natural selection over vast stretches of time, and that the disappearance of many species was also a slow process involving long periods of time. However, increasing evidence has discovered that many species seem to have died out in very short periods of time. These mass extinctions seem to have often occurred *en mass* over very short periods of time.

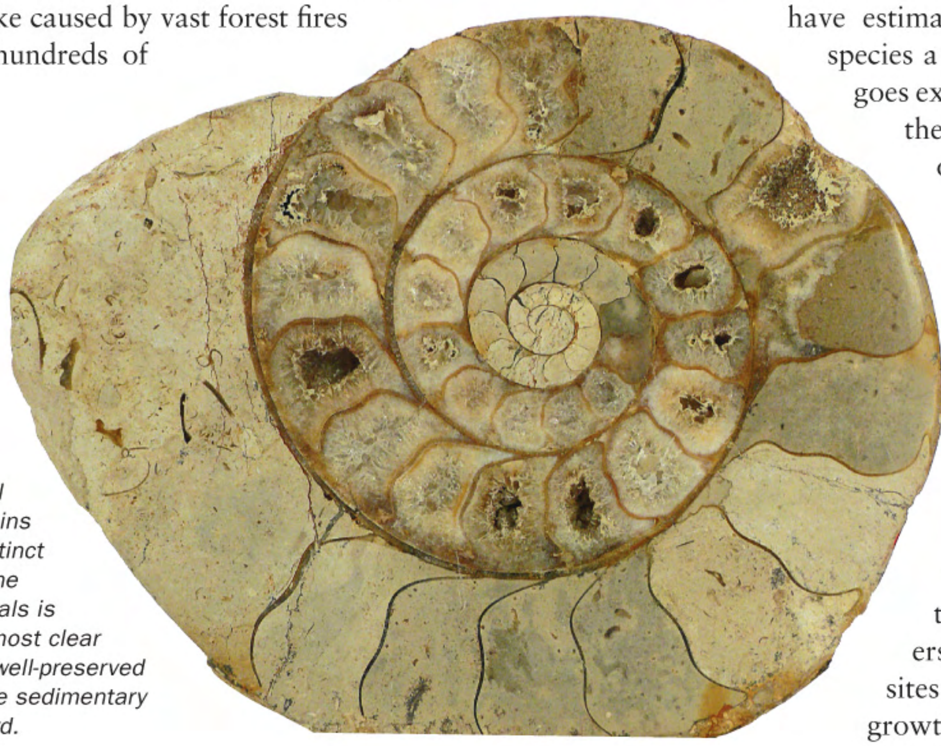
There is no doubt that a massive loss occurred at the end of the Cretaceous Period, which also ends the Mesozoic Era. In the case of the extinction of the dinosaurs, a catastrophe theory was proposed by an outsider to evolutionary sciences. Lewis Alvarez, a physicist, and his son produced The Alvarez Theory, which proposed that the massive extinction of the Cretaceous Era was the result of a catastrophe from outer space. A large asteroid or comet hitting the earth and creating a nuclear winter represented a revival of catastrophist explanations.

The Alvarez theory proposes that a massive asteroid hit in the Gulf of Mexico next to the Yucatan Peninsula with tremendous force, forming part or all of what is now the Bay of Campeche. The impact of the massive asteroid was so powerful that its explosion vaporized large quantities of rock, created massive tidal waves, and threw masses of dust into the sky. As the explosive plume of dust and smoke caused by vast forest fires for hundreds of miles rose to the stratosphere, it created a so-called nuclear winter. The dust particles blocked the light of the sun, reduced temperatures on earth drastically, stopped photosynthesis, and almost completely destroyed life on earth.

Supporting the Alvarez theory is the presence of iridium in the thin clay layer that separates the Cretaceous Period from the Tertiary Period and the beginning of the Cenozoic Era. Iridium is an element that is found concentrated in meteorites, but not very often on the surface of the earth. For it to be found in a layer marking the boundary between the Cretaceous Period and the Tertiary Period is evocative at the least. Attempts to prove that the concentration of iridium was due to leaching from water failed.

A competing theory is the volcanic plume theory. Its hypothesis is that a volcanic eruption occurred from deep within the mantle of the earth, originating somewhere between the crust and the core. The mantle plume was an enormous cloud of volcanic dust that created a nuclear winter. The theory of Gerta Keller is based on a variety of geologic and paleontologic observations, including microfossil assemblages found in core samples from deep in the earth.

In addition to major extinctions such as the dinosaurs, many species become extinct as a part of the background development of life. Scientists have estimated that on average, one species a year up to one per decade goes extinct, or has gone extinct in the past. What are the causes of species extinction? Species tend to favor certain food, habitats, nesting grounds, or behaviors. If these or other environmental supports are lost through natural actions, then extinction can occur. Species that are specialized or have a niche are most vulnerable. For example, the ivory-billed wood peckers lost their natural nesting sites and feeding sites in old-growth forests.



The fossil remains of extinct marine animals is the most clear and well-preserved of the sedimentary record.

The earth has enormous biodiversity. However, many scientists, biologists, oceanographers, zoologists, and numerous others who work in other scientific disciplines are very concerned that the earth may soon experience a catastrophic lost of great number of species. There are an estimated 10 million plant and animal species known today. Some scientists maintain that as many as 50 times that number may exist. Thus, there is a great danger is that numerous species may disappear before they are even discovered.

MASSIVE EXTINCTION LOOMING

Polls of biologists, environmentalist, naturalists, environmentalists, and other scientist report great concern that numerous species are not only threatened with extinction, but that a massive extinction is under way. Some have estimated that 20 percent of all species could disappear by 2040, with some estimtes as high as 50,000 each year. Many biologists expect species extinction rates to remain high for at least the next 100 years. Estimates are that 20 percent of the birds, reptiles, and mammals will disappear by the year 2100.

The single major cause of massive species extinction is widely believed to be human activities. These activities include the thinning of the ozone layer, global warming, hunting, farming, mining, pollution from industry, deforestation, logging, the introduction of invasive species, habitat loss, and degradation. Critics charge that the claims of massive extinction are exaggerated and alarmist overestimations derived from extrapolations based on the destruction of rainforests or other rich habitats. When asked in opinion polls, great numbers of lay people do not believe that mass extinction is likely to occur.

The relationship between extinction and human activity goes back thousands of years. At the end of the last Ice Age, about 30,000 years ago, the number of species was the greatest it has ever been in the history of the earth. Among the vast number of species were insects, vertebrates, and flowering plants that were more adapted to the environment than in previous geologic eras. About 10,000 years ago, as continental glaciation ended, there was a massive die-off of large birds and mammals. Smaller mammals were not affected.

This die-off occurred as human became more numerous. Since the rise of humans to global domination there has been an increase in the extinction of species, which began with prehistoric peoples. In the Americas *megafauna* (mammals weighing more than 100 pounds) such as wooly mammoths, camels, horses, and saber tooth tigers disappeared after humans arrived on the scene. Speculation suggests that these extinctions were caused by human hunting parties. Also of great importance is the human use of fire for clearing grasslands and forests. In fact, the slash-and-burn method of farming is still practiced by subsistence groups of people in Central and South America.

Not all human activity is immediately destructive. The vast forests of North America were logged over several centuries. However, the logging was always in local areas so that probably half of the forest was standing at one time. As a result, most species have been able to recover as farming and timber operations have changed.

Human activity can also increase the opportunities for survival of some species. Deer and doves prefer broken country where open ground provides cover and a variety of foods. Farming of cereal grains promotes opportunities for both. However, the reforestation in areas that were marginal farmlands has reduced deer and dove habitats, but increased them again for other species.

Studies have shown that the extinction of species began to increase with the European expansion to the New World, Australia, and elsewhere. Some of the cases of extinction were the direct result of the enormous settlements of new lands. Others were due to older population stocks in Europe, Asia, and Africa.

A feature of current extinction rates is that they differ from extinction rates in previous geologic eras. Usually before massive extinctions in the past, there was a great increase in the number of new species. However, the human-caused extinctions are not being matched by the development of new species. In fact, the present rate of human-caused extinctions exceeds by a large margin the natural extinctions of previous geologic eras.

Comparisons of background extinction rates and the present calamitous extinction rates is a revealing exercise. Natural extinction occurs even in the absence of human interference. So it is natural to ask the question: What is the natural extinction rate? How many species will disappear without human involvement?

Examination of the fossil record show that most of the individual species lasted from one to ten million years. With ten million species alive on earth today, the estimate of loss would be one in ten years, a natural background rate of 0.00001 percent per year. Analysis of marine animals has supported this analysis. However, the observed extinction rate among bird and mammals is about 1 percent per century. This currently observed extinction rate is 100–1000 times greater than the background rate. Some scientists have argued against the validity of these estimates of extinction, while others have used more conservative methods and have arrived at extinction rates ranging from 36–75 times those of the natural background rate.

The graver danger to *endemic* species (those found in one location and nowhere else) is the arrival of invasive species and of humans. Endemic species have a high risk of extinction in the face of invasive species. For example, island species have evolved in a limited location against a limited set of challenges. Small numbers of a species can easily be exterminated or decimated by invasive species from the mainland.

National parks and nature reserves are really habitat islands surrounded by hostile seas of unsuitable habitat. If the areas around a national park remain undeveloped, then the habitat space is widened. However, if suburban development engulfs a national park, even those kept as battlefield monuments, the species inside are squeezed into smaller habitats. Inevitably, species losses will occur.

Fragmenting forests or other wild areas into small island habitats is eventually destructive of species. Studies of extinction rates on islands have shown that when 50 percent of the habitat is destroyed, 10 percent of the island's species will also die out. However, increasing natural habitat to a state of 90 percent destroyed will result in the loss of 50 percent of the original native species.

Very vulnerable to habitat loss and species destruction are the world tropical forests. Plants and insects account for a large percentage of tropical forest species. Estimating their survival is difficult, but estimates are that at present rate of deforestation, up to 15 percent of plant species will become extinct by 2000. In Brazil, the Amazon is being cleared at a staggering rate. In some places, virtual warfare exists between those attacking the forests in order to clear land for cattle ranches and those

The American Lion

One of the animals which used to roam the North American continent, but which became extinct in about 8,000 B.C.E. was the American lion, sometimes known as the North American cave lion. It was about a quarter as big again as the modern African lion, and roamed many parts of North America. It is possible it did not have a mane.

The lion is thought to have lived in caves as did the Eurasian lion, its counterpart in many ways, and may have lined the dens with grass and leaves, as does the Siberian tiger. There have been many fossils of the American lion found in California, and as far east as Florida, and as far north as the Yukon. No remains have been found in northeast United States or eastern Canada.

Many of the animals that the American lion preyed on are still around, such as deer and the American bison, but others such as the North American horses and the young from the woolly mammoth are also extinct. It has been surmised by people who have studied cats, that because the bones of the lions in the La Brea Tar Pits, Los Angeles, California, are evenly distributed between males and females, they might have hunted alone or in pairs; African lions, in contrast, hunt in prides and have an extremely unequal distribution.

There are several theories about how the lions became extinct. The first is that their demise may have been related to the Holocene extinction, which wiped out most of the megafauna prey. Alternatively, with many lion bones found among refuse from Paleolithic Native American sites, it might have been hunting by humans that led to their extinction.

seeking to preserve the natural habitat. Estimates are that 12 percent of the birds will go extinct in the coming decades.

SEE ALSO: Biodiversity; Evolution; Global Warming; Hunting; Mining; Rain Forests; Species.

BIBLIOGRAPHY. Michael Benton, *When Life Nearly Died: The Greatest Mass Extinction of All Time* (Thames & Hudson, 2005); Tim W. Clark, *Averting Extinction: Reconstructing Endangered Species* (Yale University Press, 1997); Douglas H. Erwin, *Extinction: How Life on Earth Nearly Ended 250 Million Years Ago* (Princeton University Press, 2006); Stephen Jay Gould,*Wonderful Life: The Burgess Shale and the Nature of History* (W. W. Norton, 1999); Tony Hallam and A. Hallam, *Catastrophes and Lesser Calamities: The Causes of Mass Extinctions* (Oxford University Press, 2005); John Charles Kunich, *Killing Our Oceans: Dealing with the Mass Extinction of Marine Life* (Greenwood Publishing, 2006); Lawrence George Lux, *Extinction of Species* (Xlibris Corporation, 2001); Paul S. Martin, *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America* (University of California Press, 2005); George C. McGavin, and David Burnie, *Endangered: Wildlife on the Brink of Extinction* (Firefly Books, 2006); Beverly Peterson, *Watching, from the Edge of Extinction* (Yale University Press, 1999); James Lawrence Powell, *Night Comes to the Cretaceous: Comets, Craters, Controversy and the Last Days of the Dinosaurs* (Harcourt Brace & Company, 1998); Richard B. Primack, *Essential of Conservation Biology* (Sinauer Associates, 2002); David Quammen and Kris Ellingsen, *Song of the Dodo: Island Biogeography in the Age of Extinctions* (Simon & Schuster, 1997); J. William Schopf, *Cradle of Life: The Discovery of Earth's Earliest Fossils* (Princeton University Press, 1999); David W. Steadman, *Extinction and Biography of Tropical Pacific Birds* (University of Chicago Press, 2006); Malcolm Tate, *Going, Going, Gone: Animals on the Brink of Extinction and How to Turn the Tide* (Think Books, 2006); Peter D. Ward, *Out of Thin Air: Dinosaurs, Birds and Earth's Ancient Atmosphere* (National Academies Press, 2006); Peter Douglas Ward, *Rivers in Time: The Search for Clues to Earth's Mass Extinctions* (Columbia University Press, 2002).

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Extractive Reserves

EXTRACTIVE RESERVES ARE a form of conservation that originated in the Brazilian Amazon in the 1980s. Unlike national parks or other protected areas that often result in the exclusion of local populations for the benefit of national and international conservation goals, extractive reserves are attractive because they include concerns for locals that are directly impacted by natural resource management. Extractive reserves are one example of a larger shift toward community conservation that considers the needs and input of local residents about natural resources. Community conservation involves a number of initiatives, including community-based conservation, community wildlife management, collaborative management, community-based natural resource management, and integrated conservation and development programs (ICDPs).

BRAZILIAN AMAZON

The Brazilian Amazon has been a hotly contested region for centuries, with multiple actors competing to access rainforest territory and the various resources within it. Additionally, conservation and development organizations concerned with biological diversity have pressured the Brazilian government to protect the rainforest from continued modification. Estimates from satellite imagery and other sources suggest that roughly 20,000 square kilometers—or 2 million hectares—of territory is deforested each year, which results in often violent competition to gain control over the remaining land. These conflicts involve various stakeholders including cattle ranchers, logging companies, agriculturalists, indigenous Indians, and rubber tappers.

In response to these factors, a coalition of actors organized to put pressure upon the national government to protect traditional rights. The rubber tapper movement, consisting of the rural workers' union of Acre, and later the National Council of Rubber Tappers, organized from the 1970s to prevent expulsion and deforestation within the region. In the early 1970s, the Xapuri Union was founded and developed the *empate*, which was a nonviolent tactic aimed at resisting competing claims upon their territory.

In the 1980s, a coalition of rubber tappers, Amazon Indians and nongovernmental organizations (NGOs) proposed the extractive reserve conservation model. Extractive reserves were first discussed as a land use option at the meeting of the National Council of Rubber Tappers and Rural Worker's Union in 1985. The Brazilian Institute of the Environment and Renewable Natural Resources (IBAMA) defines extractive reserves as areas set aside for the sustainable use and conservation of natural resources by traditional populations. Most extractive reserves involve tracts of rainforest territory that have been set aside by the Brazilian government for protection.

The state assumes ownership and offers the land to traditional residents for use according to a sustainable management plan. Extractive reserves avoid the subdivision of land into private units that normally accompany colonization projects, favoring instead communal property based on traditional resource collection. Marine extractive reserves also exist, and are increasingly popular as a means of protecting both aquatic resources and their traditional harvesters. Extractive reserves were officially instituted as part of Brazilian environmental policy in 1990, and by 2005 there were 43 that covered an estimated 80,000 square kilometers or 8 million hectares.

Extractive reserves are a form of conservation with use, meaning that residents are permitted to live within the reserves and utilize the resources that they depend upon for their survival. Traditional methods of resource collection, particularly of natural rubber and Brazil nuts, are allowed to occur within the reserve. Extractive reserves are a promising attempt to balance the development needs of local Brazilians with conservation, however, they are far from ideal. As a number of scholars have noted, traditional extraction of rubber and Brazil nuts does not generate significant profit and leaves residents in a challenging financial position. Competing land use strategies, such as cattle ranching or logging, are more lucrative by comparison. Natural rubber has remained subsidized by the Brazilian government and the development of markets for these products has resulted in more efficient forms of production. Rubber plantations, for example, have been established in Brazil and southeast Asia as a way of generating profits from these commodities.

The wave of interest in extractive reserves in the 1980s was punctuated by the assassination of the rubber tapper movement's leader, Chico Mendes, in December 1988 by two cattle ranchers. The intention of his assassination was to deflate the movement; however, Mendes's death galvanized international attention to the land use problems and accompanying tension in the Brazilian Amazon, specifically in the state of Acre, which remains one of the primary locations of rubber tapper activism. Though his death was tragic, it served as a catalyst for extractive reserves and propelled them to new heights of interest.

SEE ALSO: Amazon River Basin; Rubber; Rainforests.

BIBLIOGRAPHY. Mary Helena Allegretti, "Extractive Reserves: An Alternative for Reconciling Development and Conservation in Amazonia," in Anthony B. Anderson (ed.), *Alternatives to Deforestation: Steps Toward Sustainable Use of the Amazon Rain Forest* (Columbia University Press, 1990); Philip M. Fearnside, "Extractive Reserves in Brazilian Amazonia: An Opportunity to Maintain Tropical Rain Forest Under Sustainable Use," *BioScience* (v.39, 1989); Chico Mendes, *Fight for the Forest: Chico Mendes in His Own Words* (Latin American Bureau, 1989).

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Exxon Valdez

WHEN THE *Exxon Valdez* ran aground in Prince William Sound, it spilled over 11 million gallons (41.8 million liters) of crude oil, the largest single spill ever released in U.S. coastal waters. The spill occurred late in the evening of March 24, 1989. The ship left Port Valdez, Alaska, under the command of Captain Joseph Hazelwood. After leaving port, the captain left the bridge in charge of a third mate who was not licensed to operate in that particular area of Prince William Sound. The ship, having turned into the inbound shipping lanes to avoid ice from nearby glaciers, was supposed to return to the outbound lanes. For several reasons, including missing

Attempts were made to clean the oil on Prince William Sound's rocky beaches, but vestiges still remain today.

navigational markers and failing to disengage the ship's autopilot—the ship turned too late, and, just after midnight Alaska Time, the ship struck Bligh Reef, a well-known navigation hazard.

While Exxon and the Alyeska Pipeline Service Company—the firm established to build the trans-Alaska oil pipeline—sought to respond to the spill, the sheer volume of oil was simply too great to be contained. Compounding the problem was Alyeska's failure to maintain oil spill response equipment and material in the area, despite their promises to do so. This was made clear in initial media reports and was confirmed in later investigations; almost immediately after word of the spill reached the world, the news media converged on Prince William Sound, beaming pictures of oiled beaches and wildlife to a shocked and angry public. The spill served to mobilize environmental, fishing, and allied groups in efforts to enact more stringent regulation of oil tankers, and to enhance preparation for oil spills. For many of these interests, the *Exxon Valdez* spill was an event that had long been dreaded, and because of the impact of the spill on wildlife and fisheries, groups that had been suspicious of each other's motives were brought together in a common cause: anger at Exxon and a desire for some sort of compensation.

In the immediate aftermath of the spill, attempts to contain the oil were minimally successful. Exxon hired contractors who attempted to clean beaches of oil by using absorbent rags, and sometimes using superheated water, which may have done nearly as much damage as the oil itself. Even today, vestiges of the Exxon Valdez oil spill can be seen along the rocky beaches of Prince William Sound and south-central Alaska. The actual environmental effects of the *Exxon Valdez* spill are not fully known. Many otters and birds were killed by oil, and the salmon fishery was largely ruined for 1989 because of fears that any catch would be tainted by oil. The salmon have since recovered, but the very important herring fishery has never returned to pre-spill levels, although it is not clear whether the decline in herring was due to the oil spill. The oil spill had obvious socioeconomic consequences. Nearly the entire commercial fishing fleet in Cordova, the main fishing port in PWS, was idled by the spill, and while some fishers were able to lease their boats to Alyeska, many felt personal or community pressure to not take money from Exxon. Estimates of the economic impact of the spill ranged from $6 million to $43 million; longer-term impacts were higher.

The public policy impact of the spill was significant. The spill directly broke a 14-year legislative deadlock and triggered the passage of the Oil Pollution Act of 1990 (OPA 90), which provided for increasingly stringent regulation of tankers and other oil facilities. While the *Exxon Valdez* spill was spectacular and a key turning point in the history of federal oil spill policy, other large oil spills, such as the Santa Barbara oil well blowout in 1969 and the grounding of the Argo Merchant off Nantucket in 1976, also gained considerable attention, but without the same policymaking results. The importance of the *Exxon Valdez* in American politics can be attributed to the general proposition that symbols and images are very powerful in politics. The dominant symbols of the *Exxon Valdez* spill were of oiled otters and birds, the soiling of the "pristine Alaskan environment," and the image of a large, uncaring oil company, which employed a drunk tanker captain, spilled oil, and then failed to manage the cleanup. These images and stories focused on Alaska as a wild, pristine "last frontier," and made this event particularly compelling to many people and interest groups.

A particularly important outcome of the *Exxon Valdez* spill is the establishment of citizens' advisory councils under OPA 90. Two Regional Citizens' Advisory Councils (RCACs) were established, for the Cook Inlet Region and Prince William Sound. The RCACs are funded by assessments on the oil industry, and include numerous local interest groups. They have discretionary funds for research projects and have been able to promote policy change involving tanker escort and navigation, weather reporting, and air pollution controls.

Another significant outcome was the establishment of the *Exxon Valdez* Oil Spill Trustee Council, established to guide the spending of the $900 million fine assessed on Exxon for the oil spill as part of an agreement between the federal and state government and by Exxon. A $5 billion civil penalty was imposed on the *Exxon Valdez* in 1994, but the federal district court and the Ninth Circuit Court of Appeals have not yet resolved what the appellate court considers an appropriate figure; it has simply signaled to the lower court that $5 billion is too much. Civil claims continue 17 years after the spill.

SEE ALSO: Oil Spills; Petroleum; United States, Alaska.

BIBLIOGRAPHY. Alaska Oil Spill Commission, *Spill: The Wreck of the Exxon Valdez. Final Report* (State of Alaska, 1990); Thomas A. Birkland and Regina G. Lawrence, "The Exxon Valdez and Alaska in the American Imagination," in Steven Biel, ed., *American Disasters* (New York University Press, 2001); G.J. Busenburg, "Innovation, Learning, and Policy Evolution in Hazardous Systems," *American Behavioral Scientist* (v.44/4, 2001); Art Davidson, *In the Wake of the Exxon Valdez* (Sierra Club Books, 1990); John Keeble, *Out of the Channel* (Harper Collins, 1991); Natalie Phillips, "$5,000,000,000: Jury Sets Oil Spill Damages," *Anchorage Daily News* (September 17, 1994); Jeff Wheelwright, *Degrees of Disaster: Prince William Sound: How Nature Reels and Rebounds* (Simon and Schuster, 1994); J.A. Wiens, "Oil, Seabirds and Science," *BioScience* (v.46/8, 1996).

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Famine

IN THE PAST, famines have been defined as discrete events, where a large proportion of a population dies of starvation and disease caused by undernourishment. In recent decades, famines have been increasingly understood as more complex, open-ended processes that can have multiple outcomes. Famine can occur during events of chronic food insecurity, which represents a state of continuously inadequate access to food.

One of the worst famines in history, the Bubonic Plagues in 1345–48, claimed more than 40 million lives in Europe. While estimates are often vague, evidence suggests that at the end of the 19th century, somewhere between 30 and 60 million people died in famines in India and China. In the 20th century, more than 70 million people died in famines worldwide. Most deaths occurred in China and the Soviet Union. During the 20th century, famines shifted from Europe and Asia to sub-Saharan Africa, where large famines occurred in the Sahel and the Horn of Africa in the mid–1970s and mid–1980s.

In the 21st century, famines remain a widespread problem in the developing world. The Food and Agriculture Organization (FAO) reports that 842 million people in the world are undernourished, while the vast majority live in developing countries. Though global levels of food insecurity have slightly improved over the last decades, large regional discrepancies persist. Countries in Asia, the Pacific, Latin America, and the Caribbean have largely managed to improve their food security status; while food insecurity has been on the rise in sub-Saharan Africa, the Near East, and North Africa. The situation remains most critical in sub-Saharan Africa, where one-third of the population is chronically food insecure.

PERCEPTIONS OF FAMINE

In the past, famines have been associated with natural causes, such as drought and crop failure, and, to a limited extent, war. Up to the late 1970s, famines were considered supply side failures and resolution was attempted by increasing global food supplies through Green Revolution technologies. The recurring food crisis in parts of sub-Saharan Africa during the 1980s demonstrated the limitations of the supply-side focus, and showed that meeting demand alone was not enough. Food security became a crucial component of development as it became clear that national food security did not translate into food security at the local level, and that food security was also determined by effective demand.

In 1981, Amartya Sen argued that food insecurity was not persistent due to shortfalls in production, but due to the lack of effective demand. Sen introduced the concept of *entitlements* that referred to the condition of people lacking the means to buy or access food. In Sen's view, access was also related to structural, political, institutional, and socio-economic factors. Sen's work led to a paradigm shift that was crucial to the way that food insecurity was conceptualized.

Neither drought nor population growth are root causes of food insecurity, but exacerbate the problem, which can be caused by political, social, economic, and environmental constraints; armed conflict; uncontrolled population growth; low levels of literacy; poor access to water and health care; disease; poor or inappropriate agricultural practices; climate variability; and environmental degradation.

In the 1990s, when the understanding that food security is only one of a range of needs furthered the concept of food security, the *livelihoods* concept emerged as a result. The livelihoods approach focuses on assets and options people have to pursue alternative strategies to make a living, and has become important to provide for more effective intervention. Therefore, the risk of famine, especially when it is part of the daily struggle for survival, cannot be treated as separate from long-term development.

Chinese beggars pictured in 1909. In the 20th century, more than 70 million died in famines, many from China.

MEASURING FAMINE, VULNERABILITY

Famines are highly emotive and increasingly politicized. With humanitarian assistance turning into a large industry, and only highly publicized famines achieving global attention (such as Ethiopia, 2002; and Niger, 2005) there is increasing misuse of the term with disastrous consequences. As different levels of food insecurity demand different levels of responses, an exact definition of what constitutes a famine becomes increasingly important.

Famine vulnerability assessments are used to identify the susceptibility of populations to famines. Traditionally, vulnerability assessments aimed to predict short- and long-term changes in natural conditions (such as drought), in order to better prepare and respond. Benchmarks determine the levels of food insecurity, ranging from nutritional indicators (such as wasting, stunting, and mortality), to crop yield and food prices, to combined measurements of famine intensity and magnitude. Benchmarks are particularly controversial in situations of chronic food insecurity, where malnutrition is not a result of the lack of food, but of structural problems; these approaches tended to ignore people's own coping strategies. Now, increasing emphasis is placed on non-nutritional indicators, such as political conditions, social systems, and market indicators. More recently, emphasis has turned to monitoring livelihoods and understanding coping strategies.

Food aid is an important instrument in addressing food insecurity in terms of meeting emergency needs after disasters and addressing long-term concerns of vulnerability. However, it is highly controversial and has received wide criticism for various reasons. Food aid programs were largely driven by donor needs, mainly to dispose of North American grain surpluses. Food aid was given in a way that was hoped to advance foreign policy objectives in the Cold War era and to develop overseas markets to absorb future surpluses. Humanitarian concerns and acute needs were often secondary.

SEE ALSO: Drought; Food; Sahel; Sen, Amartya.

BIBLIOGRAPHY. C.B. Barrett and D.G. Maxwell, *Food Aid After Fifty Years—Recasting Its Role* (Routledge, 2005); S. Davies, *Adaptable Livelihoods: Coping with Food Insecurity in the Malian Sahel* (Macmillan Press, 1996); M. Davis, *Late Victorian Holocausts: El Niño Famines and the Making of the Third World* (Verso, 2002); S. Devereux, *Famine in the 20th century* (Institute of Development Studies, 2000); A. Sen, *Poverty and Famine: An Essay on Entitlement Deprivation* (Clarendon Press, 1981); *State of Food Insecurity in the World 2003: Monitoring Progress toward the World Food Summit and Millennium Development Goals* (FAO, 2005); J. Von Braun, T. Teklu, and P. Webb, *Famine in Africa: Causes, Responses, and Prevention* (International Food Policy Research Institute, 2000); M. Watts and H.G. Bohle, "The Space of Vulnerability: The Causal Structure of Hunger and Famine," *Progress in Human Geography* (v.17/1, 1993).

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Farmers' Markets

FARMERS' MARKETS ARE public markets typically held outdoors, where farmers congregate to sell anything from fruits and vegetables to meat, dairy products, honey, baked goods, and cut flowers. Most producers who sell at these events are relatively small and often use fewer pesticides and herbicides than large-scale farmers. The popularity of these events in the United States has grown tremendously over the years. In 1970, for example, there were about 340 retail farmers' markets in the United States, and by 2005 that number had increased to almost 4,000. Similar trends are also recorded in the United Kingdom, where there were no farmers' markets in the early 1990s but almost 300 by the decade's end. Farmers' markets probably originated in Ancient Greece and Rome, where venders would locate in the center of the city to sell a variety of freshly grown commodities and other goods.

For farmers, the markets provide a market to raise and sell products. They also report satisfaction knowing that they are providing locally produced food to nearby communities. On the other hand, consumers are often motivated by food freshness. They also report that they value knowing the origin of their food. A sense of community and friendship is also developed by buying from and selling to the same people week after week.

Farmers' markets are often viewed as a counter movement to recent trends in agriculture. In 1935, the number of farms in the United States peaked at 6.8 million as the population approached almost 127 million. Today, the U.S. population is approximately 290 million, yet fewer than 1 million claim farming as their principal occupation. This changing structure of agriculture has been of significant consequence. Today, farms are bigger, more mechanized, and more reliant upon chemical inputs than ever before, which negatively impacts the environment through soil erosion and water pollution, and depletes rural communities as people leave agriculture for city employment. Because less than 1 percent of the population now lives on a farm (whereas nearly 50 percent did so 100 years ago), fewer people today have a connection to agriculture and the sources of their food.

Farmers' markets provide a market for smaller farms, and does not require large investments in inputs. Moreover, farmers' markets allow consumers to see who grew their food and to ask questions about how it was raised. Moreover, the revenue is retained by the farmer, versus a "middle man." The money is therefore likely to remain in the community.

This increase in the number of jobs in a community has led to the *economic multiplier effect* of farmers' markets, which also help benefit nearby businesses and regional farms. Some studies, for example, have reported an increase in property values in areas near the market, or the increases in tax revenues. Farmers' markets, because of their low economic barriers to entry, also allow for entrepreneurial activity.

Until recently, the majority of customers at farmers' markets tended to be from the middle class; markets were often located in, or near, middle-class neighborhoods. In 1992, Congress established the Farmers' Market Nutrition Program (FMNP) to provide fresh, locally grown fruits and vegetables to WIC (Women, Infants, and Children) participants and to expand the public awareness of farmers' markets. Forty-five different states now participate in this program, which also provides grants to state agencies. WIC coupons can be used to buy unprepared fruits, vegetables, and herbs from farmers' markets that are then submitted by the farmer for reimbursement. Such coupons resulted in over $26.9 million in revenue to farmers in 2004.

Many predict that the popularity of farmers' markets will only grow as consumers continue to turn toward alternative venues for their food, and seek a place to come together to learn about how their food was raised and who raised it. They help, in short, to place a face on food.

SEE ALSO: Agriculture; Commodity Chain; Farming Systems; Food; Green Consumerism; Organic Agriculture; Pesticides.

BIBLIOGRAPHY. Kathryn Marie Dudley, *Debt and Dispossession: Farm Loss in America's Heartland* (University of Chicago Press, 2000); Helena Norberg-Hodge, Steven Gorelick and Todd Merrifield, *Bringing the Food Economy Home: Local Alternatives to Global Agribusiness* (Kumarian Press, 2002); United States Department of Agrculture farmers' market map, www.ams.usda.gov/farmersmarkets/map (cited May 2006).

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Farming Systems

FARMING SYSTEMS ARE the various methods of crop production to obtain human food and animal feed, fibers and other industrial products, or energy crops. Geographical differences are due to historical processes, environmental conditions, and the level of capitalization. Each farming system has specific production objectives, inputs and means of production, and a degree of intensification. Market farming is very input-intensive with pesticides, herbicides, fertilizers, and mechanization, while self-consumption farming ensures food for the household, and is very intensive in labor and land. There is also a broad range of combinations of agriculture with other production systems, such as livestock breeding, aquaculture, or forestry.

The most universal farming system is polyculture, which provides a diversity of food and maximizes labor and land occupation. Crop rotation increases soil productivity and reduces pest pressure. Less than a 25 percent of the product is marketed. The farming practices have a strong cultural component and are adapted to the local environmental conditions, producing heterogeneous landscapes.

Conversely, monoculture systems rely on a very small number of crops and an efficient use of inputs; they are very adaptable to market variations, but are vulnerable to changes in environmental conditions and produce homogeneous landscapes. Monoculture is common in large countries with a market-oriented economy.

Mixed agriculture, which combines polyculture with animal husbandry, is a widespread system because it generates various synergies: animals graze stubble and are employed for cultivating the fields, harvesting crops, transporting farm products, and manure is used as a fertilizer.

Swidden or shifting agriculture—locally known as *milpa* in Mexico or *fang* in Asia—is a remnant of very old practices, and its survival is threatened by sedentarization, the expansion of other agricultural systems, and cattle farming and forestry. It is an itinerant form of cultivation that sustains small communities in tropical rainforests in Central America, the Amazon Basin, Africa, southeast Asia and Indonesia. Small forested areas are cleared, vegetation is burned and seeds are scattered over ashes, a practice known as *slash and burn*. After the first harvest, productivity progressively decays in the following years so that, after four to five years, the community changes to another area to resume cultivation, allowing the forest to regenerate for 10–20 years.

Ley farming is practiced in areas with sufficient soil moisture or where irrigation is accessible. Cereals alternate with fodder or legumes, such as alfalfa, which biologically fixes nitrogen. Dry farming is an adaptation to climates with low precipitation—below 500 millimeters—using no irrigation; however, it entails a high risk of erosion.

Irrigated agriculture has some of the highest levels of productivity per unit area, as in the cases of Asian paddy rice fields and Mediterranean vegetable gardens. It is commonly a form of polyculture or mixed agriculture that combines with various livestock, depending on the geographical area: swine, cattle, fowl, or aquaculture. The areas of cultivation—valleys, flood plains, or slopes where land is scarce—are linked to water availability and elaborate systems of water storage. In monsoon and eastern Asia, small family plots yield two or three rice crops a year after multiple labor-intensive operations, with little mechanization and using organic fertilizer.

Multi-year tree and perennial plant cultivations are found in tropical and subtropical areas. In the Mediterranean, the most common crops are vineyard, dry farming, and irrigated fruit and olive trees. Plantation agriculture coexists with other long-established systems such as slash and burn. This commercially speculative agriculture, largely practiced in developing countries, is oriented to the market in developed countries. The most common crops are coffee, tea, sugarcane, bananas, cocoa, coconut, and tropical fruits; maize and soybeans; or industrial crops such as tobacco, cotton, or jute. Some countries are totally dependent on the products' income and vulnerable to price fluctuations. Coffee, the second world leading commodity and the livelihood of 25 million families, is a clear example. Episodic crises in prices are common as the result of systemic dysfunctions in supply or demand. It is very dependent on capital and labor, so large companies participate as farm owners, managers, or dealers. With a vertical structure, plantations have evolved to predominantly fragmented properties that sell to dealers, depending on the nature of the crop. The harvest is partially processed in situ before trading, to cut down transportation and labor costs.

EVOLUTION OF FARMING

Thomas Malthus considered population to expand separately, and typically faster, than agriculture. Ester Boserup's thesis of agricultural change, conversely, understands technology as endogenous, with population growth actually driving intensification and innovation in cultivation. As population rises, a reduction of the fallow period takes place while labor and technology increase to compensate yield decline. Population growth forces agricultural change in technology, followed by land reclamation and replacement by higher-yield crops. Clifford Geertz identified a process of "agricultural involution" in which poverty sharing may take place in conditions of population stress. Under conditions of demographic pressure, no incentives exist to introduce new technology because labor is abundant. As a result, yield per unit area increases at the same time yield per capita decreases.

Technology has led to innovative industrialized farming systems such as greenhouses, hydroponics, or genetic engineering. After the development in 1961 of a high-yielding, disease-resistant hybrid wheat, its use rapidly extended and made some developing countries self-sufficient and exporters. Recently, however, yield increases have stalled and in some cases, productivity has declined, due to exhaustion of soil and water resources and adaptation of pest species, leading to calls for a more sustainable form of modern agriculture.

SEE ALSO: Agriculture; Food; Green Revolution.

BIBLIOGRAPHY. Miguel A. Altieri, *Agroecology: The Science of Sustainable Agriculture* (Westview Press, 1995); Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change Under Population Pressure* (Aldine, 1965); Francesca Bray, *The Rice Economies: Technology and Development in Asian Societies* (University of California Press, 1993); B. L. Turner and S. B. Brush, eds., *Comparative Farming Systems*. (Guilford Press, 1987); Michael Collinson, *A History of Farming Systems Research* (CABI Publishing, 2000); John Dixon, Aidan Gulliver, and David Gibbon, *Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World* (FAO, 2001); Clifford Geertz, *Agricultural Involution: The Process of Ecological Change in Indonesia* (University of California Press, 1963).

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Farmland Conservation

THE ISSUE OF protecting natural resources in agriculture has long been a concern for many American farmers. Farmland conservation began with the recognition that soil erosion reduced of soil fertility. For example, many of the staple crops historically grown in the United States for export—such as cotton, tobacco, and corn—have long been planted in rows to control weeds. However, this left the land bare to rainfall, precipiting soil erosion. Sloping and hilly land is also particularly susceptible to soil erosion.

A number of early agricultural reformers began proposing various soil conserving practices. Jared Eliot, Samuel Deane, and John Taylor (during the late 1600s and early 1700s) relied on personal experiences in suggesting pasture and crop rotations to increase fertility and lessen erosion by maintaining ground cover and improving soil tilth. These early conservationists were also quick to understand the advantages of the hillside plow and horizontal plowing. Called *contour farming* today, this method involves running the furrows around the hillside on a horizontal plane. Each ridge forms a mound that serves to reduce erosion.

Yet soil erosion continued to be a problem into the late 19th and early 20th centuries. W.J. McGee and N.S. Shaler wrote extensively about the problem, as did Chicago geologist T.C. Chamberlain (who spoke at the White House on the subject in 1908). It was not until the 1930s, however, when dust storms swept through the Great Plains, that the general public began to take notice of the issue of soil erosion in particular and farmland conservation more generally.

During the 20th century, greater attention has been placed on taking land out of farmland production in an attempt to not only preserve soil, but also wildlife, wetlands, and biodiversity. Some of these strategies include agricultural conservation easements, in which the landowner transfers certain rights, such as commercial development of the land, to a conservation organization or government agency. This option provides owners certain tax advantages as well as peace of mind.

The Conservation Reserve Program (CRP) came out of the Food Security Act of 1985. The U.S. Department of Agriculture provides an annual rental payment for landowners of highly erodible farmland to establish and maintain various types of perennial vegetation and agree to leave the land idle for the length of the lease. This helps to reduce soil erosion and sedimentation in streams and lakes, improve water quality, improve wildlife habitat, and enhance forest and wetland resources. Currently, there are about 35 million areas enrolled in this program.

The Conservation Reserve Program provides cash rent payments to farmers who leave highly erodable land fallow.

Developing suburban and urban areas pressure land values and tax bases, posing a threat to the continued existence of farmland. Initiatives in the form of growth control statutes, zoning, and easements at the state, county, and municipal levels have been instituted to protect farmland from conversion to residential and commercial development.

SEE ALSO: Agriculture; Conservation Easements; Dust Bowl, U.S.; Farming Systems; Shifting Cultivation; Soil Erosion.

BIBLIOGRAPHY. Richard Brewer, *The Land Trust Movement in America* (University Press of New England, 2004); Tom L. Daniels and Deborah Bowers, *Holding Our Ground: Protecting America's Farms and Farmland* (Island Press, 1997); U.S. Department of Agriculture CRP program online, www.nrcs.usda.gov/programs/crp (cited May 2006).

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Fast Food

THE CONCEPT OF fast food developed in early 20th-century southern California in the context of economic and demographic growth, increasing dependency on cars, employment outside the home, and appreciation of novelties and convenience. Also important was the American society's admiration of technological "progress" and entrepreneurship, which began to support a centralized, homogenized chain of food processing. The model spread rapidly in the latter half of the century with the strengthening U.S. leadership in world politics, economics, and popular culture. The largest fast food corporations, such as McDonald's and Burger King, now have thousands of hamburger restaurants worldwide.

The typical location of a corporate fast food restaurant reflects its origins and logic. The search for "synergy" has led to collaboration between fast food companies, gas stations, major retail stores, shopping centers, movie theaters, and sports stadiums so that corporate burgers, fries, and pizzas now dominate the culinary options in many spaces. Irrespective of location, the knowledge of consistency saves time, provides comfort, and creates brand loyalty. Chain restaurants are identical to each another and closely resemble competitors. The restaurant space is orderly, predictable, tidy, and convenient, and is designed to maximize customer flow. An assembly-line task structure saves in training and production costs.

DIVIDED OPINIONS

For some, the global spread of fast food corporations, the supporting model of agribusiness, and their homogenizing influence on landscapes and behavior threaten cultural and ecological diversity. For others, eating corporate fast food is a social and fashion statement. Others shun corporate hamburgers but favor small, domestic, and independent fast-food businesses, such as kebab stands. Within countries, class, lifestyle, and attitudes play a role in relationships with fast food. Whereas one family considers a visit to a pizza parlor an affordable, fun evening out, another sees it as a tacky health hazard.

The more industrialized and complex the food processing chain, the more difficult it is to know what the food contains. Publicity has increased awareness of food-related health risks and fueled suspicion toward intensely processed fast foods.

Among the contested ethnical issues regarding corporate fast food are labor issues, franchiser rights, and marketing for children. Also controversial are the use of chemicals, hormones, antibiotics, fungicides, and pesticides in the mass-production of beef, poultry, and vegetables, and the treatment of production animals, ranchers, and land. Plenty of energy is required in packaging production and disposal, as well as mass production, transportation, and preparation practices. The resulting heaps of waste is usually not recycled or sorted according to biodegradability.

Disagreements between interest groups have led to lawsuits, consumer boycotts, acts of violence, and symbolic resistance in the form of a "slow food movement." One counter-trend to the homogenizing impact of corporate fast food is the growing popularity of local, regional, and ethno-culturally diverse foods that are quick to prepare and can be consumed on the move. In some countries, concerns regarding the change of cultural traditions have created market niches for local entrepreneurs, who offer traditional food items in a fast-food format. Examples include a chain of pelmeni restaurants in Riga, Latvia, and shops serving elaborate stuffed baquettes in Paris, France.

In an extremely competitive business, major corporations have relaxed uniformities in order to adapt to different cultural and legal environments. Comparisons of U.S. and European fast-food menus show how different regulations and production costs influence the price of the same meal. Regional tastes and lifestyles modify flavors; for example, to please customers in Finland, McDonald's offers a sandwich on dark, sour rye bread. Beer is also on the chain's menu in several locations outside of North America. Attempts to attract health- and image-conscious customers have met varying success. Image and target-marketing make a difference, because the nutritional value of the new product may not differ significantly from the previous options.

The visible, direct impact of the fast food industry on eating habits and on the environment are a tip of an iceberg. The corporate fast food industry continues to change patterns and practices of land use, agriculture, manufacturing, and the processing, consumption, and perceptions of food. Many of these changes proceed gradually as parts of a more comprehensive, complex transformation so that the role of one industry in the big picture is difficult to trace.

SEE ALSO: Agriculture; Food; Farming Systems.

BIBLIOGRAPHY. Warren J. Belasco, "Ethnic Fast Foods: The Corporate Melting Pot," *Food and Foodways* 2 (1987), 1–30; A. Victoria Bloomfield, "Tim Hortons: Growth of a Canadian Coffee and Doughnut Chain," *Journal of Cultural Geography* 14 (1994), 1–16; Rick Fantasia, "Fast Food in France," *Theory and Society* 24 (1995), 201–243; John A. Jakle and Keith A. Sculle, *Fast Food. Roadside Restaurants in the Automobile Age* (The Johns Hopkins University Press, 1999); Eric Schlosser, *Fast Food Nation: What the All American Meal Is Doing to the World* (Penguin, 2002).

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Fate and Transport of Contaminants

CONTAMINANTS ARE SUBSTANCES that carry the threat of contaminating the environment, and include nuclear waste, industrial by-products, and organic manure. The contamination threat may be short-term or long-term, and dangerous or nondangerous, depending on the nature of the substance and how it interacts with its surroundings. Nuclear waste, for example, is toxic to humans, remains dangerous for up to thousands of years, and its irradiated particles can pass through nearly all other substances. Organic remains, on the other hand, may be of only passing danger, and quickly degrade into inert products. The ways in which contaminants need to be transported from creation to dafe storage also vary considerably, with the resulting costs representing a disincentive for organizations to ensure safe transportation and storage. Governments often intervene to police a regulatory regime that requires contaminant-providers to bear the cost of safely transporting and storing waste.

Fate and transport also refers to the movement of chemical contaminants through groundwater, soil, gas, and the atmosphere. Research examines how fast contaminants can migrate in certain media and on the synergistic effects of chemicals within ecosystems; assesses risks to both humans and nonhumans from potential exposure; and informs management decisions for the movement and deposition of hazardous materials.

One notable example of the problems caused by inappropriate transportation of contaminants has been the continuous pollution of New York's Hudson River. In 2001, courts decided that GE Corp. was guilty of dumping polychlorinated biphenyls into the river, and that it should be responsible for dredging a 40-mile stretch of the river to ensure that the ongoing danger be mitigated, including the threat of causing cancers. This and related cases have also raised the issue of the corporate prosecution for negligence leading to seriously negative health impacts.

The detection of contaminants in the environment, often in the face of opposition from polluters, has become an important part of the task of environmental workers. This vigilance, combined with strong and enforceable laws, has helped to reclaim some areas from conditions that are dangerous to living beings. Nevertheless, the rise of newly industrializing countries, especially China, has raised fears that contamination will increase or has already significantly increased in states with severe government censorship of information. Since reporting is hindered, timely intervention to reduce problems is less likely.

SEE ALSO: China; Industrialization; Polychlorinated Biphenals (PCBs).

BIBLIOGRAPHY. Frank M. Dunnivant and Elliot Anders, *A Basic Introduction to Pollutant Fate and Transport: An Integrated Approach with Chemistry, Modeling, Risk Assessment, and Environmental Legislation* (Wiley, 2006); Ling-Ling Hung, ed., *Field Guide for the Determination of Biological Contaminants in Environmental Samples* (AIHA, 2005); Zhongguo Gong and Cheng Yuan, *Urbanization, Energy, and Air Pollution in China: The Challenges Ahead* (National Academies Press, 2005); Chunmiao Zheng and Gordon D. Bennett, *Applied Contaminant Transport Modeling* (Wiley-Interscience, 2002).

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Fecal Coliform Bacteria

FECAL COLIFORM BACTERIA are the naturally occurring bacteria found in the digestive tracts of most animals. These beneficial organisms aid in digestion, converting certain indigestible fibers and compounds into nutritious compounds. So long as they remain within the alimentary canal, these bacteria are harmless to their host. Fecal coliform bacteria are shed along with excrement, and can colonize other individuals or even species different than their original host. Infections from a foreign body's fecal coliform bacteria are typically nonfatal, although severe symptoms can lead to death. Two to four days following infection from fecal coliform bacteria, symptoms such as diarrhea, stomach cramps, headaches, and fever arise. Antibiotics can successfully treat fecal coliform infections, although there is some concern that antibiotic-resistant strains of fecal coliform bacteria are developing.

Outside of their preferred host environment, fecal coliform bacteria can survive for weeks; *E. coli*, one of the most common human fecal coliform bacteria, can survive in drinking water from between four to 12 weeks, and can lead to widespread human illness. Some fecal coliform bacteria can also become airborne, and can be inhaled or settle onto surfaces, later to be transferred onto new hosts and ingested or introduced onto mucous membranes.

DANGER IN THE WATER

One of the most damaging environmental effects of fecal coliform bacteria stems from contamination of aquatic systems, which can either be from the direct introduction of human or animal waste into waterways, or from wastewater treatment plants, septic systems, or agricultural runoff. Pet waste also contributes heavily to the contamination of freshwater systems by fecal coliform bacteria; some estimates suggest that nonpoint source, rather than point sources for fecal coliform pollution, represent a larger share of water contamination. Contamination of estuaries and marine systems with fecal coliform bacteria can halt shellfish harvesting and even lead to beach closures. Introduction in waterways and other aquatic systems can result in competition for resources with native bacteria, with effects noticeable in higher trophic levels. Additionally, the presence of fecal coliform bacteria typically indicates the incidence of more dangerous pathogens or parasites.

In aquatic environments, the source of the bacteria typically represents a rich source of nutrients, which, when decomposed, leads to lower oxygen levels and overabundance of aquatic plants and phytoplankton. This process, called *eutrophication*, in turn causes stress to aquatic organisms, and can even lead to fish kills. Furthermore, the higher turbidity of contaminated water can result in lower productivity of benthic aquatic plants, and settling particulate matter can smother filter-feeding organisms, such as bivalves.

Most of the documented cases of fecal coliform infection in humans has been a result of improperly handled, packaged, and prepared foods, typically ground beef. Fecal coliform bacteria are introduced through inadequate sanitary precautions at slaughterhouses, improper sanitation when handling food, and possibly even the spreading of animal manures onto fields. Lack of sanitary toilet facilities for agricultural workers also presents an additional source of fecal coliform contamination of food sources.

SEE ALSO: Eutrophication; Nonpoint Source Pollution; Nutrients; Wastewater.

BIBLIOGRAPHY. S.C. Edberg, E.W. Rice, R.J. Karlin, and M.J. Allen, "Escherichia coli: The Best Biological Drinking Water Indicator for Public **Health** Protection," *Journal of Applied Microbiology* (v. 88, 2000); United States Environmental Protection Agency, "Groundwater and Drinking Water: Drinking Water Contaminants," www.epa.gov/safewater (cited December 2006); A.F. Holland, D.M. Sanger, C.P. Gawle, S.B. Lerberg, M.S. Santiago, G.H.M. Riekerk, L.E. Zimmerman, and G.I. Scott, "Linkages Between Tidal Creek Ecosystems and the Landscape and Demographic Attributes of Their Watersheds," *Journal of Experimental Marine Biology & Ecology* (v. 298, n. 2, 2004); K. Reynolds, P. Watt, S. Boone, C. Gerba, "Occurrence of Bacteria and Biochemical Markers on Public Surfaces," *International Journal of EnvironmentalHealth Research* (v. 15, n. 3, 2005).

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Federal Emergency Management Agency (FEMA)

PRESIDENT JIMMY CARTER created FEMA in Reorganization Plan Three of 1979, with the intent to make FEMA the single federal response agency for disasters, thus reducing any confusing, overlapping, and duplicative efforts from other agencies. This urgency was underscored by the March 1979 Three Mile Island nuclear power plant accident, which revealed shortcomings in federal, state, and local planning for emergencies. The executive order forming FEMA was signed days after the Three Mile Island incident.

FEMA thus took on the Defense Department's civil preparedness programs; Housing and Urban Development's Flood Insurance program; fire prevention programs and community preparedness programs from the Department of Commerce; and dam safety, earthquake, and terrorism programs from the Executive Office of the President. The first director of FEMA, John Macy, sought to knit together these disparate functions through a program called the Integrated Emergency Management System (IEMS) that would serve a range of emergencies, from natural disasters to nuclear attack.

During the Reagan administration, FEMA's focus tilted heavily in favor of civil defense under Louis Giuffrida and, later, General Julius Becton. The Loma Prieta earthquake and Hurricane Hugo shattered complacency about natural hazards in 1989. FEMA's response to these events was viewed as inept, and it became clear that FEMA's top management were mostly political appointees, not emergency managers, all of which set the agency up to fail.

REVOLUTION AT FEMA

In 1993, President Bill Clinton appointed his former Arkansas emergency director, James Lee Witt, to direct FEMA. Some have called the 1993–2001 period the "Witt Revolution," because Witt—the first FEMA director with emergency management experience—streamlined agency practices and knit disparate agency factions into a single agency with a mission oriented toward natural disasters. This management reform paid dividends during FEMA's generally successful response to the 1993 Midwest floods and to the 1994 Northridge earthquake in southern California. The 1993 flood in particular induced the agency to create the Mitigation Directorate; for the first time, substantial FEMA resources and attention would be paid to taking steps to mitigate the effects of disaster before it struck, rather than relying primarily on relief and recovery to ease the damage and suffering caused by disasters.

FEMA, however, stumbled somewhat in the mid 1990s when it failed to claim the primary federal role for managing national responses to terrorism attacks, a problem that rose on the agenda with the 1993 World Trade Center and 1995 Oklahoma City bombings. FEMA's role in terrorism was therefore never clear, even before the September 11, 2001 terrorist attacks. In 2001, President George W. Bush returned to the prior practice of political appointees to lead FEMA. Under his first FEMA director, Joe Allbaugh, FEMA discontinued a popular disaster mitigation program, Project Impact. To his credit, Allbaugh did recognize that FEMA would have a role in terrorism, and he reconstituted the new Office of National Preparedness (ONP) with a focus on terrorism.

The September 11, 2001 terrorist attacks changed FEMA and national emergency systems, although it is questionable that FEMA needed wholesale change. FEMA was made a part of the new Department of Homeland Security in 2003. Many of its functions were diffused throughout DHS, and most of its leadership had little or no emergency management experience.

The agency therefore appeared inept when, in September 2005, Hurricane Katrina revealed that FEMA and other participants were unable to effectively implement the new National Response Plan and the National Incident Management System created after September 11. By 2005, confidence in the agency's competence was severely eroded. President Bush's replacement of director Michael Brown with R. David Paulison, a fire and rescue specialist, suggests a shift toward emergency management experience. Some experts believe, however, that FEMA should be removed from DHS.

SEE ALSO: Disasters; Floods and Flood Control; Hazards; Hurricanes.

BIBLIOGRAPHY. *Coping with Catastrophe: Building an Emergency Management System to Meet People's Needs in Natural and Manmade Disasters* (National Academy of Public Administration, 1993); George D. Haddow and Jane A. Bullock, *Introduction to Emergency Management* (Butterworth-Heinemann, 2003); Gary A. Kreps, "The Federal Emergency Management System in the United States: Past and Present," *International Journal of Mass Emergencies and Disasters* (v.8/3, 1990); Patrick Roberts, "FEMA and the Prospects for Reputation-Based Autonomy," *Studies in American Political Development* (v.20/1, 2006).

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Federal Insecticide, Fungicide, and Rodenticide Act

THE FEDERAL INSECTICIDE, Fungicide, and Rodenticide Act (FIFRA) of 1972 was enacted in the United States to regulate the manufacture and use of pesticides, and represented a significant reworking of the existing law, which had been introduced in 1947. The most significant amendment was the Food Quality Protection Act of 1996, which requires potential and existing manufacturers to submit applications for licenses to produce goods for commercial use. The information required by the Environmental Protection Agency (EPA) includes the contents of any formulation, which is kept confidential, the tests that have been used to determine the safety of the product, and directions for use.

Federal law generally preempts state laws in connection with FIFRA to prevent unscrupulous manufacturers from taking advantage of loopholes or weaknesses in state regulations. Second, the use of pesticides affects people, livestock, and crops across state borders. However, it is argued that a decentralized structure is more appropriate for a market in which numerous products are introduced and many specific local conditions exist, which may require special provisions. Some have argued that the preemption of state regulations have unfairly benefited pesticide manufacturers, who gain protection from tort liability for problems or health issues resulting from labeling or usage of their products. Preemption was also involved in the attempt to use FIFRA to obtain recompense by veterans of the American War in Vietnam, whose health had been damaged by the military's use of Agent Orange. Foreign nationals are not empowered to use this legislation against American corporations.

The stakes are high in such legal debates because of the money involved in intensive agriculture, which often requires extensive use of pesticides. As scientists continue to provide new types of pesticides and methods of applying them, constant reevaluation of the regulations is required, even if the basic principles do not change. Some argue, however, that extensive safety tests and regulations unnecessarily restricts competition because only a few companies have sufficient financial resources to follow the process. Non-American companies wishing to import also dislike labeling and testing regulations that are deemed unnecessary in their home countries. The largest fine imposed by the EPA concerning FIFRA regulations was in 1998, when the Monsanto corporation was fined $225,000 for persistent mislabeling of products.

SEE ALSO: Agent Orange; Environmental Protection Agency (EPA); Monsanto; Pesticides.

BIBLIOGRAPHY. Arthur Cook, "U.S. Supreme Court Limits Preemptive Effect of FIFRA," *Pest Control* (v.73/6, 2005); Roger W. Findley and Daniel A. Farber, *Environmental Law in a Nutshell* (West, 2004); Joseph Frueh, "Pesticides, Preemption, and the Return of Tort Protection," *Yale Journal on Regulation* (v.23/2, 2006).

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Federal Land Policy and Management Act (FLPMA)

AFTER THE BUREAU of Land Management (BLM) began formal planning for public lands under its charge in 1969, the Federal Land Policy and Management Act (FLPMA) of 1976 was passed due to congressional dissatisfaction with BLM land

and resource management. According to the BLM, "FLPMA is called the BLM Organic Act because it consolidated and articulated BLM's management responsibilities." The FLPMA is a BLM-specific law. The statute reduces agency flexibility, increases agency accountability to itself and Congress, and dictates an "intensive, but imprecise planning process" that requires "vast bureaucratic resources and produce[s] mountains of paperwork."

Under FLPMA, decisionmakers at the BLM are required to consider the interests of all public land users before they determine how lands will be managed. The statute was ultimately designed to address natural scarcity of both renewable and nonrenewable resources (grazing, timber, minerals, recreation, wilderness, fish and wildlife, watershed, and so on).

Section 202 of FLPMA broadly guides land use planning and does not detail the steps by which BLM should generate and revise land use plans. Some of the more important management requirements of FLPMA for the BLM to observe principles of multiple use and sustained yield; use a systematic interdisciplinary approach (physical, biological, economic, cultural); give priority to the designation of areas of critical environmental concern; consider the relative scarcity of the values and alternatives for realizing those values; weigh long- versus short-term benefits; comply with pollution control laws; and coordinate with other federal, state, tribal, and local government entities.

MANAGEMENT OF BLM LANDS

As the largest land management agency in the United States, the BLM is responsible for 175 million acres (70 million hectares) in the lower 48 states. The FLPMA is in essence a guiding statute for the management of those lands. The FLPMA also mandated that the agency perform a roadless area review for the selection of Wilderness Study Areas, study the areas, "and make Wilderness recommendations to Congress by 1991." After an incomplete review of only 25 million acres (10 million hectares), the BLM proposed 328 wilderness units totaling 9.7 million acres.

The FLPMA also requires that the BLM highlight the designation and protection of areas of critical environmental concern (ACEC). An ACEC includes lands where special management attention is required to prevent irreparable damage to important scenic values, fish and wildlife resources or other natural systems or processes. By the year 2000, the BLM had designated about 13 million acres of ACECs, with 5.9 million acres located in Alaska. Many of these ACECs are sensitive riparian zones around rivers or are important wildlife areas like the Big Morongo Canyon in California, which is a wildlife corridor, lambing area, and watering area for desert bighorn sheep.

The FLPMA's guidance of BLM's facilitation and management of public-lands livestock grazing is a very contentious issue between the BLM and conservationists, as many environmental advocates believe the BLM is understaffed and underfunded, leading to detrimental harm to the range resource. The FLPMA requires the agency to set grazing fees, analyze the value of grazing, grant 10-year grazing permits, and establish grazing advisory boards.

One of the more prominent outcomes of FLPMA was the creation of the California Desert Conservation Area (CDCA). The CDCA is a 25-million-acre southeastern California desert that has been heavily impacted by motorized recreation, mining, livestock grazing, utility corridors, illegal roads, and invasive species. The FLPMA recognized the CDCA as a highly vulnerable desert environment with unique ecosystems that are not only rare, but "extremely fragile, easily scarred, and slowly healed."

The BLM's management of this vast desert area has been marked by difficulties and public controversies since its inception. Multiple stakeholders interested in both the resource use and/or preservation of the CDCA have often clashed with each other and the BLM in the federal courts. In one such case in 2000, pressure and lawsuits from the Center for Biological Diversity resulted in the removal or restriction of cows and sheep on habitat for the desert tortoise, southwestern willow flycatcher, and Least Bell's vireo. These settlements also closed 550,000 acres of the CDCA to off-road vehicles to protect the Coachella Valley fringe-toed lizard, Pierson's milk-vetch, desert tortoise, and other imperiled species. Included were 49,310 acres of the Algodones Dunes.

SEE ALSO: Bureau of Land Management; Desert; Grazing; Habitat Protection; Land Use; Land Use Policy

and Planning; Livestock; Overgrazing; Recreation and Recreationists.

BIBLIOGRAPHY. Bureau of Land Management, "Land Use Planning," www.blm.gov/planning/policy_flpma.html (cited April 2006); Center for Biological Diversity, "California Desert Conservation Area," www.biological-diversity.org (cited April 2006); George Coggins, Charles Wilkinson, and John Leshy, *Federal Public Land and Resources Law* (Foundation Press, 1993); Dave Foreman and Howie Wolke, *The Big Outside* (Harmony, 1992); National Research Council, Committee on Riparian Zone Functioning and Strategies for Management, Water Science and Technology Board, *Riparian Areas: Functions and Strategies for Management* (National Academy Press, 2002); San Diego State University Soil Ecology and Research Group, "Habitat Restoration Project in the Little Morongo Canyon Section of the Big Morongo Canyon Preserve Area of Critical Environmental Concern," www.sciences.sdsu.edu (cited April 2004).

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Feedbacks

FEEDBACKS ARE PROCESSES within a system in which some proportion of the output is passed, or "fed back," as input to the initial conditions. Positive feedbacks enhance or reinforce initial perturbations of a system, resulting in the amplification of the output process, whereby small changes in inputs can cause large changes in outputs, possibly resulting in system instability. Negative feedbacks reduce or weaken initial agitations of a system, resulting in the reduction of the output; whereby small changes in inputs can cause the system to produce smaller changes in the outputs, possibly resulting in a steady state, or homeostasis, condition. A feedback loop is a process in which an output is returned to the system as input, often but not always originating from outside the system. Feedback loops are convenient places in the system to insert control functions to counteract, or balance, unwanted system reactions.

Feedback mechanisms are often seen in complex or nonlinear systems in which the dynamic behavior is influenced through negative feedbacks; whereby systems move to disequilibrium conditions through positive feedbacks. Organisms, including humans, respond to system changes or stimuli such as a change in the environment. Dynamic equilibrium results from the ability of organisms, or people, to detect change and to respond to the stimuli in an attempt to maintain steady state conditions or to reduce the amplitude of system perturbations.

Deforestation increases with farming, cattle pasturing, in-migration, subdivision of land, and commercial roads.

COMPLEXITY THEORY

Complexity theory holds that systems cannot be suitably understood without a focus on feedbacks and consequent nonlinearity. A complexity theory analysis of land use change aims at understanding feedbacks and changes in conditions through nonlinearities, and in relation to a dynamic and coupled human–environment system. For instance, social inequalities are seen at a regional scale as an outcome of household behavior relative to land use/land cover patterns and strategies.

In the Ecuadorian Amazon frontier, multiple stakeholders interact through endogenous and exogenous processes to create a dynamic land use/land cover system that is space- and time-dependent, where feedbacks between human activities, land use change, and ecological dynamics produce nonlinearity. The Ecuadorian Amazon is a direct product of past views, ideas, and actions at different degrees of social and landscape organization. A change in the land use/land cover system has occurred as a consequence of the influx of migrant farm families to the Ecuadorian Amazon frontier that resulted in families clearing forests to establish farms. As families acquired knowledge and skills to produce agricultural products—and as household demographics changed over time—additional land was deforested as farmers transitioned from subsistence agriculture to cash crops, as well as increased the area of land in pasture for cattle.

Further, as people continued to migrate into the region, available land was subdivided through land sales and kinship ties, resulting in land fragmentation, which in turn has feedbacks to land use/land cover. Meanwhile, substantial migration to local towns has increased markets for the farmers' products as well as providing growing opportunities for off-farm employment, both of which have feedbacks to farm land use. The expansion of oil production in the region has contributed to further growth of towns and the enhancement of the regional infrastructure.

Thus, land use/land cover patterns of colonists evolved and changed as a result of growing market linkages and contacts, increased oil production, and changing socio-economic and political dynamics of key stakeholder groups that reacted to a changing environment. These changing interactions and feedbacks are caused, for instance, by soil fertility declines on active farms, increased roads and access, and more markets for commodities.

Positive feedbacks exacerbate initial land use/land cover conditions through deforestation, agricultural extensification, and urbanization. Negative feedbacks are being changed through increased access to the region, which was initiated by petroleum companies building roads for pipelines and oil extraction. In the Ecuadorian Amazon frontier, the landscape continues to change in interesting and surprising ways, becoming more accessible and fragmented, thereby reacting to a feedback process involving in-migration and changes in land use/land cover.

BIBLIOGRAPHY. G.R. Malanson, Y. Zeng, S.J. Walsh, "Complexity at Advancing Ecotones and Frontiers," *Environment and Planning A* (v.38, 2006); J.P. Messina and S.J. Walsh, "Morphogenesis: Modeling Landuse and Landcover Dynamics in the Ecuadorian Amazon," *Plant Ecology* (v.156, 2001); J.P. Messina and S.J. Walsh, "Dynamic Spatial Simulation Modeling of the Population—Environment Matrix in the Ecuadorian Amazon," *Environment and Planning B* (v.2, 2005).

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Feminist Political Ecology

FEMINIST POLITICAL ECOLOGY represents the most recent movement to advocate for the equality of women in political, social, and economic settings, and for a substantial change in the recognition of women's role in society. Historical examples in this ongoing struggle point to Aristophanes' study of the strong feminist assertiveness in *Lysistrata*, the 19th century writings of Charlotte Brontë, and early feminist advocates like Emmeline Pankhurst, who worked to undo the political aspects of female subjugation and to bring about female suffrage.

A more activist and militant thrust to the struggle ensued with feminist movement, whose champions stated unequivocally that the social system was replete with blatant sexism. Books by Germaine Greer (*The Female Eunuch*) and Kate Millett (*Sexual Politics*) in the 1970s articulated the existence of social structures that guaranteed the oppression of women in psychological and biological ways.

Feminist political ecology uses gender as the codifying variable in its struggle for sustainable socioeconomic and political development in the quickly changing era of globalization. The field takes positions and concepts from a number of different feminist movements that have evolved over the past several decades. Among these are ecofeminism, feminist associations with environmentalism, feminist aspects of post-structuralism, and socialist feminism. Studies conducted in feminist political ecology avoid the context in which women are separate from the topical investigation underway. That is, in studies focusing on rural development, inputs of information from both women and men are solicited.

Both are considered as agents of change in efforts to maintain their locales and in making decisions about resource use, health care systems, and the sustainability of the place. Feminist political ecology considers that gender differences derive from differences in cultural and racial views of women and not from purely biological differences. This view especially distinguishes feminist political ecology from ecofeminism, which, in the jargon of the field, tends to “essentialize” and consequently “decontextualize” women.

As related in the edited book *Feminist Political Ecology* feminist political ecology uses an activist approach in striving to create and maintain healthy environments, manage resources, ensure just decisions in property disputes, and in working toward the elimination of environmental degradation. In all of these efforts, a form of “gender knowledge” prevails. In one example, a community objected to the location of a proposed sewage treatment plant in close proximity to a children’s playground. The decision to relocate the plant was based on the insistence primarily of women in the community that the sewage plant would be potentially injurious to the human health.

Another example where feminist political ecology brought about needed change centers on the conflict between colonial rules in Kenya and the alienation of women from taking full part in the economic system. The application of gender knowledge to this situation has brought about changes in this situation and a departure from the earlier system of male dominance in, and feminine exclusion from, the economic system. A further example from a Himalayan agriculture community illustrates how land ownership rights favor males and place women in a dependency role. As a consequence of this gender inequity women became marginalized and excluded from agricultural decision-making, which adversely affected the stability of the agricultural system.

In their attempts to derive theory to bolster the position of feminist political ecology, its advocates point to a number of generalizations to support the effort. These include the fact of interconnectedness at all levels of the global ecosystem and the need for equitable gender power sharing in decision-making about the environment. Neither male-dominated nor female-dominated approaches are appropriate. Implicit in the feminist ecological conceptual base is the belief that technology should not be used to dominate nature.

In addition, there is the recognition that particular cultural biases can skew access to knowledge and management of the environment. Decisions about development tend toward the direction of one gender or the other, and nearly always toward the male. The ultimate theoretical position defining feminist political ecology will certainly reflect that gender knowledge is integral to any set of power relationships that exist in political, social, and economic contexts from local to global.

SEE ALSO: Ecofeminism; Gender.

BIBLIOGRAPHY. Judith Lorber, *Gender Inequality: Feminist Theories and Politics* (Roxbury Publishing Company, 2005); Wendy Kolmar and Frances Bartkowski, *Feminist Theory: A Reader* (McGraw-Hill, 2003); Dianne Rocheleau, Barbara Thomas-Slayter and Esther Wangari, eds., *Feminist Political Ecology: Global Issues and Local Experiences*, (Routledge, 1996); *World Survey on the Role of Women in Development, 2004: Women and International Migration* (United Nations Publications, 2004); Karen Dias and Jennifer Blecha, “Feminism and Social Theory in Geography: An Introduction,” *The Professional Geographer* (v.59/1, February 2007).

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Feng Shui

FENG SHUI (FUNG seui in Cantonese) is a technique of managing the landscape to maximize favorable circumstances and minimize misfortunes. Although it is uniquely Chinese, it has spread to other east Asian countries, and, very recently, to the rest of the world.

Feng Shui defies categorization. It has been erroneously called magic, science, religion, mysticism, and charlatanry, or "the art or pseudo-science of manipulating the occult forces that are believed to run through a landscape, site, house, or even room." It is also called "geomancy," but is does not resemble the ancient Greek and Near Eastern magical art of geomancy.

In Imperial China, Feng Shui built on the experience of billions of Chinese peasants. The roots of Feng Shui are pragmatic perceptions. These include the following guidelines: not building houses or villages in a floodplain or on a steep unstable slope; not building on good agricultural land; growing trees above and around villages for protection from wind and erosion and for provision of shade, fuel, and wood; having a reliable water supply; keeping a village difficult to reach, with a winding path to discourages invaders; encircling a village with hills like a womb, with the highest hills on the windward side, to block winds and storms; no undercutting of a steep slope; facing houses south, toward the warmth and light of the sun; and situating graves relatively far from settlements and with pleasant views, since traditional Chinese believe that parts of the spirits of the dead remain with the bodies.

A further set of rules, again based on common sense, applies within the home. An occupied room should not face the front door; the kitchen should be near the main door, bedrooms farther away; and furniture should not block lines of flow. Rules for room placement and arrangement can get very complicated, but in good Feng Shui practice the arrangements are grounded in practicality.

The "occult forces" concept results from perceptions of early Chinese thought, which seems to have been broadly animist. Every rock, hill, tree, and watercourse had its spirit, often a dragon, magical tiger, or other supernatural animal. These spirits had their own will and intentionality.

These beliefs persist today and do influence Feng Shui practice. Evil spirits travel in straight lines, for instance, hence the be winding paths to the house and blocking direct air routes with trees and religious structures. Failing that, one can set up a pottery model of a fortune-bringing animal on the roof; dragons and Buddhist "lions" are popular. A house must have symmetrical double doors, partly to provide a place to attach the spiritual door guardians. Painted images of Tang Dynasty generals have the power to repel ghostly evil, as the original generals repelled living enemies.

NATURAL AND SUPERNATURAL

Wholly impersonal and disembodied forces have also become basic to the system—perhaps in more recent millennia. These forces are "natural," in that they are fundamental to nature and can be studied and felt without recourse to ritual, worship, or prayer. They are, however, "supernatural" from the point of view of contemporary physics, because they do not exist in any verifiable or measurable way. These forces seemed similar to breath or wind, and thus acquired the name *qi*, "breath" or "vapor." Qi is usually a neutral energy or subtle breath running through and animating the world, but good and evil influences are also called qi, though they are different conceptually (at least in rural Hong Kong). Earthquakes, common in northern and western China, and their well-known effects such as mountain-building and valley creation, are credited to qi flowing through the landscape. The Chinese theory of qi is not totally incommensurable with modern theories of plate tectonics; energy does indeed flow through the earth and causes dramatic effects at certain points. While the ancient Chinese could not construct modern plate tectonic theory, they could at least make a start in the right direction through observation and inference.

Inference, however, ran on far beyond observation. People assumed that good luck, bad luck, wealth, health, and other benefits could flow along the lines of qi or be carried by it. Recent tomb finds show that something like Feng Shui was known 2,000 years ago. The logic was: We know that these matters are not under our control, but they must have some pattern and rationale.

Building on all this, Feng Shui experts developed many techniques to determine the lines of qi, the bright and dark forces, and the other unseen influences bearing on a site. They also sought to understand the ways of the dragons, tigers, and other power beings that live in hills and watercourses.

Thus, Feng Shui seems to have begun as grounded in folk-scientific observations, but it was soon mystified with a steadily increasing panoply of religious and magical practices. The result was a blend of science, religion, and magic. However, the Chinese do not see it as a blend, nor was it one historically. To them, it is a single institution and a single knowledge system. The categories of magic, science, and religion are modern concepts that simply do not apply to classical Chinese thought about such matters.

The label "pseudo-science" presupposes some real science to serve as the reference point. Feng Shui in premodern times, however, was not attempting to be a "science." The tests that would have disproved it had not been invented, and the definition of "science" that would have excluded it had not been elaborated. This sort of folk Feng Shui survives in China, Korea, and neighboring countries to this day. However, the Feng Shui practiced in the Western world today can reasonably be called a pseudo-science, with experts reaping great profits by purporting to use natural forces to bring about certain results.

A system that was once a whole peoples' best guess at how the natural world worked is now an anachronism, along with alchemy, stable continents, Freudian personality theory, humoral medicine, and countless other ideas that were once the best that people could do to make sense of the available evidence.

On the other hand, we can learn from the sound observations on which the system was originally based. In the floods of June 1966, all the traditional farming villages in the western New Territories were above the water, while all the newer farms were flooded. The new farms, built in an age when Feng Shui was considered "mere superstition," had been built in floodplains. More recently, China and Korea have urbanized vast tracts of farmland, and now have to import food on a large scale. Feng Shui taught earlier builders to avoid such places and protect farmland.

Similarly, Feng Shui for the home is now a booming business not only in Asian communities everywhere, but even among the many converts among the "host" populations. At best, it is rational planning for the home, based on common sense about lines of flow, arrangement of furniture, assignment of rooms' functions, and good environmental design. At worst, it is mystification, with unnecessary talk of qi and flying dragons.

SEE ALSO: China; Geomancy; Farmland Conservation.

Cheong Fatt Tze Mansion

It has been the aim for many architects to design a house which is perfect in terms of its Feng Shui. With many projects limited by budgets or difficult locations, this can be hard to achieve. However the Cheong Fatt Tze Mansion in Penang, Malaysia, is believed to have reached "Feng Shui perfection."

Cheong Fatt Tze (d. 1916) was a wealthy Chinese businessman who made his fortune in trade between Penang, Medan (Sumatra, Indonesia), Batavia (Jakarta, Indonesia) and south China. After the 1911 Revolution in China, Cheong Fatt Tze became a member of the Chinese Parliament and went to the United States to train industrialists to help build up Chinese industry. When Cheong Fatt Tze died, the house, with its well-known blue walls, was left to his family and gradually fell into disrepair. The mansion was extensively restored in late 1980s, and some of the French film *Indochine*, starring Catherine Deneuve, was filmed there. In 1995 it received the Malaysian National Architectural Award for Conservation. Five years later it won the UNESCO "Most Excellent" Heritage Conservation Award.

During a Feng Shui conference held in Penang, experts from all over the world visited the building and were impressed by the classical symmetry of the house, which ensured the "heart" remained in the central courtyard, retaining the energy of the building. The Cheong Fatt Tze Mansion exists not only as a tourist attraction, but also as a bed and breakfast, offering guests an opportunity to stay in one of the best-restored Chinese mansions in southeast Asia.

BIBLIOGRAPHY. E. N. Anderson, *Ecologies of the Heart* (Oxford University Press, 1996); E. N. Anderson, and Marja L. Anderson, *Mountains and Water: The Cultural Ecology of South Coastal China* (Orient Cultural Service, 1973); Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (Yale University Press, 2004); Naomi Oreskes, *The Rejection of Continental Drift: Theory and Method in American Earth Science* (Oxford University Press, 1999); Richard Von Glahn, *The Sinister Way: The Divine and Demonic in Chinese Religious Culture* (University of California Press, 2004); Yoon, Hong-Key, *Geomantic Relationships between Culture and Nature in Korea* (Orient Cultural Service, 1976).

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Fertility Behavior

AT THE ROOT of population growth, decline, and change lies the behavior of real women and men, making personal life decisions that reflect their socioeconomic circumstances, culture and religion. These choices, which regulate reproduction and childbearing, are together known as fertility behavior.

The concept of fertility behavior is among the oldest in social sciences, and its study, which began in the 18th century, explores it in relation to sociology, demographics, and population sustainability. Among the relevant factors are biology, behavior, society, economics, environment, religion, age, marital status, contraceptives, and family planning approaches. An example of how these elements are studied is the report made by Neeru Gupta and Iuri da Costa Leite, who found that residence and community were an important influence on fertility behavior.

Since many couples choose to have only two children, the idea of a possible third birth has become an issue in various contexts. Depending on cultural and religious traditions, couples may assign a special importance to the third birth, such as hoping for a particular gender. In some cultures, couple desire one child of each sex, whereas in other cultures, such as India or Egypt, couples prefer sons. In rural regions of China, couples who have a daughter first will be more likely to give her up for adoption, in the hope of having a male as for a second birth.

A fairly new phenomenon since the 1970s in Europe is women having their first child at age 35 or older. In France, which has the second highest birth rate in Europe (after Ireland), the number of French women having their first child beyond 40 years has doubled between 1962 and 2004, from 8 percent to 16 percent.

Related to the study of fertility behavior are the issues of infertility and celibacy. American sociologists Peter Bearman and Hannah Brückner have studied the phenomena of virginity pledges in the United States, which is often tied into teenager's identity decisions. The issue of infertility is so heartbreaking that it has been portrayed as far back as the silent era of moviemaking (G. W. Pabst's *Secrets of a Soul* in 1926), and continues into modern filmmaking (Woody Allen's *Hannah and Her Sisters* in 1986).

SEE ALSO: Birth Control; Children; Demography; Gender; One-Child Policy, China; Religions; Sex; Social Ecology; Sustainable Development.

BIBLIOGRAPHY. William G. Axinn and Scott T. Yabiku, "Social Change, the Social Organization of Families, and Fertility Limitation," *American Journal of Sociology* (v. 106/5, 2001); Peter S. Bearman and Hannah Brückner, "Promising the Future: Virginity Pledges and First Intercourse," *American Journal of Sociology* (v. 106/4, 2001); Ann Berrington, "Perpetual Postponers? Women's, Men's and Couple's Fertility Intentions and Subsequent Fertility Behavior," *Population Trends* (v.117, 2004); Dirgha Ghimire and Paul Mohai, Environmentalism and Contraceptive Use: How People in Less Developed Settings Approach Environmental Issues, *Population and Environment* (v. 27/1, 2005); Hari Mohan Mathur, "Social and Cultural Influences on Fertility Behavior," in *The Family Welfare Programme in India* (Vikas Publishing, 1995); Simon Szreter, *Fertility, Class and Gender in Britain 1860–1940* (Cambridge University Press, 2002); Danièle Vignoli, "Fertility Change in Egypt from Second to Third Birth," *Demographic Research* (v.15, 2006).

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Fertility Rate

THE STUDY OF fertility is crucial to understanding the dynamics of population change. The term *fertility rate* refers to the actual reproduction in any given society, i.e., the number of children that are born to an individual or in a population in a given time period. This is in contrast to the term *fecundity*, which refers to the biological or physiological ability of individuals or couples to have children; some people in a society are unable to bear children because of disease or other biological, genetic, and environmental factors. The theoretical maximum fecundity for any given population is said to be 15 children per woman, but the actual number of children per woman rarely exceeds eight. There are several factors that explain the large gap between fecundity and the actual reproduction (fertility) and interfere with the process of human reproduction. The determinants of fertility include the value placed on children, cultural and social roles of women, and socioeconomic circumstances. For example, in less-developed societies, large families are often the norm as children contribute significantly to livelihoods and often take care of their parents in old age. More importantly, infant mortality rates are higher in these societies, as parents know that some of their babies will succumb to death. On the other hand, in highly developed societies, economic realities may deter parents from having large families.

The cultural, social, and economic determinants of fertility work indirectly to affect another set of factors, which demographer John Bongaarts termed the four *proximate determinants* of fertility. The four proximate determinants are the proportion married, the percent of women using contraception, the proportion of women who are infecund due to disease or prolonged breastfeeding, and the level of abortion. In highly developed regions, fertility rates are extremely low because of relatively high rates of contraception use and a low rate of marriage among women in their prime childbearing years. In the less-developed parts of the world, high fertility rates can be explained by low contraceptive usage and the promotion of early and universal marriage for women.

Demographers use different types of formulae to measure the level of fertility in a given society for a given time period. Measures such as the crude birth rate, the total fertility rate, the general fertility rate, the child-woman ratio, age-specific birth rates, the gross reproduction rate, the net reproductive rate, and others have been devised to gauge the level of fertility in different societies. However, the two most commonly used and reported measures of fertility are the crude birth rate (CBR) and the total fertility rate (TFR). The CBR is expressed as the number of births per 1,000 population—a crude measure of fertility, as the denominator does not distinguish the age or sex structure of the population. In a young population there will obviously be more births than in a predominantly older population. Thus, the TFR is a more refined measure of fertility that takes

In developed regions, fertility rates are low because of a low rate of marriage among women in prime childbearing years.

into consideration the age and sex composition of a population. The TFR summarizes the average number of children a woman would have if she were to have children at the prevailing age-specific rates as she passed through her reproductive years.

Using these two measures, the CBR in 2006 ranged from nine for a number of European countries to 50 for Liberia. On average, sub-Saharan Africa had the highest CBR, estimated at 40 children born in a year per 1,000 population, while highly developed countries in Europe and North America had a CBR of 11. The 2006 CBR for the world is estimated at 21, while the crude death rate is nine per 1000 population, resulting in a natural increase of 1.2 percent annually. The TFR ranged from 7.9 children per woman in Niger to a low of 1.3 children for a number of European countries such as Italy, Bulgaria, and Germany.

This has great implications for population growth. A TFR of 2.1 is considered to be the replacement level. In other words, a population with this rate has stopped growing and is simply maintaining itself from one generation to the next. A TRF of greater than 2.1 implies that growth is occurring, as is the case in Africa and other parts of the developing world. A rapidly expanding population in an already impoverished country such as Niger results in intense pressure on the limited resources with ultimate dire consequences for the environment and the economy at large.

SEE ALSO: Birth Control; Birth Rate; Population.

BIBLIOGRAPHY: Joseph A. McFalls, Jr., "Population: A Lively Introduction," *Population Bulletin* (v.46/2, 1991; Krishnan Namboodiri, *A Primer of Population Dynamics* (Plenum Press, 1996); Gary L. Peters and Robert P. Larkin, *Population Geography: Problems, Concepts, and Prospects* (Kendall/Hunt Publishing, 2002); Population Reference Bureau, "2006 World Population Data Sheet," www.prb.org (cited December 2006); John Saunders, *Basic Demographic Measures: A Practical Guide for Users* (University Press of America, 1988); John R. Weeks, *Population: An Introduction to Concepts and Issues* (Wadsworth Publishing Co. 2002).

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Fertilizer

FERTILIZERS ARE CHEMICAL compounds that are added to the land to stimulate the growth of plants. Since soil is formed in many different ways around the world and is subject to many different types of erosion and leaching, then the optimal provision of additional nutrients will also vary. Most commonly, fertilizers will contain nitrogen, potassium, or phosphorus, which are the main plant nutrients, together with a number of trace elements that are also variously beneficial. Fertilizers are usually divided between organic and inorganic varieties. Historically, farmers have used manure from animals or other locally available substances.

The rise of industrialization during the modern age led to the creation of much more concentrated, nutritionally balanced, and efficient forms of fertilizers, and the understanding of which ones to use to promote the growth of specific types of plants. Fertilizers are now divided according to the ways in which they are taken up by plants (by roots or by leaves), how long they remain in the soil to release their nutrients, and the extent to which they are soluble. In general, agricultural fertilizers are usually comparatively long term in their release of important nutrients. Horticultural fertilizers tend to be much more short term in their intended impact and produce rapid growth in certain species for swift cultivation and sale. These types of fertilizers are more likely to enter into the plant and become, when the plant is a food item, part of the food chain. In common with insecticides and other chemicals, fertilizers can be partly responsible for regularization of size and shape of agricultural produce, since this makes the items more saleable.

This had the effect in some areas of removing the usefulness of local knowledge, often only slowly obtained over many generations, and leading to a sense of alienation. It also meant that commercial considerations became more important in determining what was to be grown than the natural configuration of the land and its soil. Although scientific studies suggest that the use of fertilizers does not have significant negative impacts if used appropriately, fertilizer is often, in fact, not administered appropriately, and farmers often do not have sufficient information or ability to apply it on a sustainable basis.

Although fertilizers are generally beneficial in that they promote plant growth and, therefore, help feed more people, they do have some negative impacts, especially when overused. These include the possibility of runoff, in which chemicals enter the water supply and contaminate it, as well as the eventual inability to sustain fertility of the land. The entry of fertilizers into waterways can lead to algal bloom, in which rapid growth of algae changes the water ecosystem and is harmful to fish and other marine creatures. Additionally, the success of some fertilizers in large-scale agricultural areas such as the U.S. midwest, as well as commercial incentives to provide ever-increasing growth of individual varieties, has increased the transformation of land cover and land use to monocropping—which has a tendency to lead to unsustainable and high-risk environmental circumstances. However, retail interests may lock farmers into long-term contracts, requiring them to continue to produce stipulated amounts of the individual species in order to profit.

SEE ALSO: Agriculture; Farming Systems; Food.

BIBLIOGRAPHY. Philip J. Cafaro, Richard B. Primack and Robert L. Zimdahl, "The Fat of the Land: Linking American Food Overconsumption, Obesity, and Biodiversity Loss," *Journal of Agricultural and Environmental Ethics* (Vol.19, No.6, 2006); James F. Power and Rajendra Prasad, *Soil Fertility Management for Sustainable Agriculture* (CRC, 1997); Samuel L. Tisdale, Werner L. Nelson, James D. Beaton and John L. Haylin, *Soil Fertility and Fertilizers,* 5th ed. (Macmillan College Division, 1993).

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Fiji

THE REPUBLIC OF the Fiji Islands consists of 320 islands covering 18,272 square kilometers. The great majority of the country's population live on the two largest islands, Viti Levu and Vanua Levu. Though Fiji comprises all types of oceanic island, Viti Levu and Vanua Levu are of volcanic origin with mountainous interiors and fertile coastal bands where most of the country's estimated 860,000 population (2005 estimate) live and where the majority of Fiji's agricultural activity, services, infrastructure, towns and tourist resorts are located. Approximately 80 percent of the country's rural population live within five kilometers of the coast.

Fiji faces a number of environmental threats and challenges resulting from the limited amount of available fertile land, the coastal location of much of the population and most economic activity, and the shift of the economy to a more industrial base. As such, Fiji faces multiple challenges, the most important of which include land degradation from intensification of economic activity, destruction of marine habitat and erosion of coasts, land and coastal-based pollution, unsustainable exploitation of marine resources, soil erosion resulting from more intense us of land (especially hillsides), and destructive fishing practices. In rural areas, the dominance of the sugar industry has meant an increasing use and reliance on pesticides and, coupled with more intense use of land for subsistence and commercial crops, has resulted in greater sedimentation and pollution of rivers and lagoons.

Fiji faces significant and pressing environmental challenges resulting from its transformation from a rural to an urban society. The urban population of Fiji is estimated to approximately half the national population. Cities are growing in terms of population but also their wider footprint. Suva, the principal city and national capital, extends to over 6,500 ha with an estimated population of at least 210,000. Urban growth has taxed the capacity of authorities to provide adequate services and infrastructure, particularly to the country's burgeoning squatter settlements that increasingly dominate the urban landscape of even smaller regional cities. In the mid–1990s only about 40 percent of Fiji's urban population had adequate access to water, proper sanitation facilities, and waste collection services. Levels of solid waste creation per capita are increasing in many of Fiji's cities but the machinery of collection and disposal is rarely keeping pace. Environmental and health conditions in informal settlements are increasingly degraded and deteriorating with growing populations. In addition to these environmental threats, Suva now faces an increased problem of air pollution.

SEE ALSO: Coastal Zone; Fisheries; Pesticides.

BIBLIOGRAPHY. Bob Thistlewaite and Derrin Davies *A Sustainable Future for Melanesia? Natural Resources, Population and Development* (National Centre for Development Studies, Australian National University, 1999); International Waters Programme, *Priority Environmental Concerns for Fiji*, (Institute of Marine Resources, 2003).

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Film, Representations of Nature in

WHEN THE VERY first motion pictures were shown to audiences in France during 1896, many people noticed with delight that "leaves on the trees seemed like they were moving" in Lumière's short film *Le déjeuner de Bébé* ("Baby's Breakfast"). Although there are many genres and various formats of films, there are also two opposite categories: those that idealize nature or take the defense of the environment, and those that show nature, animals, or space as dangerous for humans.

THE SILENT YEARS (1895–1928)

In the early 20th century, many films were short documentaries made by traveling cameramen, showing moving images of Paris, London, Rome, or New York to remote audiences in less developed countries, and then bringing back living images of Egypt, African countries and tribes, colonies, or exotic landscapes to more developed countries. An early science fiction story, Georges Méliès' *Le Voyage dans la Lune* (Trip to the Moon, 1902), confirmed the fairy imagery of space in the early century, as it was shown again in Fritz Lang's pioneering *Woman in the Moon* (1928).

Some directors became famous in showing an idealistic representation of men living in perfect harmony with nature, especially in some ethnographic documentaries. For instance, Robert Flaherty's *Nanook of the North* (1922) showed the daily life of an "Eskimo" living in Northern Québec, near the Hudson Bay (Canada). Memorable scenes showed the joyful character Nanook chasing, fishing, and sleeping in an igloo he had built. Flaherty's movies carried on with this romantic documentary genre: *Moana: A Romance of the Golden Age* (1926), about the daily life of Samoan islanders; and again in *Tabu: A Story of the South Seas* (1931).

In his masterpiece *Gold Rush* (1925), Charlie Chaplin showed a hard winter in Alaska, with famous scenes of men fighting against the powerful natural elements: a tramp followed by a gentle white bear, a little house blown away by the stormy wind. In F. W. Murnau's masterpiece entitled *Sunrise* (1927), the whole plot is centered on nature, as the film shows the passage from the rural zone toward the city, or vice versa. In the first part of the film, the calm beauty of wild nature surrounds all characters; while in the second half, the elements are against them: during a violent storm, the beloved mother disappears in the lake.

SURVIVING NATURE: THE TALKIES

Between 1927 and 1930, silent movies disappeared. More and more films had to be shot in the studio. But still, allusions to nature and the environment were made in some movies, sometimes as a metaphor for human feelings. However, every filmmaker had his own vision of nature. Shot in Northern Ireland, Robert Flaherty's *Man of Aran* (1934) also included scenes of a violent nature against men, in this case the tide hitting the fishermen and the presence of a shark that is attacked by the local men who live on the coast. In another case of the dangerous sides of nature, French novelist Sacha Guitry's film *Roman d'un Tricheur* (Confessions of a Cheat, 1936) shows the story of a child who had lost his parents, brothers, and sisters, because they all ate poisoned mushrooms from the woods.

Some directors have drawn a parallel between the uncontrolled forces of nature and the evil side of humanity. For instance, in Jean Renoir's masterpiece *La règle du jeu* (The Rule of the Game, 1939), a group of bourgeois who go hunting for rabbits as a prelude to the elimination of an outsider in their own circle. In *Lifeboat* (1943), Alfred Hitchcock imagines a group of shipwreck survivors adrift in a lonely lifeboat, lost on the sea during World War II. A few years after the end of the war, Roberto Rosselini shoots in Sicily a moving melodrama, *Stromboli, terra di Dio* (1949). An unhappy woman (Ingrid Bergman) wishes she could leave the hostile island where she lives, but feels the local population would stop her. On the day she decides to escape her brutal husband, a volcano starts to erupt and she is caught, alone on the top.

More than any other art form, cinema has given people the impression of knowing famous places like New York City or the Wild West without ever visiting them. Hence, Western genre movies have constructed a coherent environment for countless epic stories. John Ford created the most durable, mythical image of the American West, shooting most of his films in the Monument Valley studios, the largest open-air filming location that gave the Western its aesthetic definition for generations. John Ford's color films, from *Drums along the Mohawks* (1939) to *The Searchers* (1955), gave a magnificent vision of the West.

From the early 1960s, a few European movies began to question the dehumanizing effects of urban life and industrial societies. In Italy, Michelangelo Antonioni illustrated the difficulty of communicating in two masterpieces: *L'Avventura* (1960) and later in *Red Desert* (1964). Both films showed a beloved woman (Monica Vitti) who could not deal with her human and physical environments, both seen as superficial and artificial.

Some important directors such as Luis Bunuel have given a vision of nature as dangerous. In *La mort en ce jardin* (Death in the Garden, 1955), a group of bourgeois are lost in the jungle, seeing their belongings attacked by insects. That weird perspective reappears in Werner Herzog's *Aguirre, The Wrath of God* (1972), when a group of Spanish colonialists constantly face danger from the Peruvian highlands near the Amazonian jungle. The jungle has often been used as a symbolic location for a mysterious danger, such as in F. F. Coppola's *Apocalypse Now* (1979).

Apart from a few exceptions like Walt Disney's *Bambi* (1942), many fiction films showed wild animals as dangerous. In Steven Spielberg's *Jaws* (1975), the shark was not seen as an endangered species, but rather as a giant, evil, dangerous monster, as the many film versions of *Moby Dick*, from the 1926 version by Millard Webb, up to the John Huston version produced in 1956 from Herman Melville's novel.

The documentary tradition at the National Film Board (NFB) of Canada has enabled the creation of countless short films about men and nature. Among those, Arthur Lamothe's *Bûcherons de la Manouane* ("Manouane River Lumberjacks," 1962), showed some workers in Québec's lumber camps. However, a new, respectful attitude toward nature appeared in the early 1960s, for instance in Pierre Perrault and Michel Brault's *Pour la suite du monde* (also known as Moontrap, 1963), when a group of islanders living on Isle-aux-Coudres (on the St. Lawrence River) capture a small white whale, not to kill, but in order to renew a tradition of fishing that was lost in early 20th century. At the end of the film, the captured animal is sent alive to an aquarium in New York City.

In France, François Truffaut has created a film universe where nature is often present. At the end of *Les 400 coups* (The 400 Blows, 1959), the young Antoine Doinel escapes college goes to the beach in Normandy, for the first time in his life. In Truffaut's masterpiece *L'Enfant sauvage* (The Wild Child, 1970), a wild boy about 10 years old, who probably spent all his life in a forest, is taught how to live in society in the 18th century.

AN ERA OF CONTROVERSIES: 1975–2000

In the recent decades, an important number of documentaries about environmental issues has showed a growing conflict between environmentalists and industry, or opposing the state. Significantly, many debates about movies dealing with ecological issues have appeared outside the limited circles of film critics; even some governments felt they had to react to some challenging documentaries that criticized the government's attitude.

Some cases of environmental debates took international proportions. For example, on April 29, 1987, the *New York Times* reported that the U.S. Supreme Court confirmed the U.S. govenment's right to label three Canadian documentaries as "political propaganda:" *If You Love This Planet* (1982) by Terri Nash, *Acid From Heaven* (1982) by George Mully, and *Acid Rain: Requiem or Recovery?* (1982) by Seaton Findlay.

Perhaps Australian director Dennis O'Rourke produced the most stunning documentary about the dangers of nuclear research, *Half Life: A Parable for the Nuclear Age* (1985). In this obscure film made with archival footage, the consequences of many radiation experiments on a human population from the tiny atolls of Marshall Islands is seen, after nuclear testing in the Pacific Ocean during the 1950s. But possibly the most comprehensive film essay about risks to society in terms of nuclear hazards is Peter Watkins' *The Journey* (1987), 15 hours of documentary shot in many countries over three years. Watkins's message is that we do not know much about the risks surrounding us, and neither politicians nor the media tell us about the real issues. Moreover, demonstrations shown in the media represent those who challenge or oppose these decisions as strange, violent characters, often cut from reality.

In Canada, director Robert Monderie and songwriter Richard Desjardins produced *L'Erreur boréale* (Forest Alert, 1999), about how the wide forests in Québec are exploited by giant companies. That provoking documentary created a huge debate about the dangers of clear-cut logging in northern Quebec, and many politicians had to justify these practices after the film was screened.

In France, Claude Lanzmann directed and produced a moving documentary about the memory of the Holocaust, in a nine-hour film titled *Shoah* (1985). In this film, the author Claude Lanzmann visits former Polish and German Nazi death camps with some survivors. In some cases, these camps were not transformed into memorials; they were abandoned or destroyed, so nothing remains in the woods where thousands of corpses were buried and old railways still remain hidden under the grass. In only four decades, trees have grown where there used to be prisons for innocent civilians.

THE 21ST CENTURY: NATURE AS HERO

From the mid–1990s until today, a new awareness toward environmental issues is growing, and movies starring nature itself are appearing; staging a celebration of life, sometimes even without a human presence (or referring to humans as obstacles for animals and plants), in some cases using new technologies. Many of those movies became a huge success, especially in France, where many teachers brought their classes to watch films like *Microcosmos* (1996) by Jacques Perrin; *Le Peuple Migrateur* (The Traveling Birds, or Winged Migration, 2000), by Jacques Cluzaud and Michel Debats; and *March of the Penguins* (2005), directed by Luc Jacquet. In a few cases, these documentaries were quite successful in movie theaters, which is unusual in that genre. With DVDs and the internet, new modes of distribution can help these films find a wider audience.

SEE ALSO: Animals; Anthropomorphism; Critical Environmental Theory; Nature Writing; Nature, Social Construction of.

BIBLIOGRAPHY. I. Aitken, ed., *Encyclopedia of Documentary Film* (Routledge, 2006); T.W. and Cathy Cavanaugh, *Teach Science with Science Fiction Films: A Guide for Teachers and Library Media Specialists* (Linworth Publishing, 2004); "Court Backs 'Propaganda' Label for 3 Canadian Films, 3 Films Cited by Justices," *New York Times* (April 29, 1987); Y. Laberge, "Une réappropriation symbolique d'un Fleuve," *Revue d'histoire du Québec* (v.74, 2003); S. Mathe, ed., *Antiamericanism at Home and Abroad* (Publications de l'Universite de Provence, 2000); P. Patro, ed., *Fugitive Images: From Photography to Video* (Indiana University Press, 1995); S. Schneider, ed., *1001 Films* (HMH, 2004).

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Finland

FINLAND IS A sparsely populated country of 5.25 million people in northern Europe. The population and economic activity concentrate in the south, whereas large wilderness areas characterize the climatically harsher north and east. The origins of the national economy are close to the offerings of nature (forestry, agriculture, manufacturing of linen and wool), and forestry still plays a prominent role in the economy. A large-scale transition in Finnish society from agrarian lifestyle and migration from small towns to urban industrial centers only occurred in the 1950s and the 1960s. Post-industrial, service-based consumer society characterizes today's Finland.

Finns have a strong emotional relationship with nature. Finnish mythology is rich with symbolism and narratives representative of the Finnish landscape: forest, lakes, snow, and ancient bedrock. This thematic became prominent in identity-politically inspired art in the 18th century, in the context of awakening Finnish national sentiments. Nature continues to be a popular theme in Finnish art, design, and national iconography, for example on postage stamps and currency.

The natural environment is a favorite space for recreation and leisure. Most of Finland's half a million summer cottages are found on the Baltic coast and the Lake Region (south and east), and, increasingly, in Lapland (north), which are all popular destinations for foreign visitors. The positive economic impact of these seasonal homes is considerable on the typically small, rural host communities. Outdoor sports, hunting, and fishing are popular hobbies. In addition to municipal recreation areas, Finland has an extensive, government-managed network of conservation and recreation areas, the largest of which are national parks. The Ministry of the Environment coordinates Finland's environmental administration through research institutes, regional centers, and licensing and funding authorities. The duties include management of water and land resources, environmentally sustainable land use planning in built environments, preventive measures, and conservation.

Citizens' environmental awareness in Finland is at a relatively high level. Many consumers take environmental issues into consideration in their purchasing choices and recycle actively. Environmental health and risks, sustainable development, and responsible consumer choices are frequent and sometimes hotly debated topics. Environmental organizations range from small, informal activist networks to nationwide civic associations dedicated to nature conservation, animal rights, and environmental education. The Green League of Finland party attracts 8–10 percent of the vote in parliamentary elections, typically from well-educated, young urbanites.

Differing interests and views have also created tension in Finnish society. In integrating Europe, concerns about safety and sustainability focus on food and energy production and often depend on decisions made elsewhere in Europe. Recent environmental conflicts within Finnish society have included the acceptability and methods of fur production (between animal rights activists, producers, and retailers); land ownership, sustainable reindeer herding, and mining rights in Lapland (the indigenous Sami, the local majority population, the central government, and multinational corporations); and the sustainability of Finnish forest companies' actions at home and abroad (environmental activists, land owners, and multinational corporations). The scope of Finnish society in environmental matters is thus increasingly global, diverse, and, at times, controversial.

SEE ALSO: Environmental Organizations; Environmentalism; European Union.

BIBLIOGRAPHY. Pauliina Raento and John Westerholm, eds., *Finland–Nature, Society, and Regions. Fennia 180* (Special Issue, 2002); Finland's Environmental Administration 2006, www.environment.fi (cited May 2006); Statistics Finland: Finland in Figures 2006, www.stat.fi (cited May 2006); Finnish Tourist Board 2006, www.mek.fi (cited May 2006).

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Fire

THE MASTERY OF fire separates humans from other animals. Our use of this chemical reaction—on landscapes, in hearths, and in industry—is one of our most fundamental and influences on the environment. Without fire, many of our foods and landscapes would be unrecognizable. But fire also destroys homes and habitats, and inspires or even expresses conflict between different people.

Fire is a chemical chain reaction akin to photosynthesis in reverse. Once sufficiently heated, fuels react with oxygen in the air to produce carbon dioxide, water vapor, and heat energy. The size, type, and moisture content of fuels, as well as the prevailing weather conditions (humidity, precipitation, temperature, and wind), are crucial in affecting the threshold for ignition and potential for spread. The most common fuels for fire are biomass like trees or grasses, and fossil biomass like coal or oil. Fires are more frequent in landscapes with both wet and dry periods, like seasonal tropics or Mediterranean climates. Biomass accumulates during wet seasons and then dries out. Deserts are typically too dry for combustible biomass to accumulate; humid temperate, boreal, and humid tropical regions only occasionally dry out sufficiently to allow fires to propagate.

Barring spontaneous combustion at high temperatures, most fires require external ignition to spark the chain reaction. Humans and lightning are the most common ignition sources, though falling rocks and volcanism also occasionally spark fires. Lightning's prevalence varies from region to region: while around 6,000 lightning discharges occur each minute across the globe, they are not uniformly distributed. Mountainous regions and places where lightning is not associated with drenching rainfall are particularly prone to lightning fire ignition. The western United States is one such place; 200–1,700 lightning fires occur each year on government forestlands in California alone.

In many places, humans ignite more fires than lightning. Humans first observed that the animals they hunted congregated on the flush of new grass after lightning-strike fires, or that useful plants grew in burned areas; archaeological evidence suggests that humans fully mastered the art of lighting and tending fires between 350,000 to 400,000 years ago. Our techniques evolved rapidly in recent centuries, beginning with sulfur-tipped matches in 1827 and moving toward tools like aerial bushfire ignition and turbocharged internal combustion engines.

Every human culture has stories and beliefs centered on fire, which has come to symbolize the links between humans and the divine, both in legend and in practices like cremation.

Fire can be divided into four broad categories. Landscape fires are natural landscape and anthropogenic landscape fires such as vegetation fires, biomass burning, or "wildland" fires; and point fires are domestic and industrial fires, which are contained to a single, man-made point, such as a stove, furnace, or engine.

LANDSCAPE FIRES

Natural landscape fires are ignited by nonhuman sources like lightning. Charcoal found in lake sediments and other paleo-ecological evidence shows that fires burned nearly everywhere before the arrival of fire-bearing humans.

However, humans now burn more lands than lightning, and have long relied on fire as a simple and effective tool to control and shape landscapes for a better life. Humans have also created combustible conditions by unleashing livestock or slashing vegetation. Fires renew and expand grasses crucial to both wild game and domestic livestock, and clear brushy vegetation to facilitate cultivation, travel, visibility, and security. Frequent, small, early fires are the best way to control wildfires, by avoiding fuel buildup. Fire also encourages (or discourages) specific plant types, flushes out animals for hunting or bees for honey collection, and uncovers mineral outcrops or wild tubers.

Anthropogenic landscape fires are common across the globe. For example, in Kansas, ranchers set tallgrass prairies alight each spring to improve grazing. In California, oak woodland managers copy the techniques of indigenous Yurok people, who burned in part to encourage a good acorn harvest. In Africa, wildlife reserve managers burn savannah grasslands to improve habitat for a variety of ungulates and their predators. In Scotland, hunters torch the moors to improve grouse habitat. In India, foresters use prescribed fires in *sal* forests to improve timber harvests; Florida foresters do the same in pine woodlands. In Mali and northern Australia, a mosaic of frequent fires throughout the year serves not only to shape the vegetation, but also to control the spread of later wildfires. In Oregon and Brazil, farmers burn crop stubble to facilitate the return of nutrients to the soil. In Madagascar and Thailand, farmers prepare crop fields by burning the standing vegetation.

Today, as a result of both natural and anthropogenic landscape fires, an estimated six million square kilometers, or four percent of the earth's land surface, burns annually. In some regions—particularly the savannas and grasslands of places like northern Australia, Sahelian Africa, or around the edges of the Amazon Basin—fires burn perhaps half the land each year.

POINT FIRES

Domestic and industrial fires are also an anthropogenic contribution. Domestic fires include campfires and home fires used for cooking, heat, and light. Fire allowed our ancestors to cook and cure foods, vastly expanding the range of edible foods and the possibilities for storage. Campfires at cave entrances protected prehistoric humans from dangerous predators. Their light expanded our productive capacities. Today, the campfire, fireplace, or barbeque remains an enduring site of human sociability.

Industrial fires are, like domestic fires, anthropogenic point fires, but differ in technology and fuel type. Technological advances in the past two centuries, and associated exploitation of fossil biomass fuels, contributed to the invention and rapid spread of different kinds of engines, furnaces, and factories. The campfires or wood stoves of our ancestors have, for most people, been replaced by a coal-burning power plant linked to an electricity grid, or by pipelines and bottled gas. Industrial fires are now at the root of most human productive and economic activities—from jet engines to automobiles, coal-burning power stations to gas furnaces. Humans now consume 400 million trillion joules of energy annually, or almost two-thirds of the earth's overall combustion budget.

The impacts of fire are complex and highly dependent on temporal and spatial scale. Short-term trends may not reveal major long-term effects, and vice-versa. In some ecosystems, such as oft-burned grasslands, vegetation and soil nutrients recover relatively rapidly from the immediate effects of fire; in other ecosystems, single fires can be major drivers of landscape change.

SHAPING VEGETATION COMMUNITIES

Both natural and anthropogenic landscape fires play a key role in shaping vegetation communities. At its simplest level, increased burning favors fire-adapted species. Grasses typically fare better than woody species, yet some bushes and trees display a wide variety of adaptations to fire, including the protection of thick bark, seeds that require fire to open or ash beds to sprout, the ability to re-sprout from epicormic buds, or the placement of significant plant parts underground.

In the savannah environments of Africa, early dry season burns every few years can a promote tree cover, while later fires reduce tree cover. Seed availability, grazing intensity, soil type, annual variability in timing and amount of precipitation all affect the outcome.

Many seemingly "natural" landscapes may owe at least part of their ecological character to people. Geographer William Denevan has argued that before the arrival of Columbus, the burning and cropping practices of indigenous Americans, then numbering in the tens of millions, had shaped landscapes all over the Americas. While some debate persists over this assertion, it is clear that American prairies, African savannas, or the Brazilian *cerrado* would look fundamentally different without fire.

Humans first visited the large Indian Ocean island of Madagascar only 2,300 years ago. The fires unleashed by settlers over the next millennium across this island increased grassland cover at the expense of woody vegetation, particularly in the highlands.

Fires associated with agriculture lead to even sharper vegetation changes, as people closely control the vegetation that succeeds a burn. Polynesian sailors settling new islands like New Zealand started a process of burning and clearing just as 18th century Scottish and Irish farmers used slash-and-burn agriculture to clear a foothold in America's heavily wooded Appalachian Mountains. Fires used for agriculture still play a key role in deforestation today, in places like Africa (for subsistence farming), southeast Asia (to establish oil palm plantations), and the Amazon (for the farms of colonists and ranchers).

SOIL AND WATER

Fires affect soils in several ways. Typically, erosion rates increase on burned plots for a limited time, though regular burning does not necessarily increase long-term erosion. In some ecosystems, however, fires may trigger erosion events that are major drivers of geomorphic change.

Trees display a wide variety of adaptations to fire, including thick bark and seeds that require fire to open.

Soil nutrients like nitrogen and potassium increase in the short-term after a fire, due to ash deposits and reduced plant uptake of nitrogen. Long-term effects depend on soil and vegetation type, fire characteristics, topography, climate, soil formation rates, and complex nutrient cycles. For example, in the closely studied tallgrass prairies of Kansas, where fires burn annually, researchers determined that while fire volatilizes organic nitrogen, this has no impact on grassland productivity as biological and biogeochemical feedback cycles serve to fill the gaps. Under a very different fire regime—slash and burn agriculture in tropical rainforests—soil degradation is usually minimal, except when the land in question is steeply sloped or permanently cleared.

Fire's hydrological impacts are highly ambiguous and context specific. In terms of water quality, influxes of ash and detritus are thought to be relatively short-lived. Recently burned areas can exhibit higher surface temperatures, higher evapo-transpiration potential, and less vegetation cover, leading to warmer water and faster runoff. Some impacts are counterintuitive. For example, in some South African watersheds, nonnative wattle trees lower the water table. Frequent burning can control these water-hungry trees and maintain a higher water table.

AIR QUALITY AND EMISSIONS

All forms of fire affect air quality. Since combustion is rarely perfect, fires release not just carbon dioxide and water vapor but also carbon monoxide, methane, nitrogen oxide, hydrocarbons, and various smoke particulates into the air. For humans, these emissions can be simple irritants or serious health hazards, depending on the scale. Large landscape burning events such as the 1997–98 fires in Indonesia impacted 75 million people. Health impacts like respiratory ailments led to the deaths of perhaps 16,000 infants and affected people's livelihoods.

Indoor cooking and heating fires, when poorly ventilated, contribute to a variety of diseases, including pneumonia, chronic respiratory diseases, lung cancer, and asthma. Smoke from domestic fires is blamed for over a million premature deaths per year around the world.

Fire emissions play a major role in atmospheric chemistry, radiation budgets, and climate change. Research summarized by the Intergovernmental Panel on Climate Change (IPCC) shows that increased emissions have demonstrably changed many aspects of the global climate since the pre-industrial era.

Prior to about 1940, the primary source of carbon dioxide and other greenhouse gas emissions was land clearing and cultivation. Since then, emissions from industrial fire—factories and vehicles—have far eclipsed these in impact. All the same, tropical land clearing, often through fire, continues to be major source of greenhouse gases; global landscape fires corresponding with the strong 1997–98 El Niño season were recently shown to have emitted 30 percent more carbon monoxide than vehicles and power plants during those two years.

CONFLICT OVER FIRE

The impacts of fire have long made it a topic of regulation and controversy. The pastoralist of lore, with his wandering herds and free-burning fires, occasionally clashed with those whose property his fires threatened. Villagers protected their crop fields, homes, or sacred groves from free-burning fire, and sought punishment for anyone who sparked a damaging fire.

With the Industrial Revolution came industrial fire, which freed many human productive activities from our dependency on landscape fires. fields are now fertilized with chemicals, not ashes. Along with industrialization, the 19th century also saw major advances in science, growing capitalist economies, and newly powerful state bureaucracies. These trends led to increased government and scientific intrusions into the management of many landscapes, removing them out of the hands of villagers. In such strategies, there was no room for fire.

Modern resource management in the 20th century were based on ecological theories of the day, particularly the idea of succession, which viewed change in vegetation communities as an orderly, staged progression from bare soil to a climax, usually forested. Fire was seen as an outside disturbance working against succession. Technological advances like tractors and bulldozers gave humans a mechanical means to clear vegetation instead of burning, as well as powerful tools to effectively fight fire. At the same time, state resource management bureaucracies gained further power over the management of far-flung landscapes.

EMPHASIS ON FIRE SUPRESSION

As a result, fire landscapes changed. Forest fire suppression was the core strategy for much of the 20th century in places in the United States, France, southeastern Australia, francophone Africa, and Indonesia. Fires were seen to threaten timber assets, infrastructure, and aesthetic qualities, to be anathema to economic development, and to degrade soils, water, and land cover. For example, after the massive 1910 wildfires that burned 12,000 square kilometers of forest in the northern Rockies, the U.S. Forest Service mobilized a massive fire-fighting campaign, establishing a network of fire towers, access roads, and firefighters. By 1935, stated policy was that all fires be extinguished by 10 a.m. the following day; in the 1940s, a charismatic cartoon character, Smokey Bear, was conceived to spread the fire control message to younger generations.

France took a similarly strong approach to fire suppression, even in its fire-prone Mediterranean regions, relying on impressive fire-fighting technology. In its tropical colonies, France sought to replace firestick farming with intensive agriculture and state forests. In the 1930s, the colonial rulers attempted to ban all fires in their African and Asian colonies. However, political and logistical realities forced officers to accept some pragmatic exceptions to the ban, like pasture renewal burns or preventive burning.

There were exceptions to the fire suppression approach. In America, farmers and ranchers continued to enlist fire as a key tool for managing Kansas prairies, California grasslands, and Hawaiian cane fields. Even the U.S. Forest Service continued to undertake controlled burns in the productive pine forests of the southeast. In India's *sal* forests, field foresters and local villagers convinced the British colonial forest bureaucracy that fires served a key role in the regeneration of these valuable trees.

Full fire suppression began to lose favor in much of the world in the second half of the 20th century. Already in the 1950s, colonial officers in Africa began to see fire as a "necessary evil" for range management. Lessons from field-based foresters and new ecological research began to tentatively change the paradigm in America in the 1960s. Californian forester Harold Biswell tirelessly argued for the benefits of prescribed burning. New policies emerged that allowed some "natural" fires to burn in wilderness areas, or that allowed resource managers to practice controlled, prescribed burns.

FIRE AND POLITICS

However, fire would continue to be politicized. Industrial fires fuel the growth of urban society, but lead to damaging impacts on air quality, health, and climate. Restrictions based on environmental concerns frequently clash with the use of fire as an efficient and affordable tool by a variety of land users. When city residents are forced to cough their way through a smoky fire haze, politicians call for rural land managers to stop burning. When images of slash-and-burn farming are associated with the demise of tropical forests, calls go out for an end to such techniques for the sake of biodiversity conservation. As a result, some countries reaffirmed strict suppression laws. For example, Mali outlawed all burning in the 1980s; Madagascar did the same in 2002.

Today's policymakers must deal with a number of important complexities. First, the fire suppression paradigm persists, often reflecting the concerns of an urban public. While resource managers and scientists argue for a legitimate place for some fire in some vegetation systems, public perceptions focus on the destructive side of fire. When treasured national parks burn, like America's Yellowstone in 1988, discussions of the ecological role of fire are often lost behind fiery headlines.

Nearly a century of fire repression means that many ecosystems suffer an overabundance of flammable fuel. When a lightning bolt or camper's match ignite a fire during a dry spell, the result is catastrophic. Fires burn hotter and bigger than they would in frequently burned environments. The legacy of suppression may be a key factor in the large number of catastrophic wildfires burning the forests of America, southeast Australia, and Mediterranean Europe over the past two decades. In turn, footage of raging flames and charred buildings from these events spurns continued political pressure to stop all fires.

Prescribed or controlled burning plays a key role in current fire policy. Fire is a difficult and expensive tool to master, and escaped controlled burns are not only frequent but also generate bad publicity—as when an escaped controlled burn almost torched New Mexico's Los Alamos nuclear labs in 2000. Resource management agency mandates are shifting from resource production to recreation and conservation, to the point that effective broadscale controlled burning is not always feasible.

In many wealthy nations, the spread of the rural-urban fringe puts large property assets at the risk of fire. Houses built in the forest or in abandoned farm country, whether in the foothills of the Sierra, the French Riviera, or Sydney's outer suburbs, pose a complex problem for fire managers, as fuels accumulate to dangerous levels.

Finally, fire management is vexed by the realization that there is no fundamental "right" or "wrong." The only constant is that the outcome is shaped by the decisions of humans and the vagaries of nature—unique fire creatures on a unique fire planet.

SEE ALSO: Agriculture; Amazon River Basin; Australia; Hazards; Yellowstone National Park.

Fire Down Under

Australia was relatively unique among industrialized nations in never adopting a firm anti-fire policy. "Back-burning" is a widely accepted technique for fuel management and pasture maintenance around the continent. Foresters have been lighting prescribed burns in the forests of the southwest for half a century, pioneering the technology of aerial fire ignition. In the monsoonal tropics of the north, nearly everybody–from Aborigines to livestock-raising station managers to government park managers–uses fire to take care of the land. Aboriginal burning techniques, cleverly labeled "fire stick farming" by anthropologist Rhys Jones in 1969, are now widely recognized as well suited to the management of the native vegetation. It is only in the populous and more humid southeast, where fires regularly threaten suburban homes and productive timber forests, that fire suppression gained prominence and continues to hold significant policy weight.

Perhaps the most famous anthropogenic fire landscape is the "bush" of Australia. The frequent and widespread burning of the ancestral Aborigines, who arrived on the continent at least 40,000 years ago, contributed, along with climatic changes, to a vegetation shift from southern beech-dominated "rainforest" vegetation to eucalyptus woodlands. Much of the current vegetation exhibits typical signs of fire adaptation, like the fire-cured seeds of banksia or the prodigious sprouts of eucalyptus.

BIBLIOGRAPHY. Stephen Pyne, *World Fire* (University of Washington Press, 1995); Stephen Pyne, Patricia L. Andrews and Richard D. Laven, *Introduction to Wildland Fire* (Wiley, 1996); Rocky Barker, *Scorched Earth: How the Fires of Yellowstone Changed America* (Island Press, 2005); Paul Crutzen and Johan Goldammer, eds., *Fire in the Environment* (Wiley, 1993); Thomas Vale, ed. *Fire, Native Peoples, and the Natural Landscape* (Island Press, 2000); *International Journal of Wildland Fire* (CSIRO Publishing).

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Fire Ant

SOLENOPSIS INVICTA, MORE commonly referred to as fire ants, are a particularly devastating invasive species to the southeastern United States. First introduced in the 1930s to Mobile, Alabama, the ants probably arrived via cargo ships from Brazil or Argentina. Since the 1930s, fire ants have spread to almost the entire southern United States, ranging from Florida north to Maryland and west to Texas, including Oklahoma, Arkansas, and Tennessee. More recently, fire ants have been discovered in California, southern China, Australia, and the Philippines.

Fire ants are typically more aggressive than native ant species, and swarm when disturbed. Although human death due to fire ant stings is extremely rare, swarming fire ants do kill small mammals and birds, particularly ground-nesting species, and can totally eliminate some species of birds from an area. In addition, fire ants have had an enormous impact on nonant arthropod diversity, in some cases reducing species diversity by 30 percent.

As fire ants have adjusted to their new environments, they have undergone several competitive adaptations. Because populations of ants are no longer limited by native pathogens and competitors, colonies of fire ants are larger in the southern United States than in Argentina. Fire ants favor disturbed habitats, such as agricultural fields, suburban developments, or other environments characterized by ecological alteration, where native species are under stress. Because of their aggression and lack of controlling predators, pathogens, or competitors, fire ants have devastated native ant communities in the southeastern United States. In Texas, for example, fire ants were found to have diminished native ant species diversity by 70 percent, and to have limited the total number of native ant individuals to 10 percent of their former levels. Native ants were able to survive in pockets of undisturbed and uninvaded habitats; no ant extinctions are documented as a result of the depredations of invasive fire ants.

Research has focused on controlling fire ant populations through insecticides or the introduction of species-specific South American biological controls, such as a microsporidian protozoan (Thelohania solenopsae) or the fungus Beauveria bassiana. In addition, two Pseudacteon flies, which parasitize Solenopsis ants, have been introduced into the southern United States: these flies lay eggs in the heads of worker ants, the larvae of which ultimately decapitate the ant. Because the Pseudacteon flies only affect worker ants, they serve as a limiting factor on the growth and size of fire ant colonies, and will not eliminate the species from the United States. The use and introduction of nonnative biological agents to control invasive species should be cautioned, however, as numerous cases of drastic and damaging consequences with this technique can be identified (mosquito fish and cane toads in Australia and parasitic flies for gypsy moths in the eastern United States). Efforts to control fire ants through pesticide and chemical insecticide application have impacts on freshwater systems and wetlands, as well as on other insects harmed by the chemicals.

Fire ants have caused economic damage as well. In Texas alone, fire ants are estimated to cost $1.2 billion yearly in health costs, management activities, agricultural losses, and property destruction. Fire ants even represent the leading cause of electrical shorts in traffic lights, as they chew through electrical insulation.

SEE ALSO: Argentina; Brazil; Predator/Prey Relations; Species Invasion; United States, Southeast.

BIBLIOGRAPHY. H.A. Mooney and E.E. Cleland, "The Evolutionary Impact of Invasive Species," *Proceedings of the National Academy of Sciences* (v.98/10, 2001); S.B. Vinson, "Biological Control Program: Augmentation

Biological Control of the IRA Utilizing Native Species," *Texas Imported Fire Ant Research and Management Project* (2001); Texas Imported Fire Ant Research and Management Project, www.fireant.tamu.edu (cited December 2006); United States Department of Agriculture, National Invasive Species Information Center, www.invasivespeciesinfo.gov (cited December 2006).

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First Nations

INDIGENOUS PEOPLE AROUND the world historically have been referred to by a range of names, including those of their own traditional distinctions, as well as those colonially imposed (such as "Indians" for Native Americans). First Nations is a relatively novel term, coming to prominence in Canada during the 1970s, to refer to indigenous or native peoples. The term has been applied more generally to all pre-colonial peoples of both the Americas and Australia, though the term is by no means uncontroversial. The degree to which the term is tied to a notion of sovereign "nationhood" and the requirements of historical primacy (who is "first"), both make the term politically complex. Nevertheless, the experiences of native people, especially relative to environmental rights and experiences, is remarkably common throughout the world.

First Nations have long suffered the disproportionate effects of environmental damage. According to the Worldwatch Institute, 317 reservations in the United States are threatened by environmental hazards ranging from toxic wastes to clearcuts. In the United States, more than 300 Native American reservations have been targeted for landfills, incinerators, and other waste facilities. In New York and Canada, the Mohawk have suffered damage from polychlorinated biphenyls (PCBs), which were legal and used extensively by General Motors and other companies until the mid–1980s.

As demand for energy supplies increases, so does pressure on tribes that live in areas with vast amounts of resources. Many First Nations are terribly poor, so the promise of employment from mining or payment for allowing the government to strip the land or locate wastes or toxins is compelling.

Another environmental issue facing Native Americans is location of nuclear wastes. Reservations in the United States have been targeted for 16 nuclear waste dumps. Yucca Mountain in Nevada is scheduled to become the next High-Level Nuclear Waste (HLNW) site, despite the potential impact on the western Cheyenne who call the area home. Radioactive waste dumps also affect aboriginal people in South Australia and the First Nations of islands near Taiwan.

Testing of military weapons has also lead to environmental damage. In the last 45 years, more than 1,000 atomic explosions have occurred on western Shoshone land in Nevada, making it "the most bombed nation on earth." Over 3,000 nuclear weapons are stored on the Hawaiian island of Oahu, and unexploded bombs are all over. The army accidentally shelled one area of the island four times between 1987 and 1990.

Environmental cleanup, often slow and underfunded in general, is even worse on indigenous lands. The Indigenous Environmental Network says that most indigenous governments are 22 years behind in their development of environmental infrastructures.

In addition to toxic wastes on the land, Native Americans and First Nations face the pollution of their water, which consequently threatens fish, an important food source. In the Pacific Northwest, virtually every river is home to native peoples. Salmon is a major source of nutrients, but over 107 stocks of salmon are already extinct and 89 are endangered due to high levels of mercury and other toxins.

Many environmental problems involving First Nations are the result of overuse. In 1999, the Eastern Navajo filed suit with the Nuclear Regulatory Commission (NRC) to block uranium mining on their lands. There are more than 1,000 slag piles from abandoned uranium mines on Dine (Navajo) land, releasing radioactivity into the air and water. The Seminole tribe of the Everglades has seen their land and sacred animals, including the panther, significantly diminished due to overdevelopment of south Florida. In the Amazon area, one-quarter of the forest, home to indigenous peoples, has been demolished since 1900.

Too often, First Nations have little or no voice in matters of environmental pollution and degradation of their land. While wealthier people are able to cry "Not in My Backyard," most tribes have a contentious and murky relationship with the government. In many countries native peoples retain some sovereignty yet are also governed by the state, so their ability to use courts for redress is somewhat confused.

Yet some progress has been made. The 1992 United Nations Conference on Environment and Development (Earth Summit) recognized the importance of environmental justice for indigenous peoples. In the United States, President Bill Clinton issued Executive Order 12898, drawing federal attention to environmental justice in minority and low-income populations. Native groups have worked together to defeat proposals that would bring greater environmental damage. For instance, in the 1980s the Blackfeet Indians worked with a coalition of green groups to fight off two oil firms seeking to explore the Lewis and Clark National Forest.

SEE ALSO: Clearcutting; Indigenous Peoples; Justice; Native Americans; Polychlorinated Biphenyls; United Nations Conference on Environment and Development; Mercury; Mining; Uranium; Waste, Nuclear.

BIBLIOGRAPHY. Regina Austin and Michael Schill, "Black, Brown, Red, and Poisoned," in M. Andersen, K. Logio, and H. Taylor, eds., *Understanding Society,* 2nd ed. (Wadsworth, 2001); R. Ballard, "Environmental Justice in the 21st Century," Environmental Justice Resource Center, www.ejrc.cau.ed/ejinthe21century.htm (cited May 2006); D. Grinde and B. Johansen, *Ecocide of Native America* (Clearlight Publishers, 1995); Winona Laduke, *All Our Relations* (South End Press, 1999).

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Fish and Wildlife Service (U.S.)

A BUREAU OF the Department of Interior, the Fish and Wildlife Service is the federal government's lead agency in charge of wildlife and freshwater fish conservation. Although fish and wildlife presumptively fall within the jurisdiction of the 50 states, the federal government's role has increased significantly since the late 19th century through international treaties; the creation of national parks, forests, and wildlife refuges; the Commerce Clause; and the Endangered Species Act of 1973. Today, the Fish and Wildlife Service administers a system of 520 wildlife refuges and "waterfowl production areas" covering roughly 93 million acres of land (more than half of which is in Alaska). Its Ecological Services Division oversees endangered species protection (except for marine and anadromous fish, which fall under the jurisdiction of NOAA Fisheries in the Department of Commerce).

The Fish and Wildlife Service has a complex and rather haphazard administrative history, in which various tasks and mandates accrued to it in response to changing social pressures, legal decisions, and political opportunities. Its roots include congressional acts in the 1860s that were the first federal protections of wildlife (in the Yosemite Valley and the Pribilof Islands of Alaska); Executive Orders reserving certain federal lands from private exploitation beginning in the 1880s; and the creation of bureaucratic units to study fish and wildlife resources, such as the Federal Office of Commissioner of Fisheries (1871) and the Division of Economic Ornithology and Mammalogy in the Department of Agriculture (1885). Its institutional identity, however, revolves principally around national wildlife refuges, the first of which came into being in 1903 when Theodore Roosevelt proclaimed the 3-acre Pelican Island in Florida a Federal Bird Reservation. By 1909, Roosevelt had issued 50 more Executive Orders creating wildlife reservations. Congress created still others, including the National Bison Range in 1908 and the National Elk Refuge in 1912. The Migratory Bird Act asserted federal authority over migratory birds in 1913, the same year that President Taft ordered the reservation of the Aleutian Island chain in Alaska.

The acts, orders, and bureaucratic innovations responded to crises brought on by unrestrained commercial exploitation of fish and wildlife, and they reflected the interests of specific constituencies. Many early refuges were created as "overlays" on reservoirs being constructed by the recently created Bureau of Reclamation. Federal fish hatcheries and translocations had grown, since the 1870s, into an ambitious and politically popular system for increasing fish stocks for both sport and commercial purposes; in 1903 the Fish Commission was transferred to the new Department of Commerce and renamed the Bureau of Fisheries.

The coalitions behind this growth were unstable, however, reflecting larger tensions in the ends and means of Progressive Era natural resource management: first, between "conservation" to satisfy human needs and "preservation" for the sake of nature itself; second, between centralized, bureaucratic administration to maximize "efficiency" and the state or local level authorities favored by tradition and the Tenth Amendment. Sportsmen and naturalists allied against commercial exploitation in general, but frequently parted company over whether noncommercial or "sport" hunting would be allowed in refuges. Sites like Pelican Island could be effectively conserved by simple protection, but in other places nature had to be "fixed"—bison had to be shipped from the New York Zoological Society to the Wichita Forest Reserve and Game Preserve, for example—or actively manipulated to increase harvests, as with fish hatcheries and translocations. Meanwhile, Congress was reluctant to appropriate funds for federal agencies that seemed to be intruding on matters previously left to the states, although activities that yielded economic returns to local constituencies could sometimes find favor.

The Depression and New Deal forged compromises that set the basic framework for the next four decades. The Civilian Conservation Corps provided labor to improve habitat and infrastructure on refuges; some new refuges were created from lands acquired by the Resettlement Administration from bankrupted farmers. In addition, the Migratory Bird Hunting and Conservation Stamp Act of 1934 (better known as the Duck Stamp Act) created a reliable revenue source by requiring waterfowl hunters to pay a fee. In 1939 the Bureau of Biological Survey and the Bureau of Fisheries were removed from the Agriculture and Commerce Departments, respectively, and transferred to the Department of Interior, where a year later they were merged to form the Fish and Wildlife Service. The Fish and Wildlife Act of 1956 ratified the role of refuges in national fish and wildlife policy, and a 1958 amendment to the Duck Stamp Act and the Wetlands Loan Act of 1961 helped generate funds for refuge acquisition.

Federal fish hatcheries have grown into a popular system for increasing stocks for both sport and commercial purposes.

It wasn't until 1966, however, that Congress provided comprehensive legislative guidance for the management of refuges. The National Wildlife Refuge System Administration Act explicitly authorized hunting, recreation and other public uses on refuges provided they were "compatible" with the purposes for which the refuges had been established. These and other provisions were updated and further elaborated in the National Wildlife Refuge System Improvement Act of 1997.

Passage of the Endangered Species Act of 1973 (ESA) presented the Fish and Wildlife Service with a fundamentally new challenge, although it would take some time for this to become apparent. Refuges dedicated to fish, migratory waterfowl, and game species could generally be managed in tried and true Progressive Era fashion: by demarcating boundaries, enforcing permit requirements, manipulating habitat, and in some cases producing target species for stocking. The species first protected under the ESA generally lent themselves to this approach as well, and the creation of refuges for them seemed a simple extension of past practice. But as other types of species have been listed—plants, insects, crustaceans, and all sorts of nongame birds and mammals—the Fish and Wildlife Service has had to face challenges that refuges alone cannot surmount: How to protect species whose biology and ecology are poorly understood, whose habitats extend across very large areas and/or lands unavailable for refuge creation, or whose listing triggers complex legal and regulatory issues. As a result, the Fish and Wildlife Service's identity is once again in flux, with some calling for refuges to be split from Ecological Services.

SEE ALSO: Commerce Clause; Fisheries; Wildlife.

BIBLIOGRAPHY. J. N. Clarke and D. C. McCool, *Staking Out the Terrain: Power and Performance among Natural Resource Agencies* (University of New York Press, 1996); Michael Tobias, *Nature's Keepers: On the Front Lines of the Fight to Save Wildlife in America* (John Wiley & Sons, 1998); U.S. Fish and Wildlife Service website, www.fws.gov (cited March 2007).

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Fish Ladders

FISH LADDERS ARE designed to allow fish passage around dams or other barriers by providing a series of relatively low steps that the fish may leap from one level to the next (hence the term *ladder*). Anadromous fish (e.g., salmon, sturgeon, and lamprey) need access to both the rivers where they spawn and the oceans where they spend their adult life. Dams have had such negative impacts on populations of anadromous fish because they fragment the river ecosystem, preventing adults from reaching their spawning grounds. This inability to reproduce has led to the decline or local extinction of many anadromous fish, including numerous species of salmon, steelhead, suckers, and lamprey.

Fish ladders have become the focus of political controversy on at least two counts. Some rivers, such as the Klamath River in California and Oregon, have no fish ladders. Thus fish in this river are totally blocked from habitat upstream of dams. The Klamath was once the third-largest salmon producing stream on the west coast of the United States. The fact that four dams block Spring Chinook salmon from 90 percent of their original spawning ground is cited as a chief reason that fishery is now in a state of collapse.

Fish ladders are also controversial because they are not as effective in creating fish passage as once believed. For example, fish ladders are more successful in allowing the migration of adult salmon swimming upstream to spawn than the juvenile fish who migrate downstream to the ocean. National Marine Fisheries Service reported that Fall Chinook juvenile mortality on the Lower Snake reservoirs could be as high as 20 percent per dam. Even adult migration in fish ladders is imperfect. The study further reported that up to 40 percent of adult fish in the Lower Snake fall back over the dam spillways or pass through the turbines after moving up the fish ladders. These fish are less likely to spawn. With four dams on the Lower Snake and four more on the Columbia the cumulative effect of these dams are problematic for salmon even with fish ladders.

In the Pacific Northwest, salmon are a cultural icon to Native American and other cultures. Native Americans still consume salmon, steelhead, lamprey, and other anadromous fish. The decline in these populations, however, has had significant health, cultural, economic, and social effects for these communities. Furthermore, salmon is the basis of a significant but heavily reduced commercial fishing industry on the west coast. In 2005 the inadequacy of fish ladders had been the basis for the three largest tribes in California demanding removal of four dams on the Klamath River in Oregon and California.

Fish ladders also work better for some species than others. Lamprey do not travel well in fish ladders either as adults going upstream or as juveniles attempting to reach the ocean. Although they do not have much appeal for non-Native American people, lamprey are an important food source for Native Americans. Pacific lamprey and other lamprey species have been considered for the Endangered Species status.

In 1997, the Federal Energy Regulatory Commission denied a new license to the Edwards Dam on Maine's Kennebec River on the basis that the cost to migrating fish denied access to upstream spawning grounds was greater than the benefit from the hydropower. Even if installed, it was found that fish ladders could only partially mitigate for some of the affected species. As a result, the dam was breached in 1999. One year after the Edwards Dam removal, migratory fish—including the alewife—returned by the millions to sections of river that hadn't seen them in 160 years.

SEE ALSO: Dams; Fish and Wildlife Service (U.S.); Fisheries; Salmon.

BIBLIOGRAPHY. James Lichatowich, *Salmon Without Rivers: A History of the Pacific Salmon Crisis* (Island Press, 2001); Arthur E. McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries 1850-1980* (Cambridge University Press, 1986); National Academy of Sciences, *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* (National Research Council, 2004); Kari Marie Norgaard, *The Effects of Altered Diet on the Health of the Karuk People* (Karuk Tribe of California, 2004); Charles Wilkinson *Blood Struggle: The Rise of Modern Indian Nations* (W.W. Norton, 2006).

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Fisheries

FISHERIES ENCOMPASS THE variety of human activities to harvest aquatic animals and plants. The term includes the harvest of fish *per se* as well as crustaceans, seaweeds, mollusks, and marine mammals, but not aquaculture. Fisheries can be in either inland, coastal, or high seas environments. Globally, about 90 million metric tons of fish are landed yearly, about one-eighth from inland waters, the remainder from the oceans. Fishing gears or instruments for harvest are quite diverse: from static gears such as fish traps, weirs, hooks and lines, and gillnets, to mobile gears like spears, cast nets, haul and purse seines, trawls, and dredges.

Fishers can be differentiated into two main categories: artisanal and commercial. Artisanal fisheries are typically defined by low levels of capitalization and productivity and the use of catches for subsistence or localized markets, whereas commercial fisheries are defined oppositely as highly capitalized, efficient, and oriented toward global markets. These ideal types seldom capture the empirical reality of fisheries, as many fishers deemed artisanal have motorized boats, sell their catches for distant markets, and can be quite efficient; and many deemed commercial supply local buyers only, have small boats, and are engaged in fishing informally in concert with other sources of livelihood, a characteristic generally ascribed to artisanal fishers.

DEPENDENCE ON FISHING

There are about two million fishers in Africa—the vast majority artisanal—and this number is increased several times when marketing and processing jobs are included. Six million people are employed in fishing or fisheries-related jobs in India. Fisheries are of paramount importance for often-rural localities, as they can provide employment, a tax base for local services, and cultural value. Seafood (from aquaculture and fisheries) accounts for only a small percentage of total caloric intake in almost all countries, but in many countries it accounts for 20 percent or more of protein intake and is cheaper than alternative protein sources. Many southern islands and coastal nations and Japan are highly dependent on fisheries for their food security. People in Global North countries on average eat 27 kilograms of seafood per year, while those in the Global South, nine kilograms. The reasons for this disparity include differences in human population and fishery productivity, fishery exports and imports, and the harvest of fish by foreign versus domestic fleets.

Fish also contribute to human nutrition indirectly through fishmeal. Some 30 million tons a year, a third of global catches, are reduced into about six million tons of fish meals and oils; the majority goes to feeding livestock like pigs and chickens, while aquaculture and industrial purposes get smaller portions.

GEOGRAPHIC DISTRIBUTION

Geographic distribution of fisheries stocks is very uneven. Some species are immobile or localized, like mollusks or shrimp, while others like tuna are highly migratory. Estuarine and reef ecosystems can equal the most prolific terrestrial ones in terms of productivity. Upwelling zones—where currents at continental margins push up deep water and mix it with surface layers—are also highly productive. The oceans as a whole are estimated to produce two-fifths of the earth's total primary productivity. In marine ecosystems, a productive plant biomass feeds a proportionately larger standing stock than terrestrial ecosystms. Since much of that stock consists of zooplankton that are not harvested by people, fisheries are more dependent on secondary and tertiary consumers, which are more abundant in the water than on land per unit of primary productivity. Target species on the high seas tend to be trophically more distant from primary production than those of estuarine and inland fisheries.

For thousands of years, people have engaged in fisheries, but the extent of exploitation expanded with the increase in oceanic navigation in the 16th century. The Grand Banks fishery for groundfish was incorporated into European-centered trade networks at this time, and became a prize contested between the maritime powers. In the Atlantic world economy, salted fish was a cheap source of protein for poor Europeans and African slaves in the Caribbean. Whaling expanded to supply oil for lighting and the finest lubricants available for industrial machinery.

These harvests did little to exploit the potential wealth of the sea, however, nor did the artisanal fisheries that existed in most parts of the world. The limits of the world's oceans became more visible after the industrialization of Global North fisheries from the late 19th century on through advances in shipbuilding and the means to preserve, distribute, and market seafood. Worldwide fisheries production stood at some 45 million tons in 1945. Growth in production was rapid after this time, but has since stabilized and the majority of fish stocks are now presumed to be either fully or over-exploited. Foreign fleets, decolonization, and the prospect of offshore mineral wealth spurred a movement toward extending jurisdiction over the sea to 200 miles by coastal nations. These territories were enacted by the late 1970s and are now known as Exclusive Economic Zones (EEZ's). A lack of controls on new entrants and national fishery development programs in northern countries followed extended jurisdiction and quickly replaced or surpassed the excluded foreign fishing capacity. This high fishing pressure and the treatment of the nationalized sea as a resource frontier contributed to the collapse of many fisheries since this period, such as the cod fisheries of the northwest Atlantic in the early 1990s.

Another option for northern fishing fleets was to enter agreements with southern countries for access to their waters. The European Union, through its Common Fisheries Policy, enters into fishery access agreements with African countries, exporting European excess fishing capacity south and African fish north. These agreements, which are a major source of funds for many governments, are controversial because of conflicts between foreign fleets on domestic artisanal and commercial fishers and the diversion of fish from nations with many hungry people.

FISH TRADING

International trade in fish amounted to $71 billion in 2004, four-and-a-half times the amount in 1980. Over three-quarters of all fish landings are in the Global South, and south–north fish exports produced a net trade surplus for the south of $20 billion in 2004. Japan, the European Union, and the United States are the biggest seafood importers, taking fishmeal and high-value species and exporting cheaper fishes.

Economic-development aid programs to newly decolonized countries brought about considerable change to those nations' fisheries. The first of these projects, the Indo–Norwegian Project, begun in Kerala, India, in 1952, promoted motorization of traditional fishing craft; introduction of new boat types and fishing gears; and construction of freezing plants for export-oriented production where salting, drying, and fresh products for local markets previously predominated.

THE BLUE REVOLUTION

Fisheries modernization, often called the Blue Revolution, created commercial fleets in many southern countries and increased export earnings, and its new technologies were selectively adopted by many artisanal fishers. It also exacerbated conflict between fishing sectors as the new fleets, which received most international development aid and often enjoyed state support, harvested fish stocks utilized by the preexistent fishers and used destructive gears such as bottom trawls. The modern fleets had their own problems, and many became bankrupt during the era of structural adjustment that dismantled state support and increased the prices of imported inputs. Likewise, those small-scale fishers who adopted motorization found themselves in great difficulty meeting increasing expenses under structural adjustment.

Fisherpeople in places like southern India organized into social movements from the 1970s onward to restrict the activities of modernized fleets. These groups have won some victories and gained national and international awareness of their grievances, but most development assistance continues to privilege capital-intensive, export-oriented fisheries. While much modernization has taken place, artisanal fishing are still estimated to harvest a quarter of global landings.

Fisheries have a range of ecological effects on target and nontarget species. Fishing takes biomass out of the marine environment and changes the age profile of fish populations. It can alter predator and prey relationships and disturb benthic flora and fauna, which can have secondary effects. Overfishing can result from harvesting organisms before reaching maximum size or value, or reducing organisms' their ability to spawn or otherwise reproduce.

"Bycatch," or the harvest of unwanted, non-target species, amounted to some 27 million tons in a 1994 estimate, the equivalent of 30 percent of global fish landings. Most of this "bycatch" is not brought to shore but returned to the sea, often a large proportion dead or dying. Some fisheries, such as shrimp trawling, have on average high bycatches of several times the weight of target species landed, while others such as herring and anchovy have very little. Bycatches rearrange energy flows through marine ecosystems, with seabirds benefiting the most as witnessed by explosions in their populations correlated to increases in bycatch-intensive fisheries. "Bycatch" provoked the two most prominent international trade disputes over fisheries to date, the tuna–dolphin and turtle–shrimp cases, both of which involved the World Trade Organization or its predecessor in rulings over environmental concerns about harvesting practices.

Marine benthos, the organisms that live on the sea bottom, can be greatly harmed by fishing gears that interact with the seafloor. Sandy and muddy seafloors with little emergent benthic life can return to a pre-fished condition within six months or less, while areas with more surface roughness and abundant epifauna like immobile filter feeders could take many years to recover.

FISHERY SCIENCE AND MANAGEMENT

The twin goals of fishery science and management—developing fisheries resources and protecting them from overexploitation—form the foundation of bioeconomics, which aims for the maximization of surplus value from a given fishery while sustaining the conditions of production. To achieve these ends, managers sample fish populations to derive stock assessments and guidelines for harvest. One sampling technique is surplus population modeling, which shows the number of fish over natural mortality a fishery may harvest to reproduce the population. Management attempts to maintain populations at a rate of maximum surplus production, where neither too few breeding stock exist to reproduce nor too many adults to slow down rates of increase. The rate of harvest that approximates this condition is known as Maximum Sustainable Yield (MSY). Given that fishery population parameters are very difficult to know with certainty and environmental factors may alter conditions unpredictably, managers may set a Total Allowable Catch (TAC) according to a Maximum Consistent Yield (MCY) that factors in a precautionary margin. Another target often used in management is Maximum Economic Yield, the harvest that produces the greatest net return on aggregate capital investment.

The concept of "The Tragedy of the Commons" is synonymous with fisheries because of the common property nature of fishery resources. Open-access fisheries are prone to overcapitalization, where more is invested than necessary to harvest a fishery stock. This reduces overall fishery profitability and can aggravate tendencies toward overfishing. Mitigating these tendencies has taken many forms, most commonly limits on participation, restrictions on gear types, and time and spatial closures of fisheries. Marine Protected Areas (MPA's), where little or no fishing is allowed, have become increasingly popular. While proponents of fishery modernization have pushed for Individual Fishing Quotas to resolve common property problems through marketization of access, this trend is opposed by many fishers who see it as a means of dispossessing them from their livelihoods. Common property theorists offer an alternative prescription for co-management of fisheries through institutional mechanisms to control and allocate access to resources. Perspectives from political ecology that examine the distributional effects on producers from conservation programs are important to the future of fisheries as terrestrial natural resource management strategies are increasingly employed in aquatic contexts.

SEE ALSO: Fish and Wildlife Service; Subsistence; Tragedy of the Commons; World Trade Organization (WTO).

BIBLIOGRAPHY. S. Jennings, et al., *Marine Fisheries Ecology* (Blackwell Science, 2001); A. Le Sann, *A Livelihood from Fishing: Globalization and Sustainable Fisheries Practices* (Intermediate Technology, 1998); I. Tvedten and B. Hersoug, *Fishing for Development: Small-Scale Fisheries in Africa* (The Scandinavian Institute of African Studies, 1992).

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Flight

FLIGHT IS THE process of moving through the air. It occurs among many animals, notably birds, which employ true or powered flight through the use of wings and specially adapted bone and feather structures. Other animals and some plants can use gliding for flight with slightly less volition over direction and range of flight. Gliding relies upon a body or shape that offers resistance to the air and possibly using upwardly moving air thermals to maintain or increase height. The purposes of flight in nature include mobility, escape, ability to reproduce, and the search for food.

The human desire to achieve the freedom of flight inspired the imagination of many scholars and scientists over the centuries. Leonardo da Vinci sketched a flying machine reminiscent of modern helicopters. The first successful attempts to enter the atmosphere were achieved by large hot air or other gas-filled balloons which, obtaining a density of less than the surrounding air, float and can be maneuvered by machinery. The author H.G. Wells imagined such balloons used as weapons of war, which could fly the oceans to drop bombs on enemy cities. It was not until the early 20th century that powered, mechanical flight was first achieved; the brothers Wilbur and Orville Wright were instrumental in designing and flying such machines. This period coincided with the growth of mass manufacturing facilities that assisted in the rapidly increased production of airplanes for use in World War I. As weapons, airplanes were initially of little importance and were used largely for reconnoitering until the invention of the synchronized machine gun. Subsequently, the possession of air superiority has become an increasingly important military goal, and the technology and expense devoted to it has become of enormous significance in the global economy.

Notable developments in flight technology have included jet engines, guided missiles, large passenger airplanes, and the entry into space. Men have walked on the moon, but not on more distant astronomical objects. Unmanned probes have been dispatched with some success. In addition, the same form of technology has been used to set numerous satellites into space around the globe, which has helped spread telecommunications applications around the world.

Improvements in flight technology have enabled cheap air travel greater numbers of people able to travel long distances, which has intensified with growth in the number of budget air carriers. Flight has been very influential in the creation of a global tourism industry and international business. This has not been an entirely beneficial process, as large areas of land have been given over to creating airports and the flights are significant contributors to pollution. Noise pollution near airports is a major problem for residents and can cause health problems. The burning of hydrocarbon fuel by airplanes, among other byproducts of powered flight, makes them one of the biggest contributors to global climate change. Air flights have been threatened by terrorist activity, shot down by rockets, hijacked and used as a weapon, or blown up in midair. The terrorist attacks in the United States on September 11, 2001 are perhaps the most well known of a series of such attacks. One consequence of this is the increase in security in airports and the inconvenience to passengers.

SEE ALSO: Globalization; Pollution, Air; Space Program (U.S.).

BIBLIOGRAPHY. Jonathan Metcalf, ed., *Flight: 100 Years of Aviation* (DK Adult, 2002); George Monbiot, "For the Sake of the World's Poor, We Must Keep the Wealthy at Home," *The Guardian* (February 28th, 2006); United Kingdom Department of Transport, www.dft.gov.uk (cited October 2006).

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Floodplains

AS RIVERS EXTEND from high areas to the lower lakes or seas, they pick up silt or alluvium and deposit it further downstream. The flow of water tends to decelerate as the amount of alluvial material increases, and because the slope along which the river flows tends to flatten. Depending on the kind of ground through which the river moves, the water may continue downcutting into the ground, or else build up the floor and walls of the river through alluvial deposits. Where the latter occurs, a floodplain may be created in which the river flows laterally and covers the land during times of high flow. In these cases, the flat floodplain can be rapidly flooded and thereby bring about large-scale displacement and drowning of people and livestock, and considerable devastation. The country of Bangladesh, in particular, suffers from the regular flooding of the dozens of rivers that criss-cross the country coming from the Himalayan Mountains to the north. Floods kill thousands, and millions are made homeless or marooned for extended periods of time.

The propensity of rivers to flood their plains in northern and central China has led not only to unknown millions of deaths, but also to the creation of immense engineering projects aimed at controlling the flow of water and providing irrigation for large-scale agricultural activities. This control of water has enabled the Chinese state to create and sustain a civilization lasting millennia. However, such engineering prowess has not been available to all states, due to to geographical reasons. The interaction between the variables that influence the flow of a river can lead to a very diverse range of floodplain surface development, buildup of vegetation, and the creation of natural, although often temporary levees.

The deposits of alluvial material, together with flooding, can create fertile land that is very valuable for agriculture, and can extend over very wide areas. The Mississippi floodplain, for example, extends up to 80 miles across and has an estimated total land area exceeding 50,000 sqare miles. Since flooding erodes existing topographical features and deposits soil in low-lying areas, the floodplain becomes increasingly flattened, which extends the reach of the floodplain and makes it easier to work for agricultural purposes. For many millions of people, the river and floodplain close to where they live represents both the source of their livelihood and the most likely threat to that livelihood.

Changing patterns of weather associated with global climate change and the unpredictability of emergent weather phenomena mean that the threat of flooding may be exacerbated in the future, and may affect even some of those floodplains for which adequate river management precautions have been put in place. The flooding of New Orleans as a result of Hurricane Katrina demonstrates the vulnerability of even one of the most technologically advanced societies in the world. The costs of designing and executing the engineering projects necessary to pacify rivers with the potential to flood are already enormous. Many states have sought to tame the rivers through the use of dams, which have the additional benefit of generating hydroelectric power. However, the justice of upstream-dwelling people restricting the flow of a resource on which perhaps millions of downstream-dwelling people rely (as in the case for example of the Mekong) is highly contested.

SEE ALSO: Bangladesh; China; Dams; Floods and Flood Control; Hurricanes; Mekong River.

BIBLIOGRAPHY. Paul A. DeBarry, *Watersheds: Processes, Assessment and Management* (John Wiley, 2003); J.S. Bridge, *Rivers and Floodplains: Forms, Processes and Sedimentary Record* (Blackwell Publishing Limited, 2003); Mursaleena Islam and John B. Braden, "Bio-Economic Development of Floodplains: Farming versus Fishing in Bangladesh," *Environment and Development Economics* (v.11/1, 2006).

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Floods and Flood Control

FLOODS OCCUR WHEN a body of water, e.g., a stream, lake, or sea, overtops its normal channel or basin because of excessive inflow of water or geophysical or atmospheric activity. The two broad categories of floods are stream flooding and coastal flooding. Most types of floods are a very normal part of the hydrological rhythms of water bodies. In fact, many riparian and coastal systems generally depend upon cycles of flooding to maintain a healthy ecology. Human societies in coastal and riparian regions have evolved agricultural and resource extraction systems dependent upon cycles of flooding to maintain productivity and sustainable livelihoods. Since the onset of the Industrial Revolution, urbanization, and increasing populations, however, the equation between human societies and floods has changed into a largely negative one.

TYPES OF FLOODING

Of the two broad types of flooding, stream flooding impacts more people than coastal flooding because of the higher concentration of human populations in river valleys. The world's great river valleys—the Nile, Tigris-Euphrates, Indus, Ganges, Huang He, Yangtze and Mei Kong were not only cradles of human civilization but also have extremely high population densities. Natural causes for stream and river floods include seasonal snow melt or precipitation, glacial slip and/or landslides in the headwaters. Glacial slip happens when a glacier in the headwaters of a stream breaks off and slips into the main channel, causing temporary damming of the channel. The dam inevitably breaks from the pressure, causing a wall of water to flow down the channel. Glacial slip and landsliding can cause some of the most sudden and devastating floods.

Sudden, high-level flooding is also called flash flooding, and can also be caused by intense precipitation. Flash floods have the most adverse impact for life and property. If the ground is fully saturated as a result of prolonged precipitation, even very small amounts of precipitation on saturated ground in a watershed can cause intense flood events.

Beyond the natural causes of flooding, human impacts on watersheds, such as urbanization, deforestation and agricultural activity further accelerate flood peaks. Smaller amounts of precipitation in a watershed naturally flows downhill as surface runoff. A considerable amount of precipitation is interrupted by a well-vegetated watershed, and is stored in the plants or reevaporated into the air, percolated into the ground, or directed into the water table. Urbanized surfaces with concrete and asphalt cause precipitation to flow out of the watershed as surface runoff, causing higher flood peaks downstream. Furthermore, agricultural or deforested surfaces lack vegetative cover to intercept the precipitation, or have been compacted to the extent that their absorptive capacity is much lower than a natural surface, causing similar impacts as urbanized surfaces. Human modification of watersheds all over the world is becoming a more important cause of downstream flash flooding.

MANIPULATION OF WATERWAYS

Human manipulation of streams for irrigation, flood control and navigation have also impacted the pattern of flooding in world's streams and rivers.

Increasingly, it is difficult to find streams or rivers that have not been manipulated. Part of the problem is increasing human occupancy of floodplains. The spatial extent of a floodplain is by definition the area along the stream channel, which may be flooded in the normal rhythm of flooding in a stream. Humans have occupied floodplains since the dawn of civilization because of the availability of fertile soils, hydropower, and river transport. Many preindustrial societies were well adapted to the cycles of flooding along their streams, but with higher population levels, urbanization, and industrialization, modern societies are increasingly inflexible in the face of cycles of nature. Consequently, modern societies have increasingly tried to control and tame streams and rivers instead of trying to adapt to their rhythms, with disastrous results.

Development of dams, canals, barrages, and other diversion structures on rivers for irrigation purposes is today considered an important and legitimate use of water resources—to an extent. As more and more water is withdrawn from streams, their normal flows are curtailed, leading to increasing deposition of silt in the stream channels, leading to lowering of the channel capacity of the streams. Even moderately high flows of water, which otherwise could have been accommodated in the stream channel, end up overtopping the banks of the channel, causing damage to life and property. Neither the Colorado River delta nor the Syr and Amu Darya deltas in Central Asia makes it to the sea in most years because of excessive water withdrawals upstream, causing loss of livelihoods for the people living in the delta and immense damage to ecosystems.

Dams are a popular means of water development for irrigation, power generation and flood control. Whereas dams have proved themselves effective in controlling low to moderate intensity floods, their impact on river geomorphology downstream has not been very positive for flood peaks. Dams serve to lower the channel capacity of the streams. Since all dams are subject to failure, in the event of large inflows of water, they can actually serve to accentuate flood peaks downstream from the dam site.

Levees are another popular means of flood control and maintaining navigability of streams. On many of the world's great rivers, from the Mississippi to the Indus to the Huang He Rivers, levees line the channels, facilitating human encroachment upon the flood plains. Levees, depending upon their capacities, are effective in retaining surplus water within stream channels in the event of low to moderate flooding. Levees ensure that rivers stay within a course that a society deems convenient. However, in the long run, as rivers and streams continue to deposit silt within their levee-enclosed channels, stream beds can become higher than the surrounding flood plain. In the event of a levee breach, the flood peaks in the flood plain can be much higher than expected. All levees are designed for certain flood peaks; a levee may be designed for a flood peak equivalent to a flood with a 100 year return period, or 1% chance of happening in any given year. The return period calculation based on histor-

Mitigating vulnerability of the population to the adverse effects of flooding is key to reducing damages.

ic floods is nothing more than a projection based on past record. But the role of levees in controlling low to moderate flood peaks, coupled with the inflated sense of certainty that the "return period" statistic conveys, instill a false sense of security among the floodplain residents. The result is more intense human use of floodplains, more levee building and greater devastation when the levees inevitably fail or are overtopped. Furthermore, levees require large capital outlays to build and maintain. Most societies can simply not afford the expense for their maintenance and hence must seek adaptation to flood hazard rather than outright control.

COASTAL FLOODING

Coastal flooding is growing in importance due to the increasing number of humans living in coastal regions. With increasing globalization, many of the world's largest metropolitan areas are in coastal areas. Furthermore, in countries like the United States, Netherlands, Bangladesh, and China, along with island nations, very high proportions of the populations live in coastal regions.

The main cause of flooding in coastal regions is tropical storm activity. Intense tropical storms are called hurricanes, typhoons or cyclones, depending on the region. Tropical storm activity is largely limited to tropical and subtropical regions, though storm systems can and do penetrate deep into the higher latitudes to cause damage.

Hurricanes can pack very high-velocity winds and intense rainfall, causing storm surges in coastal regions. Hurricanes draw their energy from the warms waters of tropical seas and they lose their energy very quickly once they come on land. Barrier islands and coastal mangrove swamps serve as natural barriers to storm surges. In the second half of the 20th century, however, there has been increasing human occupancy of barrier islands. In fact, in places like the southern United States, they are considered prime real estate because of their recreational amenities. Consequently, property damage has been increasing with every successive hurricane that has hit U.S. coasts. In developing countries, however, such as Bangladesh, people flock to the low-lying barrier islands because of economic necessity. With increasing populations and most of the prime inland land already taken over, the armies of landless have little choice but to move to the more dangerous, low-lying areas.

MITIGATING FLOODS

There is no known way of controlling a hurricane. Some engineering interventions can be somewhat effective, such as reinforced building construction and sea walls. But even these solutions have their limits, with the result that even in weathier countries, the best course of action in the face of hurricanes is speedy evacuation. With developments in meteorology, satellite-based forecasts, and the diffusion of media, societies have a much greater capacity to predict and disseminate information about the onset of hurricanes days in advance of landfall. This is particularly true in developed countries. Once the warning has been received, these countries also have the infrastructure to evacuate large numbers of people from danger zones. Recent experience of hurricanes in the United States, however, has shown that there are large segments of the population who either do not get warned in good time, or do not have the resources to evacuate—e.g., the poor, ethnic minorities, single-parent households, and the elderly.

In poorer countries, the reach of electronic media is relatively limited, compounded by absence of infrastructure and resources for a timely evacuation, even if the warning reaches the at-risk populations in time. In these countries, everyone who is exposed to the risk of hurricanes is not necessarily equally vulnerable to them. Vulnerability is a key concept to understanding the pattern of damage from all types of hazards, including floods. Vulnerability is defined as the susceptibility of individuals or groups to be adversely affected by environmental extremes and their relative inability to recover from those adverse effects. In the less-developed countries, women, children, elderly, and poorer segments of the population are more vulnerable to hurricanes. Women, particularly in patriarchal societies, may not have the education or confidence to make decisions on behalf of their households in the event of an impending emergency. The elderly and children, with their weaker immune systems and limited mobility, may be more exposed to waterborne diseases that may break out in the aftermath of coastal flooding.

In case of both riverine and coastal flooding, mitigating vulnerability of the populations to the adverse effects of flooding is key to reducing damages. Many researchers have documented the profile and location of populations vulnerable to flood hazard and the complex causes for their vulnerability, demonstrating that (1) human manipulation of stream hydrology in the name of progress has created new spatial distributions of flood hazard; (2) hydrological manipulations have often benefited a few powerful segments of the society at the expense of exposing larger, weaker segments to flood hazard; (3) flood protection for urban areas often accentuates flood peaks for upstream and downstream rural areas; and (4) segments of population are differentially more vulnerable even at the same location because of their limited access to resources, lack of education, marginal social status, age, and gender.

A different stream of research, also known as *pragmatist*, has been concerned with human societies' "range of choice" in the face of flood hazard, and was pioneered by Gilbert White in the first half of 20th century. According to pragmatist research, human societies have an infinite range of choices in the face of environmental hazards, which is curtailed by the exclusive focus on engineering solutions to hazards in general and flood hazard in particular. The key pragmatist insight considers multiple solutions through scientifically informed and reasoned public debate, including nonengineering solutions to flood hazard.

Nonengineering solutions found particular resonance in the policy field. In the United States, for example, public policy goes beyond building levees, dams and protective civil works to include flood insurance, flood plain mapping, flood warning, evacuation, flood-proofing of houses, and wetland restoration.

Nampho Dam

One of the largest dams to prevent floods is the Nampho Dam or the West Sea Barrage located near the port city of Nampho (or Nampo) in North Korea. Its primary task is to regulate the water level of the Taedong River to prevent the flooding of Pyongyang, the North Korean capital. Its secondary roles are to help with the irrigation of land, and stop the intrusion of seawater into freshwater.

The Nampho Dam is 10 miles west of Nampho and consists of a 6 mile long series of dams, three lock chambers and 36 sluices. Going across the mouth of the Taedong River it goes from the village of Schaegammun on the north, to the southern bank of the river, connecting with Phi Island. It will allow the passage of ships up to 50,000 tons and was completed in five years, work starting in 1981 and being completed in 1986.

Throughout recorded history there has been regular flooding of parts of Pyongyang and also the nearby areas. Indeed it was in the swamps near Pyongyang that the first U.S. ship into North Korea, the Sherman, ran aground in 1866. The Nampho Dam was a major accomplishment of civil engineering. It is visited by many international tourists to North Korea, among them being Jimmy Carter—a painting of Jimmy Carter with the North Korean leaders Kim Il Sung and Kim Jong Il dominates the tourist center near the dam. It is also often used as a backdrop for North Korean television news broadcasts and appears on some North Korean postage stamps. The estimated total cost of the dam has been put at about $4 billion.

CIVILIZATION AND FLOODPLAINS

Human civilization originated in the floodplains of the great rivers of the world and for good reason. Cycles of flooding replenished the fertile soils of great river valleys and allowed for increased agricultural production, as well as enhanced fisheries. Agricultural systems were well adapted to cyclical floods and almost depended on them for their sustainability. In the Nile River, the ancient Egyptian calendar was based on the cycles of the Nile's floods. In the Mei Kong River basin, entire cultures have developed around flood farming and fisheries that are made available by the floods of the Mei Kong.

SEE ALSO: Dams; Floodplains; Hurricanes; Rivers.

BIBLIOGRAPHY. Liakath Ali, *Integrated Approach for the Improvement of Flood Control and Drainage Schemes in the Coastal Belt of Bangladesh* (Taylor & Francis, 2002); Donald P. Batzer and Rebecca Sharitz (ed.), *Ecology of Freshwater and Estuarine Wetlands* (University of California Press, 2007); Karen M. O'Neill, *Rivers by Design: State Power and the Origins of U. S. Flood Control* (Duke University Press, 2006);

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Fluoridation, Drinking Water and

FLUORIDE IS ONE of the most abundant natural elements on earth, and is found in U.S. drinking water. Fluoride is located in the earth's crust as well as in the air and water. Fluoride is also a nutritional source for our body; it maintains our body's proper development and growth. The addition of fluoride to drinking water has been shown to assist in maintaining oral health by preventing tooth decays, when it is at a level prescribed as safe.

Originally, researchers and scientists found that the people living near drinking water supplies with natural enhanced fluoride levels close to 1.0 part per million (ppm) had fewer visits to the dentist for cavities than those who did not. Normally, the level of naturally occurring fluoride is usually too low to benefit oral health. *Fluoridation* is the process that augments naturally occurring levels of fluoride in drinking water so that the element is effective in preventing tooth decay.

Usually when the level of natural fluoride in water is greater than 0.7 ppm, then that water is considered to be naturally fluoridated. Throughout the United States today, 67.3 percent of the population has access to fluoridated water, mostly through the water fluoridation process. Grand Rapids, Michigan, was the first city to have manually adjusted the water fluoride level to 1.0 ppm in 1945.

Fluoridation of drinking water not only reduces tooth decay, in some cases it prevents teeth from decaying at all. It works by combining with saliva in the mouth to form a protective coating on topmost layer of human teeth, known as tooth enamel. Fluoride not only can help prevent cavities while the teeth are still developing, but even after the teeth have been completely developed.

Though there are many who praise the benefits of fluoridation, others are opposed to the idea of altering the percentage of fluoride in drinking water. Experiments were done on rats at different ages and those who were given the same dosage of fluoride had different results, depending on their age. The results of the experiments showed that those who were exposed to the fluoride before birth were hyperactive throughout their lives while others suffered depression. Some of the experiment subjects were even found to have brain and kidney damage. The level of fluoride in the water given the rats was 1.0 ppm, the same level that is considered the beneficial for humans. The reactions from the rats were considered toxic effects and humans could possibly have similar reactions. Throughout the United States today, many associations dispute the health benefits and potential negative effects of fluoridation.

SEE ALSO: Drinking Water; Water; Water Quality.

BIBLIOGRAPHY. Christopher Bryson and Theo Colborn. *Fluoride Deception* (Seven Stories Press, 2004); Fluoride Action Network, www.fluoridealert.org (cited June 2006); National Research Council, Fluoride in Drinking Water: A Scientific Review of EPA's Standards (National Academies Press, 2006).

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Fodder

FODDER CROPS ARE plants grown exclusively or primarily for the purpose of feeding livestock. They include maize, clover, and alfalfa, which are favored for their palatability for livestock and because of their ability to bind nitrogen from surrounding atmosphere and soil, which significantly enhances the protein value of the fodder and hence increases rapid and healthy growth of the livestock. The three main classes of fodder crops are grasses, legumes, and root crops. Fodder may be grown on temporary meadows or in natural settings, but in societies with more advanced agricultural industries, it is likely that dedicated land will be set aside for regulated and intensified growth of fodder crops. Compound foods are more common for livestock in developed countries, which have resources to maximize rapid growth by mixing different types of input.

Widespread animal rearing in a region requires intensive fodder growing, which leads to the transformation of the land. For example, the clearances of the Highlands, when Scottish crofters (smallholders) were forcibly evicted by English landlords to make way for sheep to graze on the land, was a result of fodder crop growth. The extensive use of U.S. land for cattle is also inefficient in terms of overall food production value.

However, land use change, in which land of marginal value is claimed for fodder growth, has enabled increases in food security and improved health for many people. At the same time, the space for shifting cultivation around the world has been reduced as population increases and desertification processes reduce the amount of land available overall. In countries such as Laos, where livestock has traditionally roamed free in forest or jungle land because of the limited amount of naturally occurring fodder available for large herbivores, these shifts in land use are both increasing the amount of agricultural land as a whole while converting the ways in which people have lived for many generations.

The commercial opportunities from animal slaughter has led to the use of animal material in fodder. This is in itself unnatural, as it leads to some natural vegetarians ingesting meat-based ingredients; contaminated animal fodder has been linked with the spread of bovine spongiform encephalopathy ("mad cow disease") and other conditions. It is also believed that the use of fish meal for animal fodder on a commercial basis has also contributed to the denuding of oceans and the collapse of their ecosystems.

SEE ALSO: Agriculture; Crop Plants; Livestock; Mad Cow Disease.

BIBLIOGRAPHY. Brad Collis, "Livestock for Livelihoods in Laos," *Appropriate Technology*, (v.31/4, 2004); Muhammad Dost, "Fodder Success Story: Improved Fodder Crop Production in the Northern Areas of Pakistan," (Food and Agriculture Organization, 2001), www.fao.org (cited December 2006); United Nations Food and Agriculture Organization, www.faostat.fao.org (cited December 2006).

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Food

WE MUST EAT in order to survive. Food contains energy, vitamins, and nutrients necessary for the human body to function properly. But people's eating habits vary considerably from one region and cultural sphere to another.

One reason behind this diversity is the global variation of the natural environment. The earth has a myriad of variably sized habitats and ecosystems, which affect the availability of foodstuffs. For example, people residing along waterways and coasts have traditionally eaten more fish than those living inland. Human curiosity, mobility, and the subsequent exchange of ideas and goods has greatly diversified these patterns. New food items and ways of preparing and consuming food have typically spread along trade routes, landing in the primary centers of exchange.

The dependency of cities on a continuous food supply from the countryside has further shaped the regional patterns of food production. Land around cities is typically more valuable, which directs agricultural production in these areas toward labor-intensive, easily perishable food items that need to reach their urban markets and processing facilities without delay. One example of this regional differentiation per land value, production costs, and demand is the dairy and vegetable production "belt" around the cities in the Great Lakes area and eastern seaboard in the United States. Meat, corn, and wheat can be produced farther away, on cheaper land, but still within good transportation connections to processing plants and urban centers.

Urban settlement is a direct result of agriculture. For an estimated 2.5 million years, humans lived as hunters and gatherers. The gradual development of agriculture enabled them to give up their nomadic lifestyles and cluster in settlements. The earliest evidence of planted crops include rice in what today is South Korea (about 15,000 years ago) and figs in the Jordan River Valley in the Middle East (11,000–12,000 years ago). Dogs, goats, pigs, and sheep were among the first domesticated animals.

Surplus food produced by the land encouraged a differentiation of tasks and increased trade between the settlements. Specialized professionals, such as makers of tradeable goods, administrators, merchants, and soldiers, were supported by the producers of food. Food thus became a strategic resource, guaranteeing survival, increased prosperity and power. The saying, "armies marching on their stomachs," is well known, for only well-fed troops stay healthy, disciplined, and capable of efficient combat. Mighty cities have fallen after their supply of food has been cut off and their defenders have faced starvation to death.

GLOBALIZATION

The trade of food between cities and countries expanded the scale of movement and business transactions, paving the way for what today is called *globalization*. Early international traders, such as the Greek and the Venetians, introduced new food items and their preparation methods to domestic and foreign lands. The colonization of the New World by Europeans added to the selection of spices and luxury consumables in Europe. "Fashion foods" in Europe of the era included New World drinks such as cocoa, tea, and coffee, and several fruits, which all led to innovations in kitchenware, serving styles, and socializing. As result of this globalization of food, diets, customs, landscapes, habitats, and economies changed dramatically on a global scale.

The commercial exchange and related rivalry between the world's superpowers created unstable dependencies, the legacy of which is still present in global politics and economy. Huge parcels of conquered land were turned into producers of raw materials and were designed to serve the needs of colonial masters. This production of export-serving "cash crops" often impoverished soils, homogenizing and limiting local agricultural production. The former colonies in Africa, Asia, and Latin America now have political independence, but their national economies may still depend on the production and trading patterns created during the colonial–imperial era. The contemporary world is highly unbalanced and unequal from the perspective of food production, distribution, and consumption. While some countries struggle to feed their population and children grow up malnourished, others try to resolve problems of overproduction and life-threatening obesity.

Beef from Brazil and lamb from New Zealand compete with domestic meat production in many European countries.

Food now travels across the globe faster and more comprehensively than ever before. Industrial mass production, trade, technological innovations, and expedient transportation and communication networks support a complex worldwide food system of supply and demand. Ease of travel allows for new culinary experiences, acquiring of tastes, and production of new customer demand. Migrants introduce new foods and foodways to their host populations, and create new demand for imports. A variety of import and export companies, specialty restaurants and corner groceries have sprung up in urban centers, diversifying local culinary landscapes. For the wealthy, everything is available all the time: fresh tropical fruit are sold year-round in developed countries, and beef from Brazil and lamb from New Zealand compete with domestic meat production in many European countries. Seasonality and food storage and transportation challenges have diminished significantly over the past few decades. Change has accelerated, as simultaneous global, local, homogenizing, and diversifying forces complement one another and individuals, goods, and ideas move to create global flows and patterns.

BOUNDARIES AND IDENTITY

The concerns and the tightening control over imports, exports, and national boundaries point to the continuous strategic importance of food and food safety to national interests. National governments seek to maintain self-sufficiency, reducing their dependency on outside supplies and guaranteeing continuity and quality of the domestic food supply.

Food-related safety concerns is a factor dividing the world into nation-states, countering some trends of globalization. Attention has turned toward local and regional production as an environmentally sustainable alternative to longer food chains, as a way to support employment, and as an expression of local, regional, and national feelings of belonging. This illustrates the importance of food for human identity.

Particular food items and foodways have thus gained strength as markers of local, regional, or even national pride and as profilers of their production regions. The European Union supports local and regional specialties in its member countries by protecting their name, traditional method of preparation, or geographical origin: Feta cheese of Greece, the prosciutto ham of Parma, Italy, and the Jersey Roy-

Food Safety and Ethics

Industrial mass production and processing of food, its global trade, and the year-round abundance are sources of ethical and environmental concerns. Also criticized are the treatment of animals and the usage of pesticides, fungicides, chemical fertilizers, growth hormones, and gene manipulation technologies. Ideologically motivated eating habits, consumer choices, and food boycotts are grassroots ways to manage concerns related to food items, their production, and consumption. Some choose a form of vegetarianism or veganism for ethical and moral reasons related to animal rights. Others object to the environmental costs, economic inequality, and health risks associated with agribusiness. They may therefore grow some of their own food, buy organic produce from local independent farmers, and select products distributed through Fair Trade networks. Particular companies may be pressured through boycotts to revise their production or marketing ethics and practices. Examples include consumer boycotts against Coca-Cola, Nestlé, and McDonald's.

Concerns about food-related health risks among Western consumers grew significantly in the late 20th century, when issues about animal diseases, growth hormones, antibiotics, and toxic residues in animal agriculture and food processed for human consumption made global headlines. Under the conditions of expedient mass production, open borders, and global trade, animal diseases spread faster than ever before, making consumers question the safety of their food.

Consumers began to avoid certain products, and governments issued warnings or set restrictions on certain food items and produce originating from particular countries. For example, the "mad cow disease" epidemic in Britain devastated the country's agriculture, export income, image, and lives of individual farmers, as animals were slaughtered en masse, farms and meat-processing facilities were shut down, and the world refused to import and eat British beef.

al potatoes of Britain. In the United States, place-specific food associations include Maine lobsters, Idaho potatoes, and the Philly cheesesteak sandwich. Culinary hybrids created through cultural contacts and experimentation have become integrated into "national" cuisines. For example, the stereotypical dishes of "Mexican" and "Japanese" food were first invented in the United States, then introduced to those countries whose cuisine they are perceived to represent. "National cuisines" are illusions in a sense that they typically are collections of regional specialties and imported ingredients, preparation methods, and dishes, which continue to evolve. However, they maintain strong national profiles, reputations, and stereotypes, such as Italians living on pasta and an English meal as incomplete without brown gravy and pudding.

CUSTOMS SHAPED BY ENVIRONMENT

Availability and customs steered by the environment (for example, preservation by drying, salting, or immersion in vinegar or oil) have influenced ideas of desirability and acceptability. The same consumer may be disgusted by one rodent (rat), but happily eat others (rabbit, hare, guinea pig). The same fish may be tasty for one person when seasoned with salt and vinegar, but will not go down dried.

The variety and relativity of food-related customs, preferences, and taboos confirm that these practices are historically, socio-culturally, and environmentally conditioned. Most Europeans and North Americans would typically not eat insects or dogs, but grasshoppers are a salty street snack in parts of Asia and Latin America, and a particular dog breed makes a prestigious specialty in parts of Asia. A variety of meats produced by other domesticated animals, crabs, mussels, snails, and frogs are delicacies for one, but disgust another. These boundaries are very strong.

For example, it is hard to see that the controlled farming of rats would help solve the world's protein deficiencies, even if the omnivorous, quickly reproducing rodent might be environmentally, ethically, and economically more sustainable than large, slowly reproducing and selectively eating farm animals. At the same time, preferences for particular types of fish and meats, and related economic profits, repeatedly lead to crossing of sustainable and ethnical boundaries, shaking the delicate ecological balance of entire ecosystems in particular areas and treating sentient beings as industrial commodities.

INEQUITABLE DISTRIBUTION

It is clear that the range of options and ability to choose are very unevenly distributed across the world. Whereas fashion foods and consumer boycotts may be routine for the privileged wealthy, much of the world's population still focuses on daily survival. Population growth, natural and human-induced environmental disasters, the complex legacies of colonialism and imperialism; and contemporary world politics and economies keep entire countries on the threshold of major humanitarian disasters. In many areas, the sustainable limits of the local environment have been exceeded and the balance may tip over from scarcity to starvation.

Dependency on exportable raw materials, outdated technology, immediate economic and human needs, political instability, unequal land ownership, and commercial greed complicate the improvement of these conditions and interfere with emergency preparedness. Emergency measures, such as international food aid, often come late, may create new dependencies, and cannot replace preventive, long-term approaches to sustainable development. Droughts, fires, overgrazing, overfishing, salinization of irrigated lands, and disastrous cases of mishandling hazardous or sensitive materials exemplify that a variety of natural and human hazards can affect any society, often sending cumulative shock waves across the world.

SEE ALSO: Agriculture; Farming Systems; Fast Food.

BIBLIOGRAPHY. Harvey A. Levenstein, *Revolution at the Table* (Oxford University Press, 1988); David Bell and Gill Valentine, *Consuming Geographies* (Routledge, 1997); Barbara G. Shortridge and James R. Shortridge (eds) *The Taste of American Place. A Reader on Regional and Ethnic Foods* (Rowman and Littlefield, 1998); Peter Atkins and Ian Bowler, *Food in Society: Economy, Culture, Geography* (Arnold, 2001); Carole M. Counihan (ed.) *Food in the United States: A Reader* (Routledge, 2002); Alan Davidson, *The Penguin Companion to Food* (Penguin, rev. ed. 2002); Reay Tannahill, *Food in History*

(Review, new updated ed. 2002); Pauliina Raento, "The Changing Food Culture and Identity in Finland," *Journal of Finnish Studies* 10 (Special Issue, 2006); Agriculture and Rural Development in the European Union (2006). www.ec.europa.eu/agriculture (cited June 26, 2006).

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Food and Drug Administration (U.S.)

THE FOOD AND Drug Administration (FDA) was created as a governmental entity in the United States by virtue of the 1906 Pure Food and Drugs Act passed during the administration of President Theodore Roosevelt. Health problems caused by impure foods had plagued the country since its inception, with both imported and locally produced items responsible for a variety of poisoning incidents. The publication in 1906 of Upton Sinclair's novel *The Jungle*, which documented conditions in the meatpacking industry, was also influential. That book, though dedicated to exposing the harsh working conditions for immigrants, was largely received by the American public as a message about food safety.

The first national law concerning pure food had been passed in 1848 during the Mexican War. However, the growing sophistication of the food and pharmaceuticals industries in a large and rapidly modernizing economy required a much more comprehensive raft of legislation to deal with often predatory commercial interests. State-supported scientists helped farmers to improve their own produce and to introduce the modern scientific innovations in chemical additives and colorings appropriately, while also helping them to identify which of their industrial competitors may have been adulterating their products or otherwise producing sub-standard items.

From the passing of the 1906 act to 1938, the FDA in conjunction with the Bureau of Chemistry struggled to keep pace with the demands for regulation. In 1938, the FDA was greatly expanded in scope and size as a result of the Food, Drug, and Cosmetic Act (FDC) of that year. This act demanded high food safety standards and that new drugs be proved safe prior to them coming on the market. In 1962, in response to the Kefauver-Harris Amendments to the FDC, the FDA introduced new guidelines to ensure that drugs are proven effective before they are sold. In 1968, it acted to regulate microwave cookers and their radiation and subsequently followed this up by considering the safety implications of a range of catering and medical equipment. The FDA's mandate continued to grow as new types of products were brought under its jurisdiction. Between 1990–92, the FDA worked with consumer interest groups to help devise suitable nutritional guidelines with which food producers must comply. Also in 1990, the FDA was a leading figure in trying to create international standards on food and drug safety. In 2002, it was charged with maintaining the food security of the United States in response to possible bioterrorism threats.

The FDA has seen its mandate grow as new products are introduced and as a result of the internationalization of trade. In particular, advances in medical and pharmaceutical sciences have greatly increased the complexity and time required to administer and monitor resource-intensive testing procedures. Intensification of agricultural production has also raised the potential for problems such as bovine spongiform encephalitis ("mad cow disease") and avian influenza ("bird flu"), which demonstrate the dangers of improperly supervised livestock management. The FDA has been as active in monitoring food production facilities as it has been in considering licensing possible treatments for HIV/AIDS and other complex new medical complaints.

New legislative issues emerge from changes in diet and lifestyle, such as the plague of obesity and the threat of mature-onset diabetes. The FDA must navigate between its ability to regulate externally and its willingness to provide incentives to improve citizens' activities and methods. Realizing that safe and healthy products can provide a competitive advantage in the consumer marketplace has been a key finding, and is likely to become increasingly important for the FDA. At the same time, the FDA is also likely to wield increasing powers in obtaining recompense for consumers from companies adjudged to have provided improper goods.

The FDA has come to oversee an enormous part of the overall economy, and has had considerable levels of resources devoted to it in its routine work of testing, monitoring, researching, and formulating policy and legislation. It plans a leadership role for itself, both nationally and internationally, in the search for cures for presently untreatable medical conditions and innovative pharmaceutical delivery mechanisms. It plans to continue its regulatory approach for product testing and to help raise standards globally. A certain culture permeates the FDA and its mandate to protect the public from the myriad natural and unnatural dangers of the world; and some people, whether members of regulated industry or not, find this culture unhelpful and even confrontational. Additionally, ideology drives some to object to the size and the power of the FDA, and consider it to intervene excessively in the profit-making ability of commercial enterprises and that it should, therefore, undergo reform to reduce its power and influence.

SEE ALSO: Chemical Additives; Drugs; Food; Food Irradiation; Roosevelt, Theodore Administration.

BIBLIOGRAPHY. Fran Hawthorne, *Inside the FDA: The Business and Politics Behind the Drugs We Take and the Food We Eat* (Wiley, 2005); Meredith A. Hickman, ed., *The Food and Drug Administration (FDA)* (Nova Science Publishers, 2004); Marc T. Law, "How Do Regulators Regulate? Enforcement of the Pure Food and Drugs Act, 1907–38," *Journal of Law Economics and Organization* (v.22/2, 2006); FDA, www.fda.gov (cited November 2006).

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Food Irradiation

FOOD IRRADIATION IS the process of treating food with ionizing radiation to eliminate germs and possible disease from the food. The need to treat food for the presence of germs has been known since the work of Louis Pasteur and the invention of the pasteurization process. Food irradiation is a technology that is generally supported by government agencies and food companies. It reduces the spoilage of food and increases the shelf life of a wide range of products. Various techniques are used in irradiation, including bombardment by electrons, x-rays, and gamma radiation. Some consumer groups are concerned with as yet unknown side effects of the process, and oppose food irradiation.

In the United States, a small number of foods are treated with irradiation for specific purposes. For example, pineapples and other tropical fruits from Hawaii are irradiated before importation to the mainland to prevent the spread of fruit fly pests. Other foods for which irradiation has been deemed suitable are spices and herbs, fresh and dried fruits and vegetables, and some types of meat and seafood, all of which are subject to infestation by microorganisms. When such foods are labeled clearly, the amount of consumer resentment to the treatment has been reduced. However, research indicates that consumer resentment increases when the labeling is unclear, unexplained, or appears misinforming. In the European Union, a number of food producers distributing products that have been irradiated, but not accurately labeled, have resulted in official action. However, the extent to which testing of products takes place varies significantly from country to country. Regulations govern the nature of the premises in which irradiation may take place.

Opponents of food irradiation maintain that the process creates harmful free radicals, reduces the quantity of vitamins and other nutrients in food, creates new chemicals within food that would not otherwise be present, and negatively affect the quality of the food. The issue has been subjected to intensive scientific research over the years and the majority has concluded that the process is safe. However, the increase in consumer awareness of global production processes and cynicism about many corporate activities mean that many people continue to treat irradiation with suspicion.

SEE ALSO: Food; Food and Drug Administration (U.S.); Microbes; Pasteur, Louis.

BIBLIOGRAPHY. Commission of the European Communities, *Report from the Commission for Food Irradiation for the Year 2002* (Brussels, 2004); John A. Fox, Dermot J. Hayes, and Jason F. Shogren, "Consumer

Preferences for Food Irradiation: How Favorable and Unfavorable Descriptions Affect Preferences for Irradiated Pork in Experimental Auctions," *Journal of Risk and Uncertainty* (v.24/1, 2002); Robert B. Miller, *Electronic Irradiation of Foods: An Introduction to the Technology* (Springer, 2005).

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Food Webs (or Food Chains)

FOOD WEBS ARE depictions of the feeding relationships that exist among species within an ecosystem, indicating flows of energy and biomass between trophic levels. Although a food web is a more complex conception than a linear food chain, it remains a relatively static and binary depiction: species either interact or they don't. Despite these limitations, food webs are useful conceptual tools, providing insights into the organization of communities and the interactions among different species within them.

Food webs are organized into trophic (or feeding) levels. Species are categorized as either producers or consumers. Producers or *autotrophs*, literally "self-feeders," constitute the first trophic level—those species that synthesize their own food through processes of photosynthesis or chemosynthesis and includes most plants, algae, phytoplankton, and some species of bacteria. Photosynthetic species use carbon dioxide, water, and the light energy of the sun to produce sugar molecules as well as oxygen. Thus, these species are responsible for producing the relatively oxygen-rich atmosphere that exists on earth today. Chemosynthetic species produce carbohydrates via several different possible chemical pathways. Some use the chemical energy bound up in inorganic molecules (such as hydrogen sulfide), to produce carbohydrates from carbon (derived from carbon dioxide or methane), and oxygen.

Consumers, also termed heterotrophs, feed on other organisms, both living as well as dead. Those that eat the latter are *decomposers* or *detritus eaters*. All organisms eventually enter the detrital food web after they die and decompose or are consumed and their remains excreted. Herbivores, species that consume autotrophs, occupy the second trophic level. Carnivores are species that feed upon herbivores or other carnivores, with those that feed on herbivores occupying the third trophic level and those that feed on carnivores occupying higher trophic levels.

Food webs encompass a number of dynamic and interconnected food chains. A species may be an omnivore, consuming both producers and consumers, eat consumers from different trophic levels, and be preyed upon by a variety of species at different trophic levels, including fellow members of its own species. Some producers, such as Sundew and Venus Flytrap, supplement their primary production with the consumption of animals. There are also temporal dimensions to food webs. Predator–prey relationships may change both seasonally and through the life history of a species. For example, adult herring prey upon juvenile cod or eggs and may, in turn, be preyed upon by adult cod. In addition, some species, such as cod, cannibalize younger members of their own species.

Terrestrial and aquatic food webs are generally separated in space; however, some species facilitate cross-habitat fluxes of nutrients and detritus. Seabirds and some of the large vertebrate predators (humans, pinnepeds, polar bears) link marine and terrestrial food webs, transferring nutrients of marine origin to the land. Similarly, the migratory Pacific salmon grows to maturity in marine waters and returns to spawn and die in the freshwater environments where it was born, thereby connecting freshwater, marine, and terrestrial food webs. Salmon carcasses provide food for a wide variety of terrestrial animals, including bald eagles and bears, and are an important source of marine-origin nutrients in some freshwater streams.

The abundance of higher trophic level species is ultimately dependent on the productivity of autotrophs. A large proportion of the energy, as much as 90 percent, is lost in each trophic level transfer (as uneaten waste, feces, heat, consumer energy, and respiration, and so on). Because of this, there are limits on the absolute number of trophic levels found within an ecosystem. While the first and second laws of thermodynamics dictate that a substantial amount of bottom-up (nutrient driven) regulation of food webs exists, there is some evidence that top-down (predator dominated) control of food webs is or was important in some ecosystems.

HUMAN IMPACT ON FOOD WEBS

There are few, if any, food webs, on earth that have not been significantly affected, or even dominated, by human activities. Humans impact food webs in two general ways: creating deficits by extracting organisms from ecosystems; and by producing subsidies, concentrating and transporting wastes from one system to another. Agricultural production is significant in both respects. Plant-based agricultural systems replace natural systems, substituting monocultures for greater species diversity and extracting most of the primary production from the system for human consumption. The application of pesticides disturbs food webs, creating secondary outbreaks and resurgences of the targeted populations. On the other hand, industrial animal husbandry concentrates manure and other wastes, which if not managed adequately, may pollute aquatic systems, overfertilizing them and ultimately leading to eutrophic conditions.

Commercial and recreational fishing and hunting constitute significant impacts to some ecosystems. Removing predators from ecosystems can lead to trophic cascades, changing food web structure and dynamics, perhaps irreversibly. Pollutants, too, move through the trophic levels of food webs as animals eat and in turn are eaten by others through processes of bioaccumulation and biomagnification, causing problems for organisms at high trophic levels, and especially in northern latitudes, including birds of prey, marine mammals, and babies fed human breast milk. Global climate change may pose the greatest challenge to the stability of food webs, altering growing seasons, changing the geographical ranges of species, creating unpredictability in predator–prey relationships and ultimately threatening many species with extinction.

SEE ALSO: Disequilibrium; Ecosystems; Endangered Species; Equilibrium; Global Warming; Hunting; Overfishing; Pesticides.

BIBLIOGRAPHY. Kenneth T. Frank, Brian Petrie, Jae S. Choi, William C. Leggett, "Trophic Cascades in a Formerly Cod-Dominated Ecosystem," *Science* (v.308/10 June, 2005); Henry F. Howe and Lynn C. Westley, *Ecological Relationships of Plants and Animals* (Oxford University Press, 1988); Daniel Pauly, Villy Christensen, Johanne Dalsgaard, Rainer Frose, and Francisco Torres Jr., "Fishing Down Marine Food Webs," *Science* (v.279/6 February, 1998); Stuart L. Pimm, *Food Webs* (Chapman and Hall, 1982); Stuart L. Pimm, *Food Webs,* 2nd ed. (University of Chicago Press, 2002); Gary A. Polis, Mary E. Power, Gary R. Huxel, eds., *Food Webs at the Landscape Level* (University of Chicago Press, 2004).

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Forest Organic Act

THE FOREST ORGANIC Act of 1897 established the rationale and management authority for the first forest reserves in the United States. The act was in part a response to debates arising from the passage of the 1891 General Revisions Act, which repealed the 1873 Timber and Culture Act and included a rider granting the president of the United States power to set aside portions of the public domain for perpetuity as forest reserves. By failing to mandate authority for the management and protection of these lands, however, the 1891 act left as an open question the purpose of forest reserves in the United States. By the end of his term in 1893, President Benjamin Harrison had set aside approximately 13 million acres, intensifying the stakes for early conservationists and powerful western mining, timber, and water interests.

The Forest Organic Act stated that forest reserves in the United States were intended to secure "favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States…" It called upon the U.S. Geological Survey to assess existing and potential future reserves in the public domain. The Department of Interior was named the active managing authority and required to carry out its duties according to systematic, objective, and scientifically driven principles of modern resource management. In this way, the act situated the new forest reserves within the utilitarian foundations of an emerging progressive conservation philosophy.

Following the recommendations of the 1896 National Forestry Committee of the National Academy of Sciences, the act laid out the initial framework for timber management on public lands. The secretary was not only required to protect the reserves from fire destruction, but also for the purpose of preserving growing timber and promoting younger growth, to develop a systematic process to designate, appraise, mark and sell "dead, matured, or large growth trees." Those appointed to prepare the sale can not profit from the sale in any way. In addition, the act stated this timber could not be exported, but sold to purchasers for use only in the state or territory in which it was situated.

The act also addressed the economic concerns of those wary of a persistent federal presence on public lands. Western mining and agricultural interests were appeased in the act's requirement that all forest reserve lands were subject to the "highest and best use." This meant specifically that lands deemed more valuable for their mineral resources or agricultural productivity could not legally be included within forest preserves. With presidential approval, the secretary could recommend returning existing forest reserve lands to the public domain if the land was found to be "better adapted" for other purposes. All reserves remained open to future mineral prospecting and development.

Private property owners were also protected under the law. A lieu lands clause allowed landowners to trade lands located within a forest reserve for lands of equal value located elsewhere. Those choosing to keep their holdings retained right of access to their property. Finally, all water resources, timber, and stone found on the reserves could be used "free of charge by bona fide settlers, miners, residents, and prospectors for minerals, for firewood, fencing, buildings, mining, prospecting, and other domestic purposes."

The Forest Organic Act was significant on at least two counts. First, in conjunction with the 1891 General Revision Act, it marked an historic departure in the general trend of U.S. public lands policy up to that time, from one based solely on the privatization of public lands, to a mix of privatization and the intentional federal retention of selected lands. Second, the act provided the early framework of utilitarian, multiple use, state-based, scientific resource management that continued to shape U.S. forest management through the 20th century.

SEE ALSO: Forest Management; Forests; Public Land Management.

BIBILIOGRAPHY. R. Andrews, *Managing the Environment, Managing Ourselves* (Yale University Press, 1999); M. Dombeck, C. Wood, and J. Williams. *From Conquest to Conservation: Our Public Lands Legacy* (Island Press, 2003); P.W. Gates, *History of Public Land Law Development* (GPO, 1968); P. Hirt, *A Conspiracy of Optimism: Management of the National Forests Since World War Two* (University of Nebraska Press, 1994); H.K. Steen, *The U.S. Forest Service: A History* (University of Washington Press, 1976).

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Forest Management

FOREST MANAGEMENT IS concerned with a range of scientific and management activities involved in the husbandry and administration of forested areas in countries around the world. Forests offer a variety of resources that can be exploited for commercial development, but ineffective monitoring regimes in many countries have led to over-exploitation of the forests, often on an unsustainable basis. The teak forests of Thailand, for example, have been almost destroyed through overlogging.

The rate at which the extensive rainforests of the Amazonian region of South America and elsewhere are being felled not only damages the habitation of the people and wildlife living there, but also has a serious negative impact on global warming. When forest management efforts have sought to replant forests, there have been problems caused by the inability of this method to recreate the diversity of the original forest cover. Further, the loss of trees also reduces the ability of the land to hold water, which contributes to flooding, mudslides, and other problems, causing significant loss of life in many parts of the world.

Forest management aims to balance the opening of forestland to a reasonable degree of public use and commercial exploitation within a framework of sustainability. Forestlands in developed countries are often employed to provide aesthetic, tourist, and recreational opportunities, which places some pressure on a finite resource. In less-developed countries, forests may house valuable, or at least rare, wildlife species, necessitating assistance from governments and nongovernmental organizations (NGOs). Many people need forest resources for hunting, gathering, and fuelwood. Some semi-nomadic peoples practice swidden or slash-and-burn agricultural patterns, which have become unsustainable in the modern world in the face of population density and decreases in available forest land. Assistance is also required to help nomadic peoples adjust to new lifestyles on a sedentary pattern. In several parts of mainland southeast Asia, for example, a number of different ethnic minority groups have become accustomed to growing opium as a cash crop, which has been suppressed to a significant extent in recent years through aerial surveillance and multinational cooperation. Government schemes demonstrate alternative cash crops, including coffee and some types of vegetables. In other cases of inappropriate commercial exploitation of the forest, then the land may be designated a protected area and legal sanctions put in place to prevent the activity. These preserved areas may be combined with tourist destinations in some cases.

FOREST MANAGEMENT PLANNING

To plan for management of forestry, it is important to first map and document the existing extent of the woodland and its flora and fauna. This can be difficult, time-consuming, and expensive, especially when human resources and technical capacity are comparatively low. The mapping process has been considerably facilitated by the availability of satellite mapping services, which are now able to cover the surface of the earth with some accuracy. However, creating new maps does not always help to understand the past nature and extent of forests, before more recent forms of degradation took place. The best that can be achieved, in these cases, is to provide a representation of forests as they were a comparatively few years ago.

Ideally, the forest management plan should be drawn up with contributions from local people and all relevant stakeholders. This can be problematic in those countries lacking a sufficient democracy. Planning should take account of the identification and preservervation of water resources within the forestland, together with the physical infrastructure that may be required for tourism, for people still living within the forest, and any other purposes. Accurate evaluation of the nature, maturity and size of trees, animal life, and profit opportunities should be conducted. This information can empower and inform forest workers and persuade local people or commercial interests of the implications of such acts. Incentives should ensure that not only do they understand the implications of forest exploitation, but that they also have solid alternatives for income-raising activities. Some states have been exploring public–private sector partnerships in managing forests in this way.

Reforestation projects to replace depleted forests or areas that were not previously forested have been comparatively successful in terms of providing plantations of exploitable trees, but less successful in creating diverse forested areas. The use of single species, for example of eucalyptus trees in Thailand, has resulted in depletion of soil nutrients and damage to neighboring species.

SEE ALSO: Conservation; Forests; Joint Forest Management; Reforestation.

BIBLIOGRAPHY. Lawrence S. Davis, Norman K. Johnson, Pete Bettinger, and Theodore E. Howard, *Forest Management: To Sustain Ecological, Economic, and Social Values* (Waveland Press Inc., 2005); Michael J. Mortimer and Scott D. McLeod, "Managing Montana's Trust Land Old-Growth Forests: Practical Challenges in Implementing Scientific Policy," *Administration and Society* (v.38/4, 2006); R.H. Waring and W.H. Schlesinger, *Forest Ecosystems: Concepts and Management* (Academic Press, 1985); Daniel Zarin, Janaki R.R. Alavalapati, Frances E. Putz, and Marianne Schmink, eds., *Working Forests in the Neotropics: Conservation through Sustainable Management?* (Columbia University Press, 2004).

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Forests

FORESTS ARE ONE of the dominant forms of land cover on earth, and forested landscapes are central in constituting human environment relationships. Human relations with forests are also highly specific, complex, and dynamic, featuring considerable historical and geographical variation, making a universal definition of what actually constitutes a forest difficult.

Nevertheless, the Food and Agriculture Organization of the United Nations (FAO) does attempt to define and track forest cover: "Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10 percent, or trees able to reach these thresholds in situ." Even in this basic definition, there is evidence of some subjectivity and convention, as these standards would seemingly exclude much of the far northern boreal forests. Forested regions are generally broken down into boreal, temperate, and arid and moist tropical types, although there is tremendous variation within these categories. Forests are also often classified according to whether they are dominated by coniferous trees (softwoods), deciduous trees (hardwoods), or a mix of each.

Overall, the FAO reports net deforestation on a global level, estimated to have amounted to the loss of 7.3 million hectares per year between 2000–2005. The primary driver of this loss continues to be conversion to agriculture, although the rate of net deforestation has slowed since the 1990s. In terms of forest use, roughly half of global demand for wood continues to come from fuel wood demands, driven by the dependence of one-third to one-half of the world's population on biomass as a primary fuel for heating and cooking. Other significant sources of demand for wood come from industry for the production of wood products such as pulp and paper, lumber, and veneer. Roughly one-third of global forests are managed specifically for the purposes of producing wood and non-wood products and commodities.

FOREST COVER AND SPATIAL TRENDS

Beneath the aggregate trends, however, there are pronounced regional disparities in both rates and drivers of forest cover conversion. For instance, there is actually net afforestation in parts of Europe and in Asia, particularly in China, driven by large-scale planting programs. The FAO also notes conversion in forest types within the forested category, generally from what the FAO calls "primary" or unmanaged forests and from what are called "modified natural forests" to plantation forest types. Although actual plantation forests only account for 4 percent of global forested area according to the FAO, relatively large increases in plantation forest area have been witnessed in the last 15 years in Asia and in North America. Attempts to track the conversion of species-rich, complex forests to typically simpler, plantation-style forests is important because of the pronounced implications for forest biodiversity and worldwide rapid rates of species loss.

Spatial unevenness disguised by these aggregate numbers, and the juxtaposition of net deforestation in some places with net afforestation in others, affirms the importance of understanding regional processes in and of themselves as well as in relation to one another. This includes critical interrogation of the ways in which afforestation may be enabled by or linked to deforestation in others (such as afforestation driven by recreational and conservation policies in one place abetted by the substitution of fiber from distant places). In addition, regional disparities and afforestation in some places reinforces that overgeneralizations about deforestation as a condition of human interface simply cannot be sustained, particularly when this interface is conceptualized in terms of raw population, e.g., "less people equals more forests." Things are just not that simple. Consider, for instance, that the defining feature of European land use since the development of agriculture, and later industry, may well be the clearing of woodlands. Yet over the much more recent past, Europe has become home to the most rapid rates of afforestation on earth, particularly of less intentionally managed forests that are reclaiming significant areas. The political ecology of small, fragmented savannah woodlands in Africa links the misinterpretation of these fragments as signs of deforestation (rather than as evidence of intentional afforestation by local forest users) to a pervasive global imaginary that posits forests everywhere to be in decline. Many undoubtedly are, but not all, and certainly not all for the same reasons.

There are highly specific cultural connotations of "forest," far beyond a word merely to convey a collection of trees.

HUMAN–FOREST RELATIONSHIPS

Forested landscapes constitute social relations and institutions, as well as of systems of meaning and representation governing human–environment relationships, in myriad and complex ways that make forests sites of rich, integrated political ecologies. For instance, forest conversion and management is not only an ecological process but also a human one, with distinct implications in the formation of property rights, political economies, and the reflection and reinforcement of ways that nature is understood. James Scott links the rationalization and ordering of European forests governed primarily for the purposes of commodity production to the territorial and administrative consolidation the modern nation-state.

These schemes represented not only ecological simplifications, but also social ones, as myriad and overlapping use rights and property claims on forested landscapes were rationalized and consolidated in the interests of efficient commodity production, and streamlined administration of increasingly simplified property claims organized in Cartesian grids of individuated and exclusive plots of land. Here we see the complex interweaving of ways of acting and understanding in relation to the natural world with ecological and political economic change. Work of this character also serves to highlight the fact that exclusive claims to individual parcels of land, whether individually owned or state controlled, are by no means typical of the ways in which forest access is controlled and managed in all social and cultural settings.

Rather, many forests (and agro-forestry systems) are characterized by complex and overlapping claims to particular forest species right down to the level of individual trees and shrubs. These specific systems of access may underpin the production of a rich array of wood and nonwood forest products, but they also reflect and reinforce social relations along axes of class, race, and gender.

In fact, the complexity and diversity of relations between humans and the nonhuman biophysical world characteristic of forested landscapes and their appropriation for spiritual, subsistence, and commercial purposes is one of the obstacles confronting seemingly objective, rationalist classification schemes used to organize knowledge of forests. These schemes tend to smuggle in culturally specific and often evaluative notions about what is and what is not a forest, what type of forest it is, and whether or not the forest is healthy or degraded. Visitors from North America to Germany's Black Forest, for instance, often comment on the strikingly ordered, almost sanitized character of the forested landscape, with trees typically of uniform age lined up in neat rows one after another, with remarkably little undergrowth, and with almost sidewalk-smooth paths. The disconnect speaks in part to highly specific cultural connotations of "forest." It is, evidently, not merely a word meant to convey a collection of trees.

In addition, different connotations are seldom innocent. Paul Robbins, for instance, very neatly demonstrates how specificity in knowledge of forests among different social groups can lead to very different systems of forest classification, and different measures of the extent of forest cover. He then implicates these differences in the material "production" of forested landscapes via policy incentives for land management.

Robbins examines forest cover classification in the Indian region of Rajasthan, asking local farmers and land users to classify the surrounding landscape, and then asking professional foresters to do the same. Grouping resulting classification schemes into roughly comparable typologies, he finds large disparities in the total area considered forested by these respective groups. Among the reasons is that a common but invasive woody shrub species called Mexican mesquite (*Prosopis juliflora*) is highly successful in the area, and is considered forest by the foresters. But the locals tend to consider this waste or scrub land, and exclude it from forest. Why?

One reason is that the species tends to crowd out all others, not least because of its poisonous effect on the soil around it, undermining local land uses. While local users tend to classify land as forested only if it is useful to them, professional foresters face institutional imperative from the state to encourage tree cover. If their views are accepted, Robbins notes, this will tend to encourage rather than curb the expansion of Mexican mesquite.

EVOLVING CULTURAL CONNOTATIONS

While cultural constructs of forests may be specific, they are not static. Evidence from English literature and historical records, for instance, indicates that the prevailing connotation of forests was once quite negative, and that forested landscapes in England were represented until relatively recently as dark, mysterious, and generally foreboding places. The emergence of this negative connotation may be linked to the enclosure of forests by landed elites, effectively barring access to peasant and working classes during the 17th and 18th centuries. This enclosure was violent, and violently resisted, lending to forest areas a connotation of danger and threat, at least for those whose rights of traditional access were removed. More generally, the association of threat and evil with forests is very much connected to a negative or threatening connotation of uninhabited wilderness, or "wilde" spaces in the English literary tradition as recently as the 18th century. Only more recently, and largely in the American environmental imaginary, has wilderness taken on an unambiguously positive light. This has been attended by the elevation of old-growth forest landscapes to iconic status. All of this points to the need to approach human–environment relations in forested landscapes with great attention to local specificity and context, while attending to the ways in which the "local" articulates with broader processes of landscape transformation and representation.

SEE ALSO: Forest Management, Forest Service (U.S.), Forest Transition Thesis.

BIBLIOGRAPHY. J. Barry, *Environment and Social Theory* (Routledge, 1999); W. Cronon, *Uncommon Ground: Toward Reinventing Nature* (W.W. Norton & Co, 1995); D. Demeritt, "Scientific Forest Conservation and the Statistical Picturing of Nature's Limits in the Progressive-Era United States," *Environment and Planning* 19: 2001); J. Fairhead and M. Leach, *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic* (Cambridge University Press, 1996); R. Guha, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya* (University of California Press, 1990); N. Langston, *Forest Dreams, Forest Nightmares: The Paradox of Old Growth in the Inland West* (University of Washington Press, 1995); H. Rangan, *Liberation Ecologies: Environment, Development, Social Movements* (Routledge, 1996); P. Robbins and A. Fraser, "A Forest of Contradictions: Producing the Landscapes of the Scottish Highlands," *Antipode* (35(1): 2003); R. A. Schroeder, *Shady Practices: Agroforestry and Gender Politics in the Gambia* (University of California Press, 1999); J. C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press, 1998); E. P. Thompson, *Whigs and Hunters: The Origin of the Black Act* (Pantheon, 1975); A. Tsing, *Friction: An Ethnography of Global Connection,* (Princeton University Press, 2004).

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Forest Service (U.S.)

THE U.S. FOREST Service is the federal agency responsible for the management of 155 national forests and 20 national grasslands in the United States. A chief forester provides broad policy direction and oversees budgetary matters for the entire Forest Service. The chief reports to the undersecretary of natural resources and environment in the Department of Agriculture, and works closely with the presidential administration and Congress over budgetary and policy matters. The national forest system is divided into nine regions, usually encompassing several states. Within each region, a regional forester oversees management plans, budgetary issues, and coordinates various activities with the forest supervisors for each of their national forests. Each national forest is further divided into districts that vary in size from 50,000 to more than 1 million acres. Each district is run by a district ranger, who oversees a staff of 10–100 persons with specialized training in forestry, range conservation, travel management, resource economics, and anthropology.

The agency's mission consists of five parts: 1) to protect and manage natural resources on national forest system lands; 2) to conduct research on all aspects of forestry, rangeland management and forest resource utilization; 3) provide community assistance and cooperation with state and local governments, forest industries, and private landowners to help protect and manage nonfederal forests; 4) to achieve and support an effective workforce that reflects the full range of diversity of the American people and; 5) provide international assistance in formulating policy and coordinating U.S. support for the protection and management of the world's forest resources. Despite this diverse and broadly defined mission, much of the agency's history concerns the dominance of timber production and the challenges of bringing conservation management issues to the forefront.

The Forest Service was created in 1905 when the Forest Division in the General Land Office of the Department of the Interior was transferred to the Department of Agriculture. Management priorities included protecting water resources and providing an efficient and continuous supply of timber for the nation. The first chief forester, Gifford Pinchot, argued that the nation's resources could best be developed to serve the "greatest good, for the greatest number, in the long run" by replacing the short-term profit motives of unregulated industrial development with rational scientific management, carried out by state and federal agencies.

For the first four decades, the Forest Service worked closely with and realized mutual interests from players in timber, livestock, and mining interests. This arrangement (touted by some as a "iron triangle" or subgovernment), when coupled with athe acency's ideal of scientific objectivity in management decisions, presented a significant barrier to the adoption of new management priorities, constituencies, and interests.

PARALLEL GROWTH OF INTERESTS

However, just such new constituencies, and concomitant tensions, emerged in the post-World War II era. On one hand, rapid economic development, urban expansion, and the rise of new export markets created new demand for timber products. Timber production, which had already doubled during the war to approximately 4 billion board feet (bbf) per year, rose to 9 bbf by 1962, and reached 12 bbf by 1970. On the other hand, the newly expanding middle class increasingly looked to national forests as sites for recreation and relaxation. Environmental and outdoor recreation organizations, many pre-dating the creation of the Forest Service, gained renewed popularity and new political influence.

Concerned that proponents of a wilderness bill might succeed in removing lands from the national forests as wilderness areas, the Forest Service and timber interests promoted the 1960 Multiple Use and Sustained Yield Act. Hoping to pacify wilderness advocates, the act stated that the national forests "shall be administered for outdoor recreation, range, timber, watershed, wildlife and fish purposes." It implied that each use, including recreation and wildlife protection, would have equal priority in Forest Service management decisions. However, by leaving the interpretation of the law to individual forest managers, it resulted in little actual change. The passage of the 1964 Wilderness Act set aside 9 million acres of national forest land as wilderness and required the Forest Service to conduct a review of all unlogged, roadless areas for potential wilderness designation.

New laws such as the 1969 National Environmental Policy Act (NEPA) and 1973 Endangered Species Act also affected the Forest Service by requiring environmental impact statements that mandated public input (in the case of NEPA) and including citizen suit provisions. The latter allowed individuals to challenge federal agency management decisions in court, as evidenced in the 1971 report of the Forest Service's first Roadless Area Review Evaluation required under the Wilderness Act. The Sierra Club sued, arguing that the Forest Service study, which recommended that 6 million acres be set aside as wilderness, failed to examine millions of other potential acres. In response, the Forest Service conducted a second, 1977 study, which identified an additional 9 million acres for wilderness designation.

PUBLIC OUTCRIES

In the mid–1970s, public concern over the continued high volume of timber production on national forests, along with practices such as clear cutting and even age stand management, led to the passage of the 1976 Forest Management Act. The act authorized clear cutting, but regulated its use. Most significantly, it required long-term management plans for each national forest, once again mandating public input into the planning process.

Meanwhile, environmental organizations uncovered new problematic managerial practices, including below-cost timber sales. Tensions between ecological preservation and commercial timber production divided the Forest Service, as evidenced in the creation of Association of Forest Service Employees for Environmental Ethics (AFSEEE). The groups' publication, *Inner Voice*, raised critical questions about some Forest Service management priorities and policies.

These tensions reached a head in the conflict over the northern spotted owl and old-growth logging in the Pacific Northwest, where environmental organizations promoted listing the northern spotted owl as endangered. The timber industry framed the debate as a choice between jobs or the environment, although the local industry was already in decline. Nonetheless, the Northwest Forest Plan of 1994, brokered by President Clinton, sought to integrate habitat protection, forest restoration, and economic aid to local communities as part of a collaborative, ecosystem-wide approach to national forest planning and management.

A significant step toward adopting an ecological preservation management priority for the Forest Service occurred with the signing of the Roadless Area Conservation Rule in 2001, prohibiting road construction and timber harvest on over 58 million acres of national forests. The rationale was to protect the ecological integrity of these lands, which hold value as sites for recreation, wildlife habitat, and water resources. It also sought to halt the problematic situation of creating new roads for timber sales, whose proceeds would address a small fraction of an $8.4 million backlog in maintenance costs for 386,000 miles of existing roads.

The George W. Bush administration put the Roadless Area Rule on hold, passing decision-making authority back to local forest managers. In the wake of large wildfires in the early 2000s, the administration also promoted the 2003 Healthy Forests Restoration Act, which called for renewed increases in logging levels in order to reduce fuel for wildfires, applying to the entire national forest system. Because much of the timber is small diameter with little commercial value, the act encourages the inclusion of larger, more commercially valuable trees within restoration timber sales to help defray the costs. Critics see this as evidence of the continued priority of timber production.

SEE ALSO: Forest Organic Act; Forest Management; Forest Transition Thesis; Forests.

BIBLIOGRAPHY. J.N. Clarke and D.C. McCool, *Staking Out the Terrain: Power and Performance Among Natural Resource Agencies* (SUNY Press, 1996); P.W. Hirt, *A Conspiracy of Optimism: Management of the National Forests Since World War Two* (University of Nebraska Press, 1994); K.A. Kohm and J.F. Franklin, eds., *Creating a Forestry for the 21st Century* (Island Press, 1997); R.A. Sedjo, ed., *A Vision for the U.S. Forest Service: Goals for Its Next Century* (Resources for the Future, 2000); H.K. Steen, *The Forest Service: A History* (University of Washington Press, 1976).

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Forest Transition Thesis

THE FOREST TRANSITION thesis suggests that as countries undergo a process of social and economic development, forest cover follows a u-shaped curve. At first, deforestation is rapid; but as the country develops, deforestation slows and finally reverses. The theory is of great interest because it suggests that one way out of the current biodiversity crisis of deforestation—which is often blamed on economic development—is to encourage more economic development. Since growing forests take carbon dioxide out of the atmosphere, the theory is also of interest in debates about the role of forest recovery in national carbon budgets and global warming policy.

The forest transition thesis was developed to explain historical forest cover trends in developed countries like the United States, Portugal, Denmark, Japan, and South Korea. In the United States, for example, the northeast and southeast are much more forested now than they were 100 years ago. Working with contemporary cross-national datasets, some analysts also find associations between development indicators and forest recovery rates; more developed countries have lower deforestation rates.

The theory holds that modernization brought about increased agricultural productivity, while industrialization brought improved urban labor opportunities; together, these changes transformed rural landscapes. Already-deforested regions with large expanses of arable and irrigable lands responded to mechanization and chemical inputs. In areas where topography, soils, and water constraints limited the application of new agricultural technologies, however, farming became increasingly marginal, especially as productivity gains in prime agricultural areas drove down prices and decreased the competitiveness of small-scale agriculture in the marginal areas. Meanwhile, industries and employment concentrated in the cities. As a result, rural households in marginal areas abandoned their small farms and sought a better life in the city. Forests regenerated on abandoned fields, and national forest cover increased.

The forest transition thesis also holds that modernization changed the ways forests were valued, such that forest mining was replaced with sustainable forest management and protection. Possible catalysts for this change included the substitution of fossil fuels and alternative energy for firewood, changes in attitude about the recreational and conservation values of forests, and improved forest management technologies. The most important mechanisms, however, were probably related to institutional change. As wood and forested lands became scarce, their value to society also increased. Governments passed laws, established protected forest areas, and funded forest protection bureaucracies, and landowners also began to plant trees and protect woodlands.

UNDERDEVELOPED VS. DEVELOPED

A central issue for forest transition theory in the current context of tropical deforestation and biodiversity loss, however, is whether forest transitions observed in developed countries reflect the situation in developing countries. With its emphasis on a seemingly unilinear, homogenous, and poorly defined process called "development," the forest transition thesis assumes that the future of "underdeveloped" countries will emulate the history of "developed" ones.

Several researchers argue that if there are tropical forest transitions in developing countries now, they will be significantly different from those observed in developed countries. They notice significant differences in current urbanization and industrialization patterns from those that took place historically, and place those changes in a context of globalization and an international political economy of agriculture that is also very different. The increasing internationalization of agriculture, for example, discourages small farmers from local markets. Meanwhile, migration patterns sometimes permit the maintenance of rural populations through remittances. Although opportunities for forest recovery and conservation probably exist in areas where current technology and international agricultural policy make farming marginal, these opportunities must be sought in the context of national and local institutional changes; they do not derive automatically from a process of national economic development.

SEE ALSO: Deforestation; Forests; Reforestation.

BIBLIOGRAPHY. Alan Grainger, "The Forest Transition: An Alternative Approach," *Area* (v.27, 1995);

D. Klooster, "Regional Forest Transitions in Highland Mexico? The Importance of Local Institutions in a Globalized Countryside," *Professional Geographer* (v.55, 2003); Thomas K. Rudel, Diane Bates, and Rafael Machinguiashi, "A Tropical Forest Transition? Agricultural Change, Out-Migration, and Secondary Forests in the Ecuadorian Amazon," *Annals of the Association of American Geographers* (v.92, 2002).

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Fortress Conservation

FORTRESS CONSERVATION IS a conservation model based on the belief that biodiversity protection is best achieved by creating protected areas where ecosystems can function in isolation from human disturbance. Fortress, or protectionist, conservation assumes that local people use natural resources in irrational and destructive ways, and as a result cause biodiversity loss and environmental degradation.

Protected areas following the fortress model can be characterized by three principles: local people dependent on the natural resource base are excluded; enforcement is implemented by park rangers patrolling the boundaries, using a "fines and fences" approach to ensure compliance; and only tourism, safari hunting, and scientific research are considered as appropriate uses within protected areas. Because local people are labeled as criminals, poachers, and squatters on lands they have occupied for decades or centuries, they tend to be antagonistic toward fortress-style conservation initiatives and less likely to support the conservation goals.

A vocal supporter of fortress or protectionist conservation is John Terborgh, a tropical ecologist. He asserts that when needs of humans are weighed against needs of the natural world, nature always loses. He warns that the urgency of biodiversity conservation requires protection of species-rich areas by whatever means necessary, even if this requires suspending all economic activity in and around protected areas.

Many social scientists, such as geographer Roderick Neumann, argue that conservationists' ideal of what "natural" landscapes "ought" to look like imparts heavy social consequences. It has facilitated the eviction and disempowerment of local people whose livelihood practices created the "natural" landscapes that conservationists seek to protect. This critique of fortress conservation points to the lack of scientific evidence to support conservation based on a separation of humans from nature. Drawing on nonequilibrium (or disequilibrium) ecological theory and recent advances in environmental history and anthropology, researchers have demonstrated that human interactions with the environment can play a valuable role in managing and maintaining biodiversity. James Fairhead and Melissa Leach challenge the contention long held by colonial and postcolonial scientists that the African savanna-rangeland's extensive climax forest has been reduced to savanna as a result of human mismanagement. They demonstrate that current islands of forest were in fact created by human settlement in a once vast savanna. Their analysis reverses the traditional understanding of the direction of environmental change in that region.

In his book *Fortress Conservation: The Preservation of the Mkomazi Game Reserve, Tanzania* (2002), Dan Brockington critiques the protectionist conservation model, yet laments that fortress conservation will continue to be widely used despite its failure to adequately protect biodiversity. He argues that the alternative models of community-based conservation have been even less effective than the protectionist ones because it is nearly impossible that the benefits realized from conservation will ever offset the cost of being displaced from homelands; those who pay the costs are politically marginalized; and communities are comprised of many diverse interest groups, and their agendas may not coincide with conservation priorities.

Opponents to fortress conservation argue that conservation can only be successful if the needs of the local populations are taken into account. Alternatives to fortress conservation come in many forms, including extractive reserves, joint forest management, community-based conservation management, and integrated conservation and development projects. Community-based conservation models promote benefit sharing, which seeks to compensate local people for the resources they have given up by distributing income, employment, and other benefits from tourism. In other community-based conservation models, local people are contracted to manage part of their land for conservation goals, thereby ensuring that the financial benefits of conservation do reach the community most affected by conservation.

Central to the debate is the question of who gets to decide what resources are protected and in what manner. Supporters of protectionist conservation argue that scientific knowledge should be the primary measure of the need for conservation. Opponents of fortress conservation counter that it is time to diversify the voices that decide how to use and protect natural resources.

SEE ALSO: Biodiversity; Community-Based Conservation; Conservation; Disequilibrium; Ecosystems; Ecotourism; Equilibrium; Extractive Reserves; Indigenous Peoples; Livelihood.

BIBLIOGRAPHY. Dan Brockington, *Fortress Conservation: The Preservation of the Mkomazi Game Reserve, Tanzania* (Indiana University Press, 2002); James Fairhead and Melissa Leach, *Misreading the African Landscape* (Cambridge University Press, 1996); Katherine Homewood, "Policy, Environment and Development in African Rangelands," *Environmental and Science Policy* 7 (2004); Roderick Neumann, *Making Political Ecology* (Hodder Education, 2005); Nancy Peluso, "Coercing Conservation: The Politics of Resources Control," *Global Environmental Change* (v.3/2, 1993); John Terborgh, *Requiem for Nature* (Island Press, 1999).

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Fossey, Dian (1932–85)

DIAN FOSSEY (1932–85) was born on January 16, 1932 in San Francisco, California. After a brief career in occupational therapy, Fossey pursued an interest in researching mountain gorillas (*Gorilla gorilla beringe*) in Africa. During the course of two decades, Fossey became one of the world's foremost primatologists specializing in gorilla behavior. Fossey's interest in gorillas was initially inspired by reading *The Mountain Gorilla* (1963) by zoologist George Schaller, and then during a safari to Africa that same year when she met the renowned paleoanthropologist Dr. Louis Leakey.

Dian Fossey lived in Rwanda for nearly 18 years among gorillas, eventually earning their complete trust.

Three years later, Fossey met again with Leakey, and he urged Fossey to follow through on her desire to study gorillas, telling her that long-term studies of the great apes were key to understanding their behavior. With funds that she has raised, as well as additional financial support from Leakey, Fossey returned to Africa in 1966. Fossey first visited Jane Goodall (who was conducting research on chimpanzees) to learn about her research methods, and then made her way to the Democratic Republic of Congo to begin observing mountain gorillas. However, difficult relations between Fossey and local authorities, as well as political unrest, led her to move her study site a few kilometers to the Rwandan side of the Parc des Volcans, a mountain reserve straddling the Congolese, Ugandan, and Rwandan borders.

Once settled in Rwanda, Fossey established the Karisoke Research Center in the Virunga Mountains. Fossey lived at Karisoke for nearly 18 years among the gorillas, eventually earning their complete trust by developing techniques to imitate gorilla behavior. Fossey discovered and publicized the peaceful nature and nurturing family relationships of the gorillas. The research center also brought in other scientists to study different aspects of gorilla biology. Fossey was a proponent of "active conservation," which involved the establishment of anti-poaching patrols in an attempt to stop the capture and slaying of gorillas, as well as the preservation of their natural habitat. Fossey preferred this active approach to "theoretical conservation," which included the promotion of tourism and gorilla capture for zoos, both of which she opposed.

FATAL DEDICATION

In January 1970 National Geographic published an article by Fossey about her work with the gorillas. The article's description of her favorite gorilla, Digit, as well as the explanations of the poaching problem, accompanied by a cover photo of Fossey with the gorillas, encouraged a large number of donations from readers. With this money Fossey established the Digit Fund and dedicated her life to saving the gorillas. Also in 1970, Fossey left Karisoke to pursue a doctoral degree in zoology from Cambridge University in England. Her dissertation summarized her work to date with gorillas. Upon completing her degree in 1974, Fossey returned to Africa and took on research volunteers, who extended her work.

On January 1, 1978 Fossey discovered that poachers had killed Digit, which sparked her high-profile campaign against gorilla poaching. In 1980 Fossey returned to the United States, where she taught briefly at Cornell University and also began writing her book *Gorillas in the Mist*, a popularized version of her research work. This book was published in 1983 and eventually made into a movie by Warner Brothers Pictures in 1988. Saying she preferred gorillas to people, Fossey returned to Karisoke to continue her gorilla research, as well as to her anti-poaching activities.

On December 26, 1985, Fossey's body was found in her cabin at the research center. The circumstances of her murder were never solved; however, local authorities believed poachers who were at odds with her anti-poaching efforts murdered Fossey. Another theory, by Farley Mowat, is that Fossey was murdered by somebody who viewed her "active" conservation efforts as an impediment to the potential financial gains to be made through tourists visiting the gorillas. Fossey's work contributed greatly to human understanding of gorilla behavior and their relationship to humans, as well as the threats to their existence. Today, the Dian Fossey Gorilla Fund (formerly the Digit Fund) is continuing to support ongoing efforts to protect gorillas. The government of Rwanda and numerous international organizations are also engaged in protecting the mountain gorillas of Africa.

SEE ALSO: Goodall, Jane; Primates; Primatology.

BIBLIOGRAPHY. Camilla de la Bedoyere, *No One Loved Gorillas More* (National Geographic (US) and Palazzo Editions, 2005); Dian Fossey, "Making Friends With Mountain Gorillas," *National Geographic* (January 1970); Dian Fossey, *Gorillas in the Mist* (Houghton and Mifflin Company, 1983); Farley Mowat, *Woman in the Mists: The Story of Dian Fossey and the Mountain Gorillas of Africa* (Warner Books, 1987).

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Fossil Fuels

FOSSIL FUELS, DERIVING their name from the ancient remains of organic matter from which they are formed, represent the major energy source in the world today. A nonrenewable resource, fossil fuels exist in finite amounts in the earth's crust. The most widely extracted and economically viable fossil fuels are coal, petroleum (crude oil), and natural gas. All fossil fuels began as living plants and cellular animals; petroleum as microscopic plants and bacteria, natural gas as plankton and algae, and coal as more dense and fibrous trees and ferns. When these living organisms died, they settled to the bottom of the seas (in the case of oil and natural gas) and swamps (in the case of coal). Over many millions of years, layers of sedimentary material settled above this organic material. As the immense weight of the above-lying sediments increased over time, the resulting pressure and heat transformed the organic source materials into hydrocarbons. These hydrocarbons, forming the basis of all fossil fuels, have a molecular structure made up of mainly carbon and hydrogen.

Today, the vast majority of the world's energy comes from burning hydrocarbon-based fossil fuels. In the United States, for example, 85 percent of consumed energy comes from fossil fuels. Throughout the world, coal, oil and petroleum-based products (like gasoline and jet fuel), and natural gas provide the energy that powers agricultural and industrial production, modes of transportation, and electricity generation enabling lighting, heating, and cooling of homes and businesses.

COAL—POWERFUL AND POLLUTING

Of the fossil fuels, coal may have the longest history of human use as energy. Experts believe that as early as 3,000 years ago, coal was used to smelt copper in northeastern China. Coal's role as an energy supply grew as a source of power during the Industrial Revolution in England. When the mechanization and industrial technologies spread to the United States, the resulting second wave of the Industrial Revolution was powered by Appalachian coal. The advent of steam-powered ships and locomotives utilized coal to fuel steam boilers. By the late 19th century, coal was baked to produce coke, a vital fuel for the iron and steel industries.

Today, coal is widely used to generate electricity, to power industry, and to produce steel. Coal is mined through surface mining and deep underground mines. Coal is mined in over 50 countries—with China the top producer—followed by the United States, India, Australia, and South Africa. The largest reserves of coal in the world are found in the United States, followed by Russia, China, India, and Australia. Coal is used as an energy source in over 70 countries. The largest coal consumer in the world is China, followed by the United States, India, South Africa, and Japan. With a relatively high sulfur content, coal is the dirtiest and most polluting of all the fossil fuels.

NATURAL GAS—CLEAN AND SIMPLE

In contrast to coal, natural gas is the cleanest and least polluting of the fossil fuels. The use of natural gas as a fuel energy is a relatively recent phenomenon. In ancient times, the seepage of natural gas from the earth's crust, ignited by a bolt of lightning, would produce a burning flame originating in the ground. Ancient civilizations marveled at these wonders, and these "eternal flames" featured prominently in the ancient religions of Persia and India. England became the first country to economically exploit coal-produced gas, which illuminated streets and homes. In the United States, the commercial extraction of natural gas (not derived from coal) began in 1859 near Titusville, Pennsylvania. In what also sparked the beginning of the U.S. petroleum industry, Colonel Edwin Drake, using a derrick and drill, struck oil and natural gas nearly 70 feet below the Earth's surface. During this time, natural gas was used primarily for illumination. The 1885 invention of the Bunsen burner enabled natural gas to also be used safely for cooking and heating. Today, energy derived from natural gas is widely used to heat and cool homes, as well as to power cooking stoves and portable heating units.

Natural gas is primarily methane, the simplest of the hydrocarbon molecules with one atom of carbon and four atoms of hydrogen. The refining process also extracts ethane, propane, butane, and related condensates. Given its many uses, natural gas is an important natural resource. The global supply is relatively localized, with Russia having the largest proved reserves in the world. Other world leaders in natural gas proved reserves include Iran, Qatar, Saudi Arabia, and United Arab Emirates. The world's largest natural gas exporters are Russia, Canada, Algeria, Norway, and the Netherlands. As with oil, the United States is the world's largest consumer of natural gas. Other major consumers include Russia, Germany, the United Kingdom, and Japan. As with all fossil fuels, the burning of natural gas releases carbon dioxide, the leading greenhouse gas, into the atmosphere. In addition, methane itself is a green house gas, even more effective in trapping heat than is carbon dioxide.

PETROLEUM—CRUDE AND PURSUED

Petroleum, or crude oil, represents the most important energy resource in the world today. Early nonenergy uses included skin salve and other medicinal purposes, paint, and waterproofing for baskets and boats. Colonel Drake's successful strike of petroleum and natural gas in 1859 ushered in the oil industry in the United States. Henry Ford's invention of the automobile opened up a large new market for petroleum. Two World Wars solidified oil's geopolitical importance for fuel-powered ships, planes, tanks, and troop transports. As the post-war demand for oil increased, the 1970s OPEC oil embargoes revealed the vulnerability, particularly in the United States, to Middle East oil. Throughout the world, petroleum powers industry, global trade, and transportation systems, as well as providing the fuel and fertilizer for agricultural production and foundation for many consumer products. The world's current and future supply of oil is concentrated in the Middle East, with Saudi Arabia being the largest oil supplier. The largest proved reserves in the world are located in Saudi Arabia, Canada, Iran, Iraq, and the United Arab Emirates. Saudi Arabia again leads the world in oil production, followed by Russia, the United States, Iran, and Mexico. The top oil exporters in the world are Saudi Arabia, Russia, Norway, the United Arab Emirates, and Iran. The United States is by far the largest consumer of oil in the world. Other top consumers, though far below the United States, include Japan, China, Germany, and Russia.

BURNING ISSUE: ENVIRONMENTAL COSTS

The tremendous societal benefits derived from the burning of fossil fuels have come at a significant cost to the Earth's natural environment, although the total nature and extent of this cost is not completely understood. Burning fossil fuels in factories, automobiles, and power stations releases such compounds as carbon dioxide, nitrous oxide, and sulfur dioxide into the atmosphere. The world's rapid industrialization and population growth through the 20th century, and into the 21st century, has drastically increased the amount of these substances in the atmosphere. Carbon dioxide, for example, is thought to be the main cause of the anthropogenic (human-caused) greenhouse effect, the accumulation of greenhouse gasses which trap and re-radiate heat within the earth's atmosphere. The resulting temperature increases (global warming) may lead to climate changes, polar ice melting, sea level rise, and the disruption of the earth's ecosystems. Another major environmental problem linked to the burning of fossil fuels is acid precipitation in the form of acid rain and acid fog. Sulfur dioxide and nitrous oxide, released by burning fossil fuels, enter the atmosphere and react with water vapor to produce acids. These acids are re-deposited on earth in the form of precipitation, harming many of the earth's ecosystems. Oil tanker spills, air pollution, smog, and the defacing of the earth by coal strip mines represent additional environmental problems linked to the production and consumption of fossil fuels.

SEE ALSO: Carbon Dioxide; Global Warming; Energy.

BIBLIOGRAPHY. Robert Belgrave, "The Uncertainty of Energy Supplies in a Geopolitical Perspective," *International Affairs* (v.61, 1985); Daniel Glick, "The Big Thaw," *National Geographic* (v.206. 2004); Kevin Krajick, "Long-Term Data Show Lingering Effects from Acid Rain," *Science* (v.292, 2001); Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (Free Press, 1991).

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Framework Convention on Climate Change (FCCC)

THE FRAMEWORK CONVENTION on Climate Change (FCCC), which became effective in 1994, is a voluntary and nonbinding declaration of standards, goals, and objectives that represents international cooperation to reduce human-made greenhouse gas emissions that contribute to climate change (known also as "anthropogenic emissions"). This convention—modeled after the Vienna Convention on Protection of the Ozone Layer—established a general framework for emissions reductions.

The text begins with a series of declarations. The first states that "Parties" (participating countries) in the FCCC, "Acknowledge that change in the Earth's climate and its adverse effects are a common concern of humankind." The FCCC document is comprised of 26 Articles, ranging in issues from defining terms to the financial mechanism to requirements for the entry of the FCCC into force.

The objective of the framework is found in Article 2, which requires parties to "achieve stabilization of the greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." This Article is intended to be the standard by which the parties' commitments under the climate regime are measured. It also states that "stabilization" should be pursued in an appropriate time frame for "ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Articles 4, 10, and 12 address more specific commitments of the parties, based on "common but differentiated responsibilities." Article 4(2) of the FCCC text distinguishes between three groupings of parties to the convention, based on present levels of industrialization: Annex I Parties (all industrialized countries), Annex II Parties (all industrialized countries except those of the former Soviet bloc in the process of economic transition to market economies), and all Parties (including developing countries). Furthermore, Article 4(2)b notes that the aim for the Annex I countries is to return to 1990 levels of anthropogenic emissions. Articles 10 and 12 outline the rules by which Annex I Parties must "adopt national policies and take corresponding measures on the mitigation of climate change, by limiting anthropogenic emissions of greenhouse gases and protecting and enhancing greenhouse gas sinks and reservoirs." Moreover, Article 4 (3-5) notes that developed countries shall assist developing countries in reaching anthropogenic emissions reductions goals through technology transfer as well as various forms of financial assistance.

The text of the convention was adopted at the United Nations (UN) Headquarters in New York on May 9, 1992. It was then opened for signature by leaders at the June 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil, a conference commonly referred to as the Rio Conference or Earth Summit. Overall, 154 countries signed the FCCC. The United States, led by President George H.W. Bush, was one of the signatories, and the U.S. Senate ratified it on October 15, 1992. The FCCC entered into force on March 21, 1994.

The entry into force of the FCCC set forth future Conference of Parties (COPs) meetings to delineate more specifics of the treaty. Most prominent is the third conference of parties (COP3) that took place in Kyoto, Japan, and produced the Kyoto Protocol. This protocol outlines more specific targets and timetables for Annex I/II Parties to reduce anthropogenic greenhouse gas emissions. To date, the Kyoto Protocol has been signed by 140 countries, and, despite U.S. nonratification, entered into force in February of 2005.

SCRUTINY OF THE FCCC

The FCCC has endured much scrutiny. First, critics charge that the few specific obligations to curb anthropogenic climate change have allowed for considerable discretion in application. Second, the proposed emissions reductions are deemed to be merely symbolic as they do not significantly mitigate greenhouse gas emissions. Third, legacies of colonialism shaping contemporary inequality and associated levels of greenhouse gas emissions are underemphasized in this FCCC country-level emissions reductions approach, and rhetorical acknowledgments (such as the Berlin Mandate in 1995) have proven insufficient. Fourth, since the entry into force of the FCCC, there has been increasingly politicized discussion and debate over the precise meaning behind the statement in Article 2. Contestation has centered on what level of greenhouse gas concentrations constitutes "dangerous anthropogenic interference." Many climate scientists assert that this threshold has already been surpassed. For instance, as of 2006, atmospheric carbon dioxide concentrations have risen to approximately 381 parts per million (ppm), marking a 36 percent increase in emissions from preindustrial levels of approximately 280 ppm, and a level not reached in the last 650,000 years. However, proponents counter that this approach is a productive first step that encourages parties to be involved in the process, before then potentially signing on to binding agreements that follow.

SEE ALSO: Carbon Dioxide; Global Warming; Greenhouse Gases; Kyoto Protocol; United Nations Conference on Environment and Development.

BIBLIOGRAPHY: Michael H. Glantz, *Climate Affairs: A Primer* (Island Press, 2003); David Hunter, James Salzman, and Durwood Zaelke, *International Environmental Law and Policy* (Foundation Press, 2001); Jeremy Leggett, *The Carbon War: Global Warming and the End of the Oil Era* (Routledge, 2001); Jane Roberts, *Environmental Policy* (Routledge, 2004).

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France

FRANCE IS THE largest country of Western Europe (211,208 square miles, including the island of Corsica, in the Mediterranean) and one of the most populated (around 60 million people in 2006). Most of the physiography of continental France is dominated by plains and gentle rolling hills, occasionally altered by higher elevations in the central part (Massif Central) and especially in the south (Pyrenees) and the East (Jura and the Alps, where Mont Blanc, at 15,766 feet is the highest peak of the country and of Europe. Climate is generally mild in summer and cool in winter except in the Mediterranean, where it may be quite warm in summer, and in the mountains where cooler conditions predominate.

The main environmental challenges faced by France concern agricultural land use and food security; waste management (including nuclear waste); the growing impacts of energy use, transportation and urbanization; and the need to limit carbon dioxide emissions. With more than 44 million acres, France still has the largest agricultural area of Western Europe. Arable land and pastures, however, are being lost to forests (5 percent expansion between 1992 and 2002) and especially to urbanization (15 percent increase in the same period). In the first decade of the 21st century, the largest population and urban growth rates are being recorded in southern cities such as Perpignan, Narbonne, Montpellier, and Nimes, chosen by a growing number of French people to retire. Sprawl is becoming very common in these cities, and the metropolitan area of Paris is considered the most sprawled urban area of the world.

About 11 percent of the country enjoys some degree of environmental protection. France has about 1,200 protected areas (24 of them in excess of 247,109 acres) and 10 biosphere reserves. In 2006, new legislation was passed to enhance the protection of natural areas with a special emphasis on marine reserves.

Because of the importance of agriculture and the need to preserve the rural landscape, several policies have been implemented in order to contain agricultural decline. The so-called Contracts Territorials d'Exploitation (land use and production contracts) in force since 1999 are addressed to remunerate the various functions performed by agriculture, not just food production, but landscape conservation as well. Agriculture, however, still contributes substantially to water (especially groundwater) pollution. Nearly 30 percent of surface waters have bad or very bad quality levels according to European standards because of high nitrate concentrations, and about one-fifth of the French population drinks water with pesticide residues above the recommended levels of the European Union (EU). In the intensive hog raising areas of Brittany in northwest France, nitrate concentrations often exceed the 50 milligram/liter mark established by the EU. In 2001, the European Comission ruled against France for failing to comply with the Nitrates Directive.

Air pollution remains an important problem in most French cities, especially in Marseilles, Dijon, Montpellier, Lyon, and Paris. Technological improvements such as catalyzers have reduced carbon monoxide emissions by 30 percent and nitrogen dioxides by 10 percent during the 1990s. Nevertheless, increases in mobility, time traveled, diesel vehicles, air conditioning, and private transportation by truck have tended to offset these gains. Hence, some cities are pursuing policies to limit private transportation by car. The Paris City Council, for instance, has multiplied the logistic obstacles for private transportation in the downtown areas, and since 2002 it has added 12 miles of tramway lanes and increased the number of bike routes by 47 percent. Partially as a result of these policies, car transportation decreased by 14 percent between 2001 and 2005. The decline in coal mining and heavy manufacturing in the eastern regions has eased the acid rain problem that used to be very acute in Alsace and Lorraine.

Industrial hazards, however, persist and become more dangerous as urbanization progresses into formerly segregated dangerous activities. In September 2001, an explosion in a ammonium nitrate factory in Toulouse caused 30 deaths and extensive damage in nearby areas. This accident, together with the impact of natural hazards such as the heat wave of 2003 (responsible for as many as 30,000 deaths, especially among the elderly) and the numerous flooding problems of the Mediterranean rivers prompted the law on Risk Prevention and Mitigation of 2003.

France has 58 nuclear power plants (second in the world after the United States), which provide around 75 percent of all electricity generated in the country. While the dependency on fossil fuels is thus reduced, the country has not made substantial efforts in the development of alternative energy sources. While nuclear power is generally acceptanced by the French public, the country still fears that it will be unable to meet the reduction in carbon dioxide emissions (54 million tons by 2010) targeted in the Kyoto Protocol. To date, how to solve the issue of nuclear waste is still being debated.

Several French companies such as Suez-Lyonnaise-des-Eaux and Vivendi Environnement rank among the most important in the world in the provision of environmental goods and services. Both companies maintain leadership positions in urban water supply and wastewater management of cities in the United States, Spain, Germany, Japan, and Latin America.

SEE ALSO: Biosphere Reserves; Pollution, Air; Pollution, Water; Urban Sprawl; Urbanization, Waste, Nuclear.

BIBLIOGRAPHY. Michael D. Bess, *Light-Green Society: Ecology and Technological Modernity in France, 1960-2000* (University of Chicago Press, 2003); Miles O. Hayes, *Black Tides* (University of Texas Press, 2000); Eric Montpetitl, *Misplaced Distrust: Policy Networks and the Environment in France, the United States, and Canada* (University of British Columbia Press, 2003).

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Pont du Gard Aqueduct

The Pont du Gard Aqueduct was added to UNESCO's list of World Heritage Sites in 1985 and is one of France's major tourist attractions, with about one-and-a-half million visitors each year.

The aqueduct was built in the middle of the first century C.E., with the work attributed to Marcis Vipsanius Agrippa, the son-in-law of the Emperor Augustus. It carried water from springs near Uzes to the Roman city of Nemausus (present-day Nîmes). With a gradient of 1/3,000, it was capable of delivering 44 million gallons of water daily. The stones in the aqueduct were held together with iron clamps—no mortar was used in the design. A massive scaffold was used in the building of it and it is thought to have taken between 800–1,000 men about three years.

In the 4th century the aqueduct started to fill with deposits of stones and soil, and was not properly cleaned. By the 9th century there was no water coming from it and people started plundering the stone for constructing houses and farm buildings. It also started to be used as a bridge for people crossing the River Gard. Some pillars were narrowed to make this task easier, but in 1702 they were enlarged for safety. In 1743 a new bridge was built at a lower level, with the aqueduct being restored in the mid-18th century by which time it had become a major tourist attraction. The aqueduct survived the flooding of the region in 1998 and a massive project to develop the area and preserve the aqueduct commenced soon afterward.

Fuji, Mount

MOUNT FUJI IS Japan's tallest and most sacred mountain, and is also known as Fujiyama, Fuji-Yo-Nama and Fujisan. At 12,388 feet, Fuji is a cone-shaped volcanic mountain located on the Island of Honshu—the largest of four major islands of Japan—and eminently stands 70 miles west of Tokyo. Geologists consider the volcano active, its last eruption occurring in 1707.

Fuji is one of the many active volcanoes that form what is popularly known as the Pacific "Ring of Fire." The earth's surface crust is divided into irregularly shaped "plates" of various sizes and thickness, which are constantly on the move. The source of this movement is found at divergent boundaries where hot viscous magma from the interior of the earth pushes its way to the surface through rifts along ocean floors. Here it cools and hardens to produce new crust while moving older crust and consequently lithospheric plates away from the divergent boundaries and each other. Along other boundaries, plates converge—crunching against, or sliding along or beneath one another. Most volcanic activity and mountain building, known as *orogenesis*, occurs along these boundaries. Mount Fuji, like many other volcanoes along the "ring," formed at a convergent boundary where lighter, less dense crust of the Pacific–oceanic plate slides below the Eurasian–continental plate. As it does, the plates fracture, and fissures channel magma to the surface of the earth where it spreads as lava. Legend has it that Fuji rose from to its present height in just one night. However, it has taken thousands of years of successive lava flows to create what many have called the perfect composite volcano.

SACRED LANDSCAPE

Mount Fuji is sacred landscape to both the Shinto and Buddhists religions. For the Buddhists, Fuji, with its snow-capped peak, resembles the white bud of the sacred Lotus flower whose petals symbolize the Noble Eight-Fold Path to enlightenment. For the Shinto, the ethnic religion of Japan, Fuji stands as a beautiful Goddess and Supreme Altar of the Sun. Climbing the volcano is a sacred ritual and is usually undertaken during the months of July and August. Prior to the Meiji Restoration of 1868, pilgrims donned white robes, and were male only. Today, pilgrims and foreign tourists of all kinds make the relatively easy climb to the ancient temples and shrines scattered in and along the edge of the crater—which has a 2,000 feet diameter—to greet the rising sun and beginning of divine day. Just beyond Fuji's base, which has a circumference of 65 miles, are lakes and foothills where summer and winter recreational opportunities abound. Tens of thousands visit the area annually yet, unfortunately, the effects on the mountain itself have been deleterious. Although ancient myth asserts that soil and stone rolling down from pilgrims' feet are magically repositioned on the mountain during the night, erosion from trail walking continues to scare its face. Discarded plastic wrappers and bottles and cigarette butts along the trails have led one to dub Fuji the "sacred rubbish dump." Considerable efforts are being made by the Japanese government to maintain Mount Fuji's reputation as one of the most beautiful landscapes in the world—from both near and far.

SEE ALSO: Japan; Mountains; Ring of Fire.

BIBLIOGRAPHY. Robert W. Christopherson, *Geosystems: An Introduction to Physical Geography* (Macmillan College Publishing Company, 1994); Anthony Huxley (ed.), *Standard Encyclopedia of the World's Mountains* (G. P. Putnam's Sons, 1962); Peter Yapp, ed., *The Travelers' Dictionary of Quotation* (Routledge, 1983).

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Fungi

FUNGI ARE HETEROTROPHIC, unicellular or multicellular microbes that colonize both living and nonliving habitats. Fungi belong to the Eukarya domain of life, and the estimated 1.5 million species of fungi may be classified into one of five major groups: Ascomycota, Basidiomycota, Zygomycota, Oomycota, and Deuteromycota. These groups are classified on the basis of cellularity (multicellular, unicellular, or clonal), type of hyphae (septate or coenocytic), reproductive strategy, habitat (aquatic versus terrestrial), and life form. All fungi contain chitin in their cell walls, and other chemical constituents of fungal cell walls are used to classify fungi for ecological, industrial, and biotechnological purposes. All fungi are chemoorganotrophs, meaning that they lack the chlorophyll necessary to produce their own food; instead, fungi excretes extracellular enzymes that break organic material into new, simpler compounds that can then be absorbed by the fungus and used as carbon and energy sources. Many fungal species have a filamentous life form embodied as hyphae; hyphae that branch, intertwine, and grow together as tufts in soil and under decaying mats of organic matter collectively constitute fungal mycelia. Some mycelial mats are easily observable with the naked eye, but other soil fungi require chemical stains and microscopes to observe. Fungi have various reproductive strategies; all groups except the *Deuteromycetes* have some sexual reproduction through spores, while fungal groups that reproduce asexually produce asexual spores called conidia. Fungi colonize new areas both by the extension of hyphae—which may extend several meters from the original mycelial mat—and by spore dispersal, often over great distances.

NATURE'S MORTICIANS

Fungi grow in very diverse habitats, including fresh and salt water; however, most fungi are terrestrial and are commonly found in soils and on dead organic matter. Soil fungi, especially the *Basidiomycetes*, are instrumental in the decomposition of organic matter into simpler carbon compounds. The decay fungi are especially effective at decomposing recalcitrant (i.e., difficult to decompose) plant compounds such as cellulose and lignin. Certain fungal species are also important in the mineralization of organic compounds into inorganic nutrients and minerals that are in turn used by plants and other soil organisms. Pathogenic fungi are responsible for the majority of agricultural diseases, and can reduce crop yields and kill plants in natural systems. Many fungal pathogens of crop and noncrop plant species such as the powdery mildews (Ascomycetes), rusts (Basidiomycetes), smuts (Basidiomycetes), and blights (Ascomycetes, *Oomycetes*) are often transmitted by windblown spores. The fungal species *Ophiostoma ulmi (syn. Ceratocystis ulmi)* and *Cryphonectria parasitica*, which cause the tree diseases Dutch elm disease and Chestnut blight, respectively, have seriously changed the species composition of deciduous forests in the United States.

Most people associate fungi with the button mushrooms commonly used in cooking, or can envision fungal brackets that colonize dead trees or logs. Many fungi also have broad, lesser-known commercial and biotechnological uses. Secondary metabolites of the Deuteromycete fungus *Penicillium chrysogenum* are used industrially to produce penicillin antibiotics, and fungal metabolites have many other important industrial and commercial

Fungi grow in diverse habitats, but most are terrestrial and are commonly found on soils and dead organic matter.

uses. Microscopic fungi also colonize the surfaces of rock either alone or in symbiotic association with algae or cyanobacteria, and in this way play a central role in the chemical weathering of rock into soil particles. Many people are not aware that the greatest fraction of biomass of any terrestrial fungus exists belowground as mycelia. A remarkable example of the below-ground expanse of soil fungi is a giant mycelial mat of the Basidiomycete *Armillaria ostoyae*, believed to be the single largest organism on earth. This single organism colonizes over 10 square kilometers of forest floor in northeast Oregon, and is believed to be between 2,000 and 8,500 years old!

SEE ALSO: Antibiotics; Decomposition; Hunter-Gatherers.

BIBLIOGRAPHY. N.C. Brady and R.R. Weil, *The Nature and Property of Soils* (Prentice Hall, 2002); T.D. Brock, M.T. Madigan, J.M. Martinko and J. Parker, *Biology of Microorganisms* (Prentice Hall Publishers, 1994). Orson K. Miller and Hope Miller, *North American Mushrooms: A Field Guide to Edible and Indedible Fungi* (Globe Pequot Press, 2006).

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Gabon

AFTER WINNING INDEPENDENCE from France in 1960, the Gabonese Republic entered a period of political stability marked by one-party rule. Thirty years later, a multiparty system was introduced and a new constitution was ratified. Drawing on its rich natural resources—including petroleum, natural gas, diamond, niobium, manganese, uranium, gold, timber, iron ore, and hydropower—and on financial backing from foreign investors, Gabon has become one of the most prosperous countries in Africa. Some 60 percent of the work force is engaged in agriculture, and timber and manganese were the mainstays of the economy until oil was discovered offshore in the early 1970s.

Currently, the oil industry accounts for half of the Gross Domestic Product. With a per capita income of $5,800, Gabon is ranked 124 of 232 nations in world incomes. Gabon's income level is four times greater than that of most Sub-Saharan African nations. Poverty levels have declined, but income disparity endures. Over one-fifth of Gabonese are unemployed. Gabon is ranked 123 of 232 countries on overall quality of life issues.

Bordering on the South Atlantic Ocean at the Equator, Gabon has a coastline of 885 kilometers in addition to 10,000 square kilometers of inland water sources. The Western African nation shares land borders with Cameroon, the Republic of the Congo, and Equatorial Guinea. The narrow coastal plains of Gabon give way to a hilly interior and savanna in the east and south. Elevations range from sea level to 1,575 meters at Mont Iboundji. The tropical climate is always hot and humid.

Despite its economic superiority over many of its neighbors, Gabon is subject to some of the same environmental health hazards that plague much of Sub-Saharan Africa. The Gabonese population of 1,400,900 experiences an HIV/AIDS prevalence rate of 8.1 percent. Some 48,000 Gabonese live with this disease, which had had killed 3,000 people by 2003. While 87 percent of the population has access to safe drinking water, less that half of rural residents can sustain that access. Only 36 percent of Gabonese have access to improved sanitation. Thus, the population suffers from a very high risk of contracting food and waterborne diseases, including bacterial diarrhea, hepatitis A, and typhoid fever and malaria, a vectorborne disease. As a result of high incidences of disease, the Gabonese experience low life expectancy (54.49 years) and growth rates (2.13 percent), and high infant mortality (54.51 deaths per 1,000 live births) and death rates (12.25

deaths per 1,000 population). Gabonese women produce an average of 4.74 children each. While almost three-fourths of adult males are literate, just over half of adult females are so classified.

Due to the of the prosperity derived from oil and mineral reserves, Gabon has been able to maintain most of its rain forest, protecting the rich biodiversity of the area. Approximately 85 percent of Gabon is forested. In 2002, the United States partnered with Gabon to extend protection of the Gabonese rain forest with a contribution of $75 million. The government created a national park system that covered ten percent of the land area using a plan drawn up by the New York-based Wildlife Conservation Society. With the creation of 13 new parks, Gabon's park system became the largest in the world.

Of 190 identified mammal species, 15 are endangered, as are five of 156 bird species.

In 2006, scientists at Yale University ranked Gabon 46th in the world in environmental performance, well above the relevant income and geographic groups. Although not low in comparison with most African nations, the lowest scores were in the areas of environmental health and biodiversity and habitat. Despite an urbanization rate of 83.7 percent, between 1980 and 2002, Gabon reduced the level of carbon dioxide emissions per capita metric ton from 8.9 to 2.6.

Under the auspice of the National Environmental Action Plan, supplemented by the National Strategic Plan for the Conservation of Biodiversity and the Plan of Action for National and Tropical Forests, the Ministry of Forestry and Environment has the responsibility for implementing environmental legislation and regulations and monitoring compliance. In addition to widespread efforts toward protecting the rain forest, the Gabonese government is working to improve the quality of drinking waster and secure access to improved sanitation for the entire population. Gabon participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Congo, Democratic Republic; Guinea.

Albert Schweitzer

Albert Schweitzer (1875–1965) was an accomplished Alsatian German philosopher and musician who decided to give up his comfortable lifestyle in Europe to become a missionary doctor at Lambaréné, Gabon, in French Equatorial Africa. In 1952 he received the Nobel Peace Prize for his efforts on behalf of The Brotherhood of Nations.

Schweitzer was born in Kaysersburg, Alsace, then a part of Germany, but now a part of France. His father was a Lutheran pastor and he studied philosophy and theology at the University of Strasbourg, gaining his doctorate in 1899. He then preached and also wrote his book *Von Reimarus zu Wrede* ("The Quest of the Historical Jesus") in 1906. This was globally acclaimed, and Schweitzer also became an organist in Strasbourg, keen on playing the work of J.S. Bach.

In 1905 Schweitzer announced that he had decided to become a missionary doctor and started studying medicine, becoming a medical doctor in 1913. He and his wife then went to Lambaréné in Gabon where, with the help of the local tribesmen, he built a hospital that he ran until his death, maintaining it initially with his own income; and later, helped by gifts from people and foundations all around the world.

After being detained as a German in World War I and released, Schweitzer carried on his work, also writing several philosophical works, the most famous being *Kulturphilosophie* ("Philosophy of Civilization," 1923). In 1924 he returned to Africa and started work on rebuilding the hospital, which had become derelict. He added a leper coloney soon afterwards. The hospital day began at 6:30 with a reveille bell, followed by regular mealtime, siesta, work, and curfew times.

By the 1960s, there were about 350 patients at the hospital, along with their relatives, and also 150 lepers, all served by local workers and 36 European doctors and nurses. Schweitzer continued to write on philosophy and theology in Lambaréné, and died there in 1965, aged 90.

BIBLIOGRAPHY. CIA, "Gabon," *World Factbook* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC–CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); UNDP, "Human Development Report: Gabon," www.hdr.undp.org (cited April 2006); World Bank, "Gabon," www.worldbank.org (cited April 2006).

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Gaia Hypothesis

THE GAIA HYPOTHESIS asserts that the earth is a single living organism with the power of self-regulation. It was the brainchild of James Lovelock and Lynn Margulis, who chose to name their theory Gaia after the Greek goddess of the earth. While the idea that the earth is alive and is the great mother to all life has very ancient roots, the idea has traditionally been regarded as a kind of metaphor for the connectedness of life, rather than scientifically demonstrable fact. However, Lovelock and Margulis employed scientific arguments in their claim that life on earth was part of a great cybernetic system with complex feedbacks, and that these, in turn, regulated the system keeping it operating within narrow bounds. They claimed that life (the biosphere) regulated the composition of the atmosphere and this regulated the temperature of the planet. Such self-regulation demonstrated that the earth was an organism like any other. Gaia initiated a debate in scientific circles that still continues. Gaia also attracted attention from the media, certain environmentalists, the clergy, and even religious mystics.

Lovelock's unique background led him to the Gaia Hypothesis. He was an independent scientist and inventor who had also worked for NASA on the *Viking* program, the first satellite to land successfully on the surface of the planet Mars. One of the objectives of the *Viking* mission was to test the surface for evidence of life. This led Lovelock to a strange conclusion—that it was not necessary to probe the surface of Mars to test for life. If life existed, it would alter the composition of the atmosphere. Since the relative proportions of the gasses in the Martian atmosphere had already been determined by traditional astronomical techniques, there was no need to send a probe to the surface to look for life. The composition of the atmosphere indicated that it was a lifeless planet. In dramatic contrast, the mixture of gasses comprising the earth's atmosphere revealed that it was a living world. The high proportion of oxygen, the by-product of photosynthesis, was perhaps the best indication of life.

Lovelock claimed that the earth regulated its temperature by regulating the composition of the atmosphere. For example, oxygen has a historical proportion of about 21 percent. If this value were much lower, perhaps 18 percent, combustion could not be sustained in most cases. If this value were much higher, perhaps 25 percent, then fires would burn wildly. The very fact that the mixture of gasses in the atmosphere had remained within very narrow bounds for eons was extremely unlikely, in fact impossible; and therefore, required some regulatory mechanism connected to life processes. In addition, the sheer volume of oxygen as a free gas made the earth's atmosphere unusual compared to the other inner planets of the solar system, and indicated a kind of chemical disequilibrium in which it was continually destroyed and created. Oxygen was inextricably connected to the forces of life, specifically photosynthesis. Such regulation of atmospheric composition was more evidence that the earth was operating as a single living organism. However, critics charged that this was not evidence of regulation at all, but simply the result of the planet's interacting living and geophysical systems.

One of the most difficult criticisms to refute was the charge that the Gaian system was teleological, that is, preordained. The dictionary definition of *teleological* is that it concerns the study of evidence of design in nature. Teleology is a doctrine that nature or natural processes are directed toward an end or shaped by a purpose. According to this reasoning, Gaia was teleological because the plants and living systems were programmed to regulate the earth system.

To answer some of the critics, Lovelock resorted to creating a computer model of an artificial planet called Daisyworld. It was a simple planet, which had only one life form, the daisy, which came in two varieties: one light and one dark. The relative proportion of each determined the albedo or reflectivity of the planet. Albedo is critical in determining the temperature, because sunlight reflected back out to space is lost to the system. Only the sunlight that is absorbed serves to heat the planet. Lovelock tried to show that such regulation of the planet's temperature through the regulation of albedo by living organisms (daisies) was simply the result of a living system interacting and modifying its geophysical environment. It did not require any forethought or planning by the living organisms, and, therefore, it was not teleology. For the most part, the critics remained unimpressed, claiming that the Daisyworld model only reflected the assumptions underlying its construction and its relation to the actual functioning of the earth system was minimal or nonexistent. Lovelock believed that the critics ignored the power of the Daisyworld model. Some of his supporters praised his efforts for their simplicity and elegance in clarifying basic regulating mechanisms on an earthlike planet. Ultimately, the Daisyworld model became the basis for the popular computer game, SIMEARTH.

The power of the Gaia Hypothesis reached well beyond its scientific origins. Throughout history, people from a variety of religious backgrounds have viewed the earth as the mother goddess of all life. Furthermore, the idea that the evolution of the earth prepared the perfect habitat for humankind had a powerful appeal. Lovelock, who had now provided a scientific basis for such beliefs, was stunned by the attention Gaia received from beyond the scientific community.

The Gaian theory called attention to the role of the biosphere in the complex geophysical relationships of planet earth. The physical systems of the earth and the biological systems of the earth evolved together, and each affects the other. Life is vastly more important to the earth system than simply a passenger on a pile of rocks. The issue of whether Gaia is simply a provocative metaphor or genuine cybernetic system will never be completely settled.

SEE ALSO: Biosphere; Disequilibrium; Equilibrium.

BIBLIOGRAPHY. James Kirchner, "The Gaia Hypothesis: Fact, Theory, and Wishful Thinking," *Climatic Change* (v.58, 2002); James Kirchner, "The Gaia Hypothesis: Conjectures and Refutations," *Climatic Change* (v.58, 2003); James Lovelock, *Gaia: A New Look at Life on Earth* (Oxford University Press, 1979); James Lovelock, *The Ages of Gaia* (W.W. Norton, 1988); Lynn Margulis and Gregory Hinkle, "The Biota and Gaia: 150 Years of Support for Environmental Sciences," in Stephen Schneider and Penelope Boston, eds., *Scientists on Gaia*, (MIT Press, 1991).

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Galápagos Islands

THE GALÁPAGOS ISLANDS (or *Archipiélago de Colón*) are located in the Pacific Ocean on the equator 600 miles (960 kilometers) west of South America. The archipelago is made up of 19 main islands with a total land area of 3,050 square miles (7,900 square kilometers), or slightly less than half the size of Hawaii. Geologically, the islands are a chain of volcanoes that have pushed up from the seafloor as the earth's crust moves over a stationary hotspot in the mantle. The Galápagos are one of the world's most volcanically active regions, and large basaltic lava flows can be seen. The climate is uncharacteristically dry for the tropics, with an average annual precipitation of 19 inches (500 millimeters).

The Galápagos Islands were discovered by the Spanish in 1535. (*Galápago* means saddle in Spanish, as the shells of the tortoises found on the islands resemble a type of saddle.) The islands were annexed by the country of Ecuador in 1832 and today are a province of that country. In the 1800s, the first permanent settlers arrived when the islands were used for whaling. During the World War II, the United States had an air base on Baltra Island. At various times, the islands were also used as a penal colony. Today, there are settlements on four of the islands, and the territory has a total population of 20,000 people. The largest town, with 8,000 people, is Puerto Ayora on Santa Cruz Island. In addition, 70,000 tourists visit the Galápagos each year.

The Galápagos is the most pristine and least-altered island chain left on earth. The archipelago retains 95 percent of its original species, many of which are endemic, or found nowhere else on the planet. They are home to the famous giant Galápagos tortoise, marine iguanas, finches, and flightless cormorants, as well as sea turtles, albatrosses, and boobies. The islands may be best known as the place where English naturalist Charles Darwin, sailing aboard the HMS *Beagle,* visited in 1835. Darwin's observations of the varied, unique, and harsh environments of the islands, and of how plants and animals rapidly adapted to them, contributed to his theory of evolution by natural selection.

In 1959, the Ecuadorian government created the Galápagos National Park, which encompasses 97 percent of the land area. In the same year, the Charles Darwin Foundation was established under the auspices of the United Nations. The foundation operates a research station, promotes environmental education, and works closely with the government on conservation. In 1978, UNESCO named the Galápagos a World Heritage site, and the islands were recognized as a biosphere reserve in 1984. In 1998, the Galápagos Marine Reserve was created, which encompasses 50,500 square miles (133,000 square kilometers) around the islands.

The three biggest threats to the Galápagos are introduced species, growth in the human population, and fishing. People have brought to the Galápagos, deliberately or accidentally, a range of nonnative species. Goats, feral pigs, cats, and rats are particularly damaging, as they denude the islands of vegetation and kill native wildlife. Hundreds of introduced plants also threaten the fragile ecosystem. A tortoise breeding program, eradication of introduced species, and habitat restoration are among the many ongoing conservation efforts. As the Galápagos gained a reputation as a tourist paradise, the human population grew from around 1,000 in 1960 to 20,000 today. Strict rules govern tourist activities. However, historically, the focus of the local population has been on resource extraction, with little concern for sustainability. The islands are home to 1,000 fishermen, and while commercial fishing is banned, small-scale fishing for reef fish, lobster, and sea cucumbers puts pressure on shoreline environments. Larger boats from the mainland frequently harvest shark fins illegally.

The Galápagos Islands are at a crossroads. The threats are grave and ecological degradation continues. Recent actions such as a quarantine inspection system and controlling immigration to the islands are positive. Ecoregion-based conservation planning is bringing together the government, private stakeholder groups, and international conservation organizations in search of a model for integrated long-term sustainable management. With decisive policies and effective conservation efforts, one of the world's magnificent natural areas can be saved.

The Galapagos retains 95 percent of its original species, such as marine iguanas, boobies, and sea turtles.

SEE ALSO: Biosphere Reserves; Ecosystems; Habitat Protection; Invasive Species; Overfishing; Species; Tourism; World Heritage Sites.

BIBLIOGRAPHY. R. Bensted-Smith, *A Bio-Diversity Vision for the Galápagos Islands* (Charles Darwin Foundation and World Wildlife Fund, 1999); Charles Darwin Foundation, homepage, www.darwinfoundation.org/ (cited June 2006); Michael H. Jackson, *Galápagos: A Natural History* (University of Calgary Press, 1993).

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Gambia

GAMBIA REFERS TO an African river as well as to the country that took its name from one of West Africa's important waterways. Surrounded on three sides by French-speaking Senegal, The Gambia's political borders enclose the lower half of a river that begins in the highlands of Guinea and cuts a swath through the country before emptying into the Atlantic. About the size of Connecticut, The Gambia is one of Africa's smallest nations. It is just 15 to 30 miles (24 to 48 kilometers) wide and less than 300 miles (483 kilometers) long. In this Lilliputian political entity, one is never far from the Gambia River, its most outstanding geographical feature.

Nearly 50 years before Columbus crossed the Atlantic, Portuguese sailors entered the Gambia River, making it part of the expanding Atlantic economy. For more than three centuries, slavers from diverse European nations operated along the Gambia River. The Portuguese, Dutch, French, British, and even a Baltic principality (Kurland) established trading posts to facilitate the slave trafficking. After the Atlantic slave trade ceased in the early 19th century, European nations took their spheres of interest and divided Africa into colonies. The Gambia became British in 1889; it achieved political independence in 1965.

More than 1.25 million people currently live in The Gambia (2004 estimate). About one-third of the population reside near the 36-mile (58-kilometer) coastal strip along the Atlantic. Three main ethnic groups comprise the country's population: the Mandinka (40 percent), the Fulani (19 percent), and the Wolof (15 percent). One of Africa' poorest countries, in a continent known for some of the most impoverished nations on the earth, most Gambians make their living from agriculture. The country's preeminent farmers are the Mandinka, and the environments shaped by the Gambia River profoundly influence the way they farm and the crops they grow. The river, its tributaries, and associated wetlands cover about one-quarter of the land surface; a slightly larger percentage comprises the plateau, where agricultural production takes place only with rainfall. Despite the country's low elevation, a variety of transitional environments are found between the plateau and river floodplains that draw moisture from diverse sources.

AGRICULTURE

The rural economy and livelihood depend on agricultural practices and crops that are adapted to the distinctive environments of the plateau and wetlands. This in turn influences the way rural households divide work between males and females. On the plateau, men grow the country's principal export crop, peanuts, in addition to millet, sorghum, and maize for food. These crops are adapted to the four-month rainy season (mid-June to mid-October). However, throughout this region of West Africa, the rainfall pattern (31–43 inches [79–109 centimeters]) is highly variable. It is often badly distributed within a year; one in every four years, precipitation is typically below normal. For this reason, the floodplains and swamps along the Gambia River are extremely important to rural well-being and survival. And it is women who farm them, for rice is traditionally a female crop.

Rice has been grown along the Gambian wetlands since antiquity. The initial species, native to Africa, is separate from Asian rice, which only replaced the lower-yielding African seed over the past half century. Since at least the period of the Atlantic slave trade, rice has been a woman's crop.

Women's farmwork in rural Gambia thus takes place in an entirely different ecological setting than that of their husbands. They grow rice and some vegetables in a variety of tidal and lowland swamps that receive water from the Gambia River, its tributaries, and the high water table of the lowlands. Even their agricultural calendar is different from that of their husbands. The wetlands enable cultivation many more months of the year than the plateau, which increases the number of months women farm. In a drought-prone environment, the wetlands are the key to food availability and survival. For this reason, since the 1960s they have received a great deal of attention by development planners.

INCREASING CROP YIELDS

Lying between 13 and 14 degrees latitude north of the equator, The Gambia like many other countries south of the Sahara experiences occasional droughts. Development assistance to the country and its neighbors has targeted the region's wetlands for pump-irrigation schemes. The goal is to extract available river water to irrigate a dry season crop. The harvests of two annual crops in the wetlands holds hope for increasing production of rice, the regional dietary staple. Some 10,000 acres (4,000 hectares) of wetlands now are developed to irrigation projects out of an estimated 60,000 acres (24,000 hectares) farmed with traditional swamp rice methods.

However, the irrigation technology has largely failed to create a sustainable form of agriculture. In part this is because the high price of diesel has made the operation of irrigation pumps extremely costly in a society where the average per capita income hovers around $450 annually. This also affects the price of fertilizer. The most productive rice varieties demand significant amounts of fertilizer, and in just 20 years its price has quadrupled. Fertilizers are now priced beyond the means of most rural producers. Inappropriate technology transfer also occurred amid misguided attempts of development planners to attract Gambian men to rice cultivation. They awarded the developed irrigated plots to women's husbands rather than to the traditional female growers. As a consequence, women became laborers on the very fields they previously managed and used for income generation. Conflict between men and women erupted frequently in the implementation of pump-irrigation schemes.

Fortunately, many lessons have been learned. Technologically sophisticated irrigation systems similar to those in California are not feasible for cash-strapped rural populations. New approaches to raising African food production now center on building upon the ecological knowledge already held by rural people in farming diverse environments. One of the crucial lessons of Gambian wetland development is the significance of women's work and environmental knowledge for raising food production. Any project that aims to improve food availability in rural West Africa now assumes that men and women often work separately, with different crops, and frequently in dissimilar environments.

The Gambia River still defines the country and its people. A river that flows through parched landscapes is being once more returned to its custodians, the female rice growers. Development assistance now helps them level the floodplains in order to restore the river's natural reach. In improving its tidal reach, the river now flows unimpeded across women's rice fields, as it seeks its outlet to the Atlantic.

SEE ALSO: Drought; Floodplains; Irrigation; Maize; Poverty; Rice; Riparian Areas; Wetlands.

BIBLIOGRAPHY. Alex Haley, *Roots: The Saga of an American Family* (Doubleday, 1976); Margaret Haswell, *The Nature of Poverty* (St. Martin's Press, 1975); Richard Peet and Michael Watts, eds., *Liberation Ecologies: Environment, Development, Social Movements* (Routledge, 2004); Richard Schroeder, *Shady Practices: Agroforestry and Gender Politics in The Gambia* (University of California Press, 1999); Donald R. Wright, *The World and a Very Small Place in Africa* (M.E. Sharp, 2004).

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Game Theory

GAME THEORY IS the application of applied mathematics and evolutionary theory to understanding people's strategies in maximizing benefits. Game theory began as a system for understanding card games with its first practical application to economics in the early 20th century. Several human behavioral sciences (psychology, sociology, and anthropology) use game theory to understand why individuals may be in conflict or cooperation given specific situations.

The two main representations of game theory are *normal*, which is sometimes referred to as *strategic*, and *extensive form* games. In the normal form game, each player has two strategies—cooperate or defect. If player one defects and player two cooperates, the defecting player's payoff (reward) is higher (e.g., $6) than the player who cooperates (e.g., $0). If both player one and two cooperate, they receive an equal payoff (e.g., $3). If both player one and two defect, they receive an equal payoff (e.g., $0). The players do not know what the others' actions will be before they make their own choice, thereby limiting their ability to cooperate by prior agreement with each other. Each play does not connect to the next.

The extensive form game is structurally similar to a normal form game, but instead tracks player choices over time, thereby enabling the assessment of more complex decision-making strategies. Extensive form games also enable players to make decisions based upon what choice the other player has made. For example, if one player decides to cooperate, the second player may then decide to cooperate (both players' payoff is $3) or defect (player two's payoff is $6 and player one's, $0). In addition, if both defect, they both receive no payoff. Since players make decisions based on previous choices, extensive form games make use of diagrams, often tree diagrams, to represent the order and outcomes of choices over time.

There are several variations of the normal and extensive form games. In a symmetric game variation, the payoffs are the same for both players. In an asymmetric game variation, the payoffs are different for each player and the strategy for each player to do well in the game is different. A game may be zero sum, in that the result of the game always equals zero because when one player has a positive payoff, the other takes a negative payoff. To explore the impact of games on decision making, one may also change the length of the game, number of players, and strategies available to the players.

In environmental anthropology, game theory has been widely used in studies of the Tragedy of the Commons. Robert Axelrod applied the normal form game—the prisoner's dilemma—to the Tragedy of the Commons. Axelrod and others are concerned with the problem of explaining why and how cooperation evolved without central authority. By being able to explain the evolution of cooperation, it can be determined how much, and in what capacity, cooperation may avert the Tragedy of the Commons. With this knowledge, viable solutions relying on realistic expectations of cooperation should result in conservation of common resources.

As important as explaining the evolution of cooperation is to commons management, what is essential is an understanding of how to maintain cooperation in a community, because only through such understanding can a program succeed. The stability of a cooperative strategy, as understood within a prisoner's dilemma game, depends on the ability of a dominant strategy to resist invasion by a free-riding strategy.

SEE ALSO: Prisoner's Dilemma; Tragedy of the Commons.

BIBLIOGRAPHY. Robert Axelrod, *The Complexity of Cooperation: Agent-Based Models of Competition and Collaboration* (Princeton University Press, 1997); Robert Axelrod, *The Evolution of Cooperation* (BasicBooks, 1984); Drew Fudenberg and Jean Tirole, *Game Theory* (MIT Press, 1991); John Maynard Smith, *Evolution and the Theory of Games* (Cambridge University Press, 1982).

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Ganges River

THE GANGES RIVER, 1,557 miles in length, flows eastward along the border separating the Himalayan complex and the flat expanse of the Indian subcontinent. Known to Hindus as the *Ganga*, the river is a source of water for human consumption, agriculture, and industry. The Ganges is worshipped in the Hindu religion as a goddess. People bathe in the waters of the Ganges to be cleansed of sins and to ensure salvation. It is believed that drinking water from the river with one's final breath will deliver the soul to heaven. The number of people living along the broad Ganges river valley approaches 300 million. The Ganges is perhaps the most polluted river on the planet. The volume of raw sewage spilled into the river is gigantic. In addition, a variety of industrial wastes find their way into the river. One in particular is especially damaging: the leather industry located near Kanpur emits large amounts of chromium into the river.

The Ganges Action Plan, initiated in 1985, was established to address serious pollution problems along the river. The program includes the building of a number of solid waste treatment plants along the river in an attempt to reduce the enormous amounts of sewage absorbed in the water. Hindu politicians have traditionally not been very active in support of the plan. Some environmentalists believe that progress is being made on this program. However, the enormity of the situation will require an energetic and sustained effort well into the future in order to significantly reduce the danger from the dumping of raw sewage.

The Ganges provides water for an extremely productive agricultural sector. A variety of crops are grown in the extensive fields along the river's course. An intricate network of canals was built over the years to direct the water to the rich soils of agricultural fields within the river valley. The river has been dammed at several sites for water management in the agricultural regions and for power generation. The hydroelectric generation plant at Farakka near the junction with the Hooghly River and close to the border with Bangladesh is an important source of power for a region containing millions of people. The Ganges empties into the Bay of Bengal and its alluvial deposits over the years have created a gigantic delta formation, the largest in the world. The delta is known as the Ganges-Brahmaputra Delta, a 220-mile wide expanse of alluvial deposits. Kolkata (formerly named Calcutta) is a major Indian seaport in the region.

The delta is highly populated with nearly 150 million people living in this precarious area. The delta is prone to flooding during the monsoon season in the spring when warm moist air from the Indian Ocean is diverted over the Indian subcontinent, bringing much-needed rainfall to awaiting agricultural fields. The rainfall is frequently excessive and flooding can occur. In 1970, an enormous cyclone hit the delta, resulting in the death of an estimated one million people. In 1998, flooding on the Ganges killed over 1,000 people and left over 30 million homeless. During that year of flooding the entire crop of rice, the main grain of the region, was completely lost.

The Ganges Delta lies within the wet tropical climate zone. As a consequence of this location the region receives between 60 and 100 inches of rainfall per year. The region is essentially alluvial plain only a few feet above sea level. The combination of high rainfall, flat land, and frequent cyclonic storms can bring flooding conditions with regularity. The region is especially vulnerable, as well, to possible increases in sea level resulting from global warming. Should this change occur in the future, the impact on the Ganges Delta would be potentially disastrous to its millions of inhabitants.

SEE ALSO: India; Indian Ocean; Rivers.

BIBLIOGRAPHY. Kelly D. Alley, *On the Banks of the Ganga: When Wastewater Meets a Sacred River* (University of Michigan Press, 2002); Stephen Alter, *Sacred Waters: A Pilgrimage up the Ganges to the Source of Hindu Culture* (Harcourt, 2001); Dennison Berwick, *A Walk Along the Ganges* (Century Hutchinson, 1986); Eric Newby, *Slowly Down the Ganges* (Lonely Planet Publications, 1998).

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Garbage

GARBAGE IS BOTH obvious and difficult to define. We know it when we see it, but how is it different from other objects? The technical definition of *garbage* is "the offal of an animal used for food," but it has also come to mean refuse in general. A more practical meaning would be that anything that has lost its usefulness and/or value is garbage. In this way, we also speak of garbage (and its siblings trash and rubbish) metaphorically—"Did you hear the garbage that candidate was saying," "Those basketball players were really trash-talking in the final game," "That book is pure rubbish." It would seem, then, that garbage is all around us. Despite its ubiquity, however, many aspects of garbage are poorly understood. The quantity of garbage produced by each person and each country has only been estimated. Collection and management of garbage differs by locality, and is therefore difficult to generalize. Further, the relationship between human beings, garbage, and the environment is a complex and little-understood one.

Addressing these issues is not any easier than defining garbage itself. No entity counts its garbage, per se. Some places, however, do keep track of the amount of solid waste they produce. If we use this as a stand-in for garbage production, we come to a better, yet very partial understanding of garbage dynamics. For example, consider the following. According to the Organization for Economic Cooperation and Development (OECD), municipal solid waste production among its member nations increased 14 percent between 1990 and 2000. There are, though, a number of problems with this statistic. First, not all countries use the same methods to measure their solid waste; many even use different definitions of solid waste to begin with. Second, many countries do not even keep or report statistics on waste. Even if we could solve these problems, we would still be left with the question of how representative the sample is; in other words, how well do the members of the OECD represent all of the countries in the world? The fact is that many of the members of the OECD are located in western Europe. The countries of North America (The United States, Mexico, and Canada) are also members. A few countries from Asia, Africa, Eastern Europe and Central and South America are included. Overall, though, the statistics from the OECD are based on a large group of (relatively) developed nations. So, what have we learned? It would appear that the amount of garbage (in this case as the proxy solid waste) increased significantly in the decade of the 1990s. But what is happening with the garbage production of all of the countries who are not part of this number?

GARBAGE MANAGEMENT

The truth is, we cannot really know, but we can make some assumptions. The amount of garbage each country produces is largely determined by the affluence of that country. Rich people and countries produce more garbage than poorer people and countries. On the face of it, then, it would appear that the less-developed countries of the world, many of whom are not part of the OECD, would produce less garbage than the more developed OECD countries. However, many countries of the world are developing quickly. This means that the rate of increase in garbage production in these areas (and therefore in the world) may be higher than the OECD claims. As garbage production increases around the globe, countries and citizens are faced with the questions of collection, treatment, and disposal. The model on which many countries base their garbage management is the system in the United States.

Garbage management depends on a number of factors. For many people, the most obvious of these include the availability of resources, the composition of garbage, and the level of technology. Just as important as these factors, however, are cultural norms about what constitutes garbage and appropriate technology for dealing with it; local, state, and national politics; and social habits of production, consumption, and environmental management. Thus, while the rest of this discussion focuses on garbage management in the United States, it cannot be assumed either that it would be the same in other places, or that the United States itself does not have its own cultural norms and social habits that shape its management of garbage.

The United States generates the most waste per capita (about 1,540 pounds/year) of any country in the world. It continues to produce more waste every year. In 1990 the country produced 247 million tons of nonhazardous waste, while in 2001 that number jumped to 409 million tons. This waste includes substantial amounts of paper and cardboard (40 percent), as well as yard waste (18 percent), metals (9 percent), plastic (8 percent) and other products. In the United States, it is still predominantly the city or county who is responsible for managing all that garbage, despite the recent trend toward privatization of such services. In the United States as a

Archaeologists of garbage argue that what a society throws away can reveal much about who they are.

whole, 64.1 percent of garbage is landfilled. There are regional differences in these statistics. For example, in New England only 36 percent of waste is landfilled while the rest is recycled or used in waste-to-energy facilities. On the other hand, in the Rocky Mountain region and the Midwest region, respectively 86 percent and 77 percent of waste is landfilled. The environmental impacts of such systems of waste management are much debated, but there is a general consensus that garbage contributes to air, water, and ground pollution.

NATURE-SOCIETY RELATIONSHIP

Garbologists, or archaeologists of garbage, argue that what we as a society throw away can tell us a lot about who we are. These researchers study the objects found in various locations from household waste receptacles to large municipal dumps. This garbage is then analyzed (weighed, measured, and identified) in order to address several broad themes, including social consumption practices and how they have changed over time, how these practices differ by location. The ability to understand particular people through their garbage is taken for granted in the cases of tabloid reporters and identity thieves who dig through VIPs' trash in hopes of a story or useable information. While the work of the garbologist is directed at a larger scale, the principle is much the same. Many archaeologists of garbage contribute to larger issues of waste management by helping policy makers better understand the waste stream.

In addition to analyzing the waste stream, there is also significant interest in the distribution of garbage dumps, incinerators, and other waste management facilities. Environmental justice activists, for example, argue that garbage and the negative environmental effects it causes are unfairly distributed. Further, some activists and scholars argue that such facilities are disproportionately located in minority and/or poor communities. Whether this phenomenon is the result of intentional practices of locating dumps and incinerators in the neighborhoods of least resistance, or is due to structural constraints or the price of land, is up for debate. In this area of research, there is an important link between garbage, society, politics, and economics.

While many environmental activists, including those advocating for environmental justice, consider garbage as a risk to the environment and public health, there are other groups who consider garbage as a resource. These are mostly comprised of people who participate in the informal garbage economy by collecting, selling or recycling other peoples' waste. In the United States, an individual looking for soda cans and plastic bottles to recycle is the most common form of this. Recreational dumpster diving, a popular activity in some U.S. cities, is another example. There are, however, many countries in other parts of the world where communities of scavengers live on large dumps and search for resalable items. It is important to note that this informal waste economy, in which garbage is considered a resource, often supplements formal recycling and disposal efforts. That is to say that many items are removed from the waste stream in this manner with no cost to the responsible government body. This reduces the amount of waste that needs to be disposed of in landfills and other facilities.

The need to manage garbage has long driven municipal policies in the United States and other areas. The existence of garbage in an urban area threatens the area's image at the same time it attracts disease vectors such as bacteria, mice, rats, roaches, feral cats and dogs. For this reason, garbage collection and disposal became an essential part of the first sanitation programs in major U.S. cities around the turn of the 20th century. The irony of society's garbage problem is that as the more developed a country becomes economically (particular in terms of replicating the mass consumer culture of the United States), the more garbage is produced. Garbage must be considered, not just a necessary side effect of development that can be managed with technology, but rather, an integral part of societies and environments that requires social, cultural, and political–economic understanding and solutions.

SEE ALSO: Environmental Racism; Justice; Landfills; Recycling; Waste Incineration; Waste, Solid.

BIBLIOGRAPHY. M.V. Melosi, *The Sanitary City: Urban Infrastructure* (Johns Hopkins University Press, 2000); L. Pulido, S. Sidawi, et al, "An Archaeology of Environmental Racism in Los Angeles," *Urban Geography* (v.17, 1996); W. Rathje and C. Murphy *Rubbish: The Archaeology of Garbage* (University of Arizona Press, 2001); P. Simmons, N. Goldstein, S. Kaufman, N. Themelis, and J. Thompson, Jr., "The State of Garbage in America," *BioCycle* (v.47, 2006).

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Garden Cities

THE CONCEPT OF the garden city is attributed to Ebenezer Howard in England, who developed the garden city concept in 1898 as a means of developing towns that had pleasing environments. According to his vision, garden cities were to be self-contained communities. Emphasis was on a manageable population size, neighborhood service centers, mixed land uses, much green space, pedestrian walkways, and a self-contained employment base. In other words, cities were to be socially, economically, and ecologically sustainable. He put his ideas into practice by founding two such cities in England: Letchworth Garden City in 1903, and Welwyn Garden City in 1920. These two cities, although far from fully realizing Howard's vision, continue to serve as excellent examples of healthy and livable communities. Ebenezer Howard is recognized as a pioneer of town planning whose utopian ideals were to establish a new social and industrial order via the establishment of garden cities. The principles applied to Letchworth and Welwyn were an experiment to try and overcome the problems of overcrowded, unhealthy cities, depressed rural areas, and the poor building standards prevailing in some areas by the end of the Victorian Era.

Ebenezer Howard's concept of the garden city had two aims: to solve together the problems of the congested city and of the "undeveloped" countryside. By mixing the town and the country together, residents would get the benefits of both. He suggested the optimum population for such a city to be 32,000 people with fewer than 30 houses per hectare. At the center of the city would be a central park or open green space surrounded by housing with factories on the edges of the city. The city would be then be surrounded by a green belt to check urban sprawl. Sewage would be recycled and put back into the land. He envisioned independent, but environmentally sound towns that were self-sufficient in almost everything.

Howard's ideas continue to guide urban planning, especially in the development of new towns that are intended to fulfill a number of functions, such as relieving overcrowding of large cities, providing an optimum living environment for residents, helping to control urban sprawl and preserving open land. Examples of such new towns influenced by Howard's work include Margarethenhohe near Essen in Germany, Sunnyside Gardens near New York, Chatham village in Pittsburgh, Radburn in New Jersey, and Reston in Virginia. Elsewhere in the world, new capital cities have been built utilizing this concept. These include Brasilia in Brazil and Lilongwe in Malawi. Other cities, for example Guayana in Venezuela, have been developed utilizing the self-contained ideas of a garden city to serve as growth poles for industrial and regional development.

Building upon Howard's ideas, one of the most important new philosophies in suburban design is the concept of New Urbanism. The philosophy stems from the unsightly nature of American urban sprawl and became very popular in the 1980s. New neighborhoods are designed to be people-friendly, with a diverse range of housing and jobs. The idea is to design neighborhoods that have pleasing and appropriate architecture and planning, and beautiful residences integrated with jobs. Such an approach to planning urban environments would reduce traffic and pollution, increase the supply of affordable homes, and contain urban sprawl. Examples of such new towns in the United States include the resort community of Seaside, Florida, whose planning follows the traditionalist approach with mixed-use neighborhood design containing gridded streets, front porches, sidewalks, and a village-like atmosphere where one can conduct daily business without the use of a car.

After a century of experimenting with Howard's ideas of the garden city, many countries have found it difficult to maintain and sustain such cities. However, such experiments have produced worthy information for designing and managing livable urban environments.

SEE ALSO: Urban Ecology; Urban Gardening and Agriculture; Urban Growth Control; Urban Parks Movement; Urban Planning; Urban Sprawl; Urbanization.

BIBLIOGRAPHY. Stanley D. Brunn, Jack F. Williams, and Donald J. Zeigler, *Cities of the World: World Regional Urban Development* (Rowman & Littlefield Publishers, 2003); Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* (North Point, 2000); Peter Geoffrey Hall and Colin Ward, *Sociable Cities: The Legacy of Ebenezer Howard* (J. Wiley, 1998); Dennis Hardy, *From Garden Cities to New Towns: Campaigning for Town and Country Planning, 1899–1946* (E. & F.N. Spon, 1991); John Ormsbee Simonds, *Garden Cities 21: Creating a Livable Urban Environment* (McGraw-Hill, 1994).

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Gardens

GARDENS ARE IMPORTANT elements of human–environment relationships. Historically, people have managed gardens for food, medicine, income, and ritual reasons, as they do today. The continuous, and most likely early, existence of gardens attests to their usefulness in multiple environments. Spatially, gardens represent intensive management of social and biophysical areas and provide insight into human knowledge systems and environmental adjustment capabilities. T. Killion defines gardens as the "polycultural mix of cultigens and useful economic species grown on small plots where the cultivator focuses on individual plants and their microhabitats by small inputs of labor on a continuous basis." C. Kimber claims that gardens are a vegetation type that "is a cultural–biological complex that can tell us much about people as they express themselves in the plant world." The species cultivated or protected in gardens reflect an individual's and a culture's decisions about which resources are valuable and deserve labor.

Biophysical relationships are not the only operative forces in garden use and change. A garden that produces needed food or medicine affects a household's future allocation of resources, providing families the ability to use cash resources for out field fertilizer, a child's school supplies, housing improvements, or other needs. Thus, the garden, by allowing households more latitude to allocate resources than nongardening families in similar settings allows a family to affect land-use decisions. Plant productivity, both in gardens and in remote fields, affects the strategies that households adopt for well-being. For example, catastrophic erosion in a field can make garden production more important than previously, engendering higher labor needs and more intensive management schemes.

Demographic and economic factors also affect gardens. As J.F. Eder explains, "continued rapid population growth, coupled with the filling in of many remaining agricultural frontiers, has significantly diminished farm size in many of the world's agricultural systems and this trend is likely to continue." Thus, garden production, carried out on small plots holds current and future promise for agricultural production. Within commodity production systems gardens serve either to augment cash earning or to lessen the need for the purchase of agricultural products, thereby reducing costs to households. By providing space and resources for diverse activities, gardens optimize the limited land available to rural families, at times being the deciding factor in household success. B.L. Turner and W.T. Sanders explain that "gardens…are spaces for the cultivation of multiple species used for additional or emergency caloric and nutritional needs, medicinals, ornamentals, and other exotic production." In addition to growing needed crops, gardens create spaces for the education of children, experimentation with plant types and cultivation techniques, and family social activities.

In the developing and developed world, gardens are components of human landscapes. The utilization of space surrounding people reflects political, economic, social, and cultural aspects of societies. These pressures act on gardeners to ensure that each garden varies significantly from others. Spatially, gardens may be located near houses or at more remote locations. Garden areas nearest houses, however, tend to receive the most attention, both in terms of intended care and unintended influence from household members and visitors. Those near house spaces are not only places of production; they are places of occupation as well. People in or near gardens select certain crops over others through use, conscious and unconscious seed dispersal, and the elimination of unwanted plants or those that grow in human activity and footpaths.

Worldwide urban gardens garner considerable interest. Nestled in unpaved, open spaces, city dwellers use gardens to produce needed food, provide a connection with nature, and create social connection with other city dwellers. In parts of two-thirds of the world, for example, gardens in large cities to alleviate economic impoverishment, in space eked out of median strips, destroyed houses, or other spaces. In the economically rich areas of the world, gardening can occur for alternative reasons, for example to avoid pesticides or genetically modified organisms. While gardens produce needed resources for families, they also provide space for social activities where children play and learn about nature, create space set apart from the outside world, and enhance the sense of community or family solidarity.

Although agricultural intensity studies demonstrate that high labor inputs often bring lower outputs per unity of work, Eder notes that "intensive garden production may not bring lower labor productivity, due to the benefits of continued harvesting and associated 'fine tuning' of management strategies." Where climatically possible, gardens are in continuous production that take very little effort on a given day but receive high levels of input when taken over the entire growing period. Measuring garden productivity in terms of production of cash or volume ignores other factors that gardeners consider important. Gardens also return variety, reduce risk, grant prestige, and preserve land races of crops. Gardens possess a wide range of cultivars both within individual and across multiple gardens. The crop diversity found in gardens owes to economic, cultural, and ecological relationships, often inseparable from one another.

Importantly, gardens are sites of experimentation and learning for plant production. Gardeners, with nearly everyday contact with their plants, notice variation and encourage preferred changes. Gardens are thus in one sense traditional, in that they have a long history with the human species, but are also fully modern in the nearly constant change and adjustments made to them.

SEE ALSO: Community Gardens; Food.

BIBLIOGRAPHY. J.F. Eder, "Agricultural Intensification and Labor Productivity in a Philippine Vegetable Gardening Community: A Longitudinal Study," *Human Organization* (v.50, 1991); T. Killion, "The Archaeology

Singapore, the Garden City

The concept of turning Singapore into a "Garden City" had its origins in 1963, when the Prime Minister, Lee Kuan Yew, initiated a large-scale tree planting campaign. Singapore became an independent country two years later, and two years after that, a plan to turn Singapore into a Garden City was formalized. This coincided with major infrastructure projects throughout the country, and public, municipal and statutory bodies were encouraged to incorporate parks, grass verges, and trees into their building and landscaping plans. The result was a dramatic improvement in the aesthetic environment of much of the country. The Botanic Gardens and other places had ensured that long before the Garden City concept, Singapore had many flowerbeds and greenery. However, from 1967 there was a concerted effort to beautify the city with trees planted along roadsides, and flowerbeds constructed along many sidewalks, under overpasses, and outside shopping arcades.

Singapore has always been known for its orchids. To make the country a "Garden City," flowers from Arabia, East Africa, India, and Latin America were introduced, including the flamingo flower from Colombia, the crossandra from India, and the peacock flower from the Caribbean, which are all now quite common in Singapore. In addition, the frangipani tree and the lantana remain popular, as does Singapore's national flower, the Orchid *Vanda "Miss Joaquim."*

of Settlement Agriculture," in T. Killion (ed.), *Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica* (The University of Alabama Press, 1992); C. Kimber, "Spatial Patterning in the Dooryard Gardens of Puerto Rico," *Geographical Review* (v.63, 1973); B.L. Turner and W.T. Sanders, "Summary and Critique," in T. Killion (ed.), *Gardens of Prehistory: The Archaeology of Settlement Agriculture in Greater Mesoamerica* (The University of Alabama Press, 1992).

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Gasoline

GASOLINE IS AN organic compound found in nature that is used to fuel gasoline engines. It is called *petrol* in Great Britain, or by other names such as *benzene* in other languages. Throughout the 20th century, the exploration and development of the global oil industry was a quest for oil that was used for refining into gasoline. Prior to about 1900, the primary product made from refined oil was kerosene. It was soon discovered that gasoline was a lower temperature distillate than kerosene—it required less refracting to be extracted. The invention and application of the gasoline engine to automobiles, boats, airplanes, and other machines stimulated the refining of gasoline. Henry Ford's development of the Model T and the assembly line to build them in vast numbers at affordable prices for working-class people provided inexpensive transportation for millions. Demand for gasoline quickly exceeded kerosene demand, creating a global quest for oil and a vast system of gasoline supplies to individual automobile driver purchases.

Internal combustion gasoline engines are a type of heat engine. They use energy at high temperature to do work. Much of the heat is then dumped so that the engine can continue to work. The gasoline engine uses the Otto cycle, which is named after Nikolaus Otto, to mix gasoline vapor and air in a cylinder-shaped chamber. The vapor and air mixture is compressed. A piston uses an adiabatic compression stroke to squeeze the air and gasoline into an explosive condition. However, if the gasoline is of good quality, an explosion will not occur spontaneously. Instead, a spark plug will be used to ignite the compressed mixture. The explosion inside of the cylindrical chamber will create a very hot pressurized gas that will push the piston out in a stroke that will turn a crankshaft to accomplish work. The octane rating measures the resistance of the gasoline to premature ignition.

Gasoline is used in great quantities. Individual cars use tons every year. The exploded mixture of air and gasoline is expelled from the automobile in the form of gas. Much of the waste gas is carbon dioxide. However, there are many other compounds in the exhaust fumes. These tons of gasoline fumes pollute the atmosphere and the in various atmospheric conditions create smog. There are many health problems caused by these fumes, including a great increase in asthma. Chemically, gasoline is C_8H_{14} plus other radicals that can or may be attached. It can be manufactured from anything containing carbon and hydrogen. These forms of gasoline are synthetic. It is also possible to obtain it from oil-bearing shale deposits and tar sands. Gasoline is found with the natural gas that accompanies petroleum. Natural gasoline is usually called *casinghead* gasoline, and is mixed with the enormous quantities of gasoline manufactured in oil refineries. Gasoline, depending upon the quality of the crude oil being refined, and many other products will come from the refracting process. These include gases, kerosene, diesel fuel, and a variety of oils, waxes, and tars. In addition, contaminants such as sulfur and metals may also be produced.

The gasoline sold commercially in the United States and around the world is gasoline plus other hydrocarbons. There are more than 25 compounds that are mixed with gasoline to make different kinds of fuels. Gasoline burns differently in different types of engines. Each engine's pistons have different compression and firing characteristics. High-compression engines and low compression engines will experience "knocking" or "pinging" from premature firing if the gasoline and the air mixture are not suited for that type of engine. The result is that gasoline for automobiles would not be the best fuel for boats, airplanes, or other gasoline-using engines. Knocking occurs in an engine when the gasoline

The octane rating reflects the percentage of hydrocarbons, which increases the tendency of a gasoline to "knock."

vapors and air in the cylinders explodes spontaneously rather than burning at a uniform rate. When knocking occurs, it causes a loss of power in the engine. Using a gasoline mixture that does not explode spontaneously as the temperature and pressure in the engine increases can prevent it.

Gasoline composed of straight chain of carbon atoms tend to knock badly when fired in a cylinder. However, gasoline composed of many branched carbon chains or those with rings have a greatly reduced tendency to knock. Straight-chained hydrocarbons have low octane ratings. However, ring-type hydrocarbons have intermediate octane ratings. The highest octane ratings are given to the high-branched alkanes and benzene ring-shaped (aromatic) hydrocarbons. Gasoline refiners can make gasoline blends composed of the branched and ringed forms of gasoline. These "designer" fuels have been standardized using standard test engines. The antiknocking characteristics of hydrocarbons used in gasoline are designated by an octane rating, which is a number that indicates the tendency of a gasoline to knock in a high-compression engine. The higher the octane rating, the lower is the tendency for an engine to knock. Iso-octane is a form of gasoline with an excellent antiknocking quality; its rating of 100 is used as a standard. In contrast, n-heptane has a zero rating because it knocks so badly. If a gasoline has a rating of 90, then it has a 90 percent mixture of iso-octane and a 10 percent mixture of n-heptane.

Lead is a soft metal that has been found to be useful in gasoline as an additive that will prevent preignition or knocking. However, while lead metal is not highly poisonous, lead can be rendered toxic when it combines with acids or oxides. The lead in gasoline expelled from exhaust pipes poses a major health hazard. A common form of lead additive was lead tetraethyl, $Pb(c2H_5)_4$. In the 1970s, state and federal governments recognized lead pollution. Despite strong resistance on the part of the petroleum and gasoline industries, steps were taken to eliminate the use of lead in gasoline. By the 1980s, most of the gasoline in the United States was no longer sold as leaded gasoline, reducing the amount of air pollution caused by automobiles. Many other countries have followed suit. Gasoline fuel engines have been the mainstay American transportation for decades. They are very likely to continue to be used as long as ample supplies of gasoline are available. However, alternatives are being researched. One of these is the hydrogen fuel cell.

SEE ALSO: Automobiles; Lead; Petroleum; Pollution, Air.

BIBLIOGRAPHY. A.F. Diaz and D.L. Drogos, eds., *Oxygenates in Gasoline: Environmental Aspects* (American Chemical Society, 2002); Terry Dinan, *Reducing Gasoline Consumption: Three Policy Papers* (United States Government Printing Office, 2002); T.K. Garrett, *Automotive Fuels and Fuel Systems: Gasoline* (Society of Automotive Engineers, 2000); Richard Jablin, *Transportation Solutions: Kicking Gasoline Dependency* (Wheatmark, Inc., 2005); Magda Lovei, *Phasing Out Lead from Gasoline: Worldwide Experience and Policy Implications* (World Bank Publications, 1998); Barbara V. Urban, *Gasoline Prices: Policies, Practices and Prospects* (Nova Science Publishers, 2005).

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Geer vs. Connecticut

GEER VS. CONNECTICUT is the 1896 lawsuit that definitively formed the basis for state law concerning the ownership of animals. The case was brought against Edward M. Geer, on the basis that he was attempting to sell animals in a state in which they would be considered illegally obtained, although he had obtained them in another state through legal means. The Supreme Court ruled that states should operate their right to wildlife as a trust for the benefit of the people.

In other words, individual states were confirmed as having the right to own and control flora and fauna above and beyond the abilities and rights of private interests. Unlike most of Europe, therefore, the bulk of the land of the United States is managed in trust by the state, which guarantees the rights of individuals to use the land and its resources in a responsible way. This means American citizens have the right to roam over the land and pursue hunting and fishing activities to a much greater extent than in most other countries, where private interests control access to those resources. These rights depend on the Court's decision that the state has inherent within it a proper "police power," which should be obeyed. This decision harked back to the precedent set by Magna Carta, in which again community rights were held to outweigh private rights.

Court decisions are subject to appeal and subsequent modification by later decisions, which may be taken in the light of new information or unanticipated environmental change as much as to correct any errors that may have occurred previously. Consequently, it is not surprising that *Geer vs. Connecticut* was overturned in 1979 by the case of *Hughes vs. Oklahoma*.

SEE ALSO: Supreme Court Decisions.

BIBLIOGRAPHY. Robert H. Abrams, William Goldfarb, Robert L. Graham, Lisa Heinzerling, David A. Wirth, and Zygmunt J.B. Plater, eds., *Environmental Law and Policy: Nature, Law, and Society,* 3rd ed. (Aspen Publishers, 2004); Robbins, Paul, "We Are the Elk: Ethics and Explanation in Political Ecology," *Plenary Lecture on "Ethics, Justice and Political Ecology," National Meeting of the Association of American Geographers*, www.personal.ecu.edu (cited 2005); Text of the Supreme Court decision, courtesy of the *New York Times*, www.caselaw.lp.findlaw.com

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Gender

ACADEMICS AND RESEARCHERS find that gender, in relation to the environment, yields certain consistencies across cultures. For example, men and women participating in the Chipko movement found that their encounter with their environment was determined by their gender. While Chipko movement members all opposed forest commons's transfer to commercial cultivation, Vandana Shiva noted that women and men had different ideas about the forest's future development. Women wanted to maintain the trees they used for fuel wood and fodder; men wanted to plant commercial trees such as eucalyptus. In other words, women were interested in sustainability; men, in access to markets.

International nongovernmental organizations such as the United Nations Development Program (UNDP) collect data on women's and men's differential access to natural resources. The current UNDP Human Development Report (HDR), "Beyond Scarcity: Power, Poverty, and the Global Water Crisis," points out that states do not value investment in sanitation, so every day millions of women and girls collect water for their families's use. Their unremunerated labors maintain gender inequalities in employment and formal education. For example, the HDR notes collecting and carrying water is a time burden that explains gender gaps in school attendance, since girls experience a direct trade-off between the time they spend collecting water and time they spend in school. The HDR's researchers point out that school attendance levels in Tanzania are 12 percent higher for girls from homes within 15 minutes's walk to water, than from homes located over an hour away from water; variation in boys's attendance rates are not explained by distance to water sources. If the UNDP asserts that women and men encounter the natural environment differently, then how do the HDR's researchers know this?

Many researchers affiliated with international nongovernmental organizations (NGOs) such as the UNDP are members of the International Association for Time Use Research, which was established to promote and sustain time use surveys. By the time use survey research method, a specialist follows an individual in order to mark how they spend their waking hours on a chart that divides each of the hours of the day into 15-minute increments. These charts serve as the basis for assertions regarding what percentage of a population's laboring time is spent in common tasks. The time use survey method has proven to be a more accurate means of recording the ways women and men spend their labor and leisure time than self-reports, which tend to underreport the amount of time spent in such repeated or habitual tasks as domestic labor. Researchers developed time use surveys in industrialized countries to follow working men's use of leisure time, including George Bevans's *How Working Men Spend Their Time* (1913) and Maud Pember-Reeves's *Round About a Pound a Week* (1913). The Multinational Time Use Study (MTUS) is based in Oxford University's Center for Time Use Research. UNDP-funded time use surveys in background papers served as the basis for the HDR's general observations that girls's and boys's educations spend less or more time in the classroom, dependent on their proximity to water sources.

METAPHORS FOR THE ENVIRONMENT

Not only do women and men encounter the natural environment differently in ways that can be measured empirically, but gender also serves as a metaphor for the natural environment. Metaphors and other figures of speech serve as a convenient tool for thinking about women and nature; the two are frequently used as metaphors for one another. For example, Washington State University's American Studies Program offers a course on gendering nature in literature and the visual arts. Premodern culture linked female-identified deities Demeter and Persephone to the earth. Goddess of the harvest, Demeter, took her revenge on humans when Hades abducted her daughter Persephone; Zeus restored order, leaving humans to suffer frosty, unproductive fields for only half the year. The woman/nature connection established in Mediterranean mythology became all the more closely linked with the emergence of modern legal and property relations during the Renaissance. Botticelli's painting "Primavera" presents an allegory on the harmony between nature and humans. In this painting, female figures represent human values and virtues; but these female figures are barefoot, their feet rooted in the earth.

The gender metaphor for the natural environment is particularly potent under modern legal systems. In Britain, a series of Enclosure Acts extended the rule of law to property during the 18th and 19th centuries, transforming entire social classes's relationships with the natural environment. During the same historical era, modernist citizenship developed to protect men's experiences, until maternalist policies came to provide social rights for women in their domestic and reproductive capacities.

Carol Pateman's *The Sexual Contract* (1988) discusses how modern concepts about political power grew from understandings of paternal power. The "state of nature" serves as metaphor for the rational choice individuals make to take on citizenship's responsibilities. The key for her argument is the point that individuals encounter the law only in those aspects that have universalized masculine rationality. As Pateman writes, "The classic pictures of the state of nature also contain an order of subjection—between men and women." Sexual difference becomes political difference, in that the law excludes those aspects of human experience that are specific or peculiar to women (whether their reproductive fertility or their domestic labor). Modernist citizenship establishes public categories for women's equation with the nature that is beyond law.

The gender metaphor for nature is also particularly compelling for modern science. As one example, primate studies serve as the basis for understandings about relationships between human beings and the natural environment in natural history museums and zoos, on television programs, in advertising and science fiction, in cinema and on greeting cards. As Donna Haraway describes in *Primate Visions* (1989), "Monkeys and apes have a privileged relation to nature and culture for Western people: simians occupy the border zones between these potent mythic poles;" along this border, a view of nature is constructed and reconstructed in these animals, who serve as gendered and racialized surrogates for humankind. *National Geographic* magazine featured the photograph of a tool-making, omnivorous chimpanzee named David Greybeard, reaching to touch the hand of researcher Jane Goodall—the same year 15 African nation-states were admitted to the UN. For Haraway, such contribute to particularly compelling myths about gender, race, and belonging in the modern world. In this way, modern science studies have naturalized the equation between women and nature.

DUAL CRITIQUES

The ecofeminist movement appropriates the metaphor that conflates gender with nature for progressive ends. Ecofeminism emerged in French with prolific Francoise d'Eaubonne publication of *Le Feminisme ou la Mort/Feminism or Death* in 1974. During the following decades, a number of activists's and scholars's endeavors compliment one another as a feminist critique of environmentalism, or an environmentalist critique of feminism. Ecofeminists draw on feminist critiques of modernism's dualistic hierarchies: mind/body, male/female, human/animal, culture/nature, white/nonwhite. Such binary categories serve as the basis for patriarchy, racism, and other oppressive systems in laws, markets, and societies. With feminist philosophers such as Rosi Braidotti, ecofeminists argue that individual and collective liberation cannot be accomplished within the modernism's binary pairs. In other words, granting women the same political rights as men enjoy will not liberate them, since masculinity grants womanhood its meaning; likewise, the natural environment is defined in culture, and is unavailable for celebration outside of the terms in which it has already been set.

With its dual critiques of feminism and environmentalism, ecofeminism is poorly represented in the professional associations that sustain both. Rather, ecofeminist scholars have developed their discussions in specialized conferences, interest groups within professional associations, for example the 1980 conference, "Women and Life on Earth: Ecofeminism in the Eighties" held at the University of Massachusetts/Amherst; as well as the 1987 conference, "Ecofeminist Perspectives: Culture, Nature, Theory" at the University of Southern California. The ecofeminist movement appropriates the gender/nature metaphor to draw activist and academic commentators from different fields. Not confined to any one field of research, ecofeminism draws on historical, archaeological, theological, economic, and political studies. This diffuse group of methodologies and epistemologies sustain a series of discussions on biodiversity, reproductive technology, indigenous knowledge in the face of intellectual property systems based on the rule of law, militarization, and globalization.

ECOFEMINIST COLLECTIONS

Ecofeminists also tend to publish in edited collections, rather than establishing a monograph series with a single press. Significant contributions include Rosemary Ruether's *New Woman/New Earth* (1975, republished 1995), Mary Daly's *Gyn/Ecology* (1978, republished 1990), Susan Griffin's *Woman and Nature* (1978), and Carolyn Merchant's *The Death of Nature* (1980). Spinifex, a feminist press in Melbourne, published *Ecofeminism*, Maria Mies and Vandana Shiva's edited volume, in 1993. Recent contributions include Nancy Howell's *A Feminist Cosmology* (2000), Peter Scott's *A Political Theology of Nature* (2003), and Sherilyn MacGregor's *Beyond Mothering Earth* (2006). Ecofeminist contributions appear on the pages of feminist journals *Hypatia* (published by Indiana University Press) and *Signs* (published by the University of Chicago), as well.

Ecofeminist works have drawn criticism from mainstream feminism and mainstream environmentalism. Third-wave feminists, in embracing perspectives that emphasize the performativity of gender, distance themselves from such essentialist positions as those within ecofeminism. And the environmentalist movement is, in general, much more comfortable with liberal democracies's general emphasis on individuals's capacities for political participation and transformation, to be comfortable with the ways in which ecofeminists are dedicated to finding patriarchal structures in multiple locations. Furthermore, with the social sciences's commitment to diversity among researchers, some critics of ecofeminism note that it develops in predominantly industrialized countries, and perpetuates certain assertions regarding women and men of predominantly agrarian communities. For these and other reasons, ecofeminist work is better-represented within multinational institutions and the research they fund, than universities.

SEE ALSO: Chipko Andolan Movement; Ecofeminism; Zoos.

BIBLIOGRAPHY. Donna Haraway, *Primate Visions* (Routledge, 1989); Carol Pateman, *The Sexual Contract* (Stanford University Press, 1988); Mark Somma and Sue Tolleson-Rinehart, "Tracking the Elusive Green Women: Sex, Environmentalism and Feminism in the United States and Europe," *Political Research Quarterly* (v.50/1, 1997).

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Gene Therapy

GENE THERAPY REFERS to a group of actual or future medical treatments that are aimed at changing the genetic structure of cells with defective genes that are causing disease. This may be attempted by trying to reverse the mutation of a gene, inserting a new genome into the genetic sequence, substitution of a normal gene for an abnormal (disease-causing) one and other techniques. The type of medical problem that can be remedied through this type of technology has customarily been untreatable until these advances were made. This includes genetic diseases, sickle cell thalassaemia, leukemia, and similar problems. Technical problems that have hampered the progress of gene therapy include the problems caused by the human immune system, which is designed to resist foreign intrusions into the body, the fact that some conditions result from multigenetic factors, thereby necessity multiple interventions, and the fact that therapies currently tend to be inherently short-term in nature and require substantial modifications to be made in order to become permanent.

In order to transfer the replacement gene into its desired position, it must be transported by what is known as a *vector*, which is customarily a virus that has been engineered for this purpose. The types of virus so far employed include adenovirus types similar to those causing the common cold, retrovirus and herpes simplex virus types. Of course, great care is necessary in dealing with this material. Various techniques have been developed for using the vector to transfer the genes, although practical difficulties mean that all remain complex and potentially expensive. Nevertheless, many people suffering from genetic disorders have had their hopes raised by the possibilities offered by gene therapy and some, for want of any alternative, are prepared to offer themselves as test subjects for unproven technologies. Theoretically, at least, the possibilities are immense.

Gene therapy is considered to present a number of ethical issues. First, it involves the issue of normality and the extent to which people with genetic disorders should be thought of as abnormal and to be cured. Second, the costs of the research are very high to the extent that the benefits of the research are likely to be rationed to the very rich. Third, the analysis and manipulation of cells, including stem cells, is considered by some to be unethical because of the ability of those cells to be part of an organism developing into an independent human being. Additional issues concern the extent to which human cells may be considered property on which experimentation may be conducted according to the dictates of the owners and the subsequent commercialization of products derived from such research. Attitudes toward these issues vary and in some cases have affected the location of firms undertaking research, which move away from states where their activities are unwelcome. Even so, commercialized products and techniques acceptable to national regulatory authorities have yet to appear.

Technological improvements have led to significant increases in the value and prospects of firms involved in providing commercial applications in the field. This has led to considerable investment in these firms and a number of attempts to sequester the possible financial advantages to be had from the technology through application of patents and other forms of intellectual property protection. This is controversial since many believe that any advances in medical technology should be made available to all the people of the world, albeit that some will add the provision of ability to pay. State governments are being required to formulate policy positions that connect both intellectual property and moral issues.

SEE ALSO: Ethics; Genetics and Genetic Engineering; Human Genome Project.

BIBLIOGRAPHY. Scott Parker, "Cell Therapy: European Legal and Regulatory Implications," *Journal of Commercial Biotechnology*, v.8, No.1, Summer 2001); Franklin Strier, "Stemming the Gold Rush: Public Policy Alternatives to Gene Patenting," *Business and Society Review*, (v.110, No.1, Spring, 2005); The Office of Biological and Environmental Research of the U.S. Department of Energy, www.ornl.gov/sci/techresources/Human_Genome/medicine/genetherapy.shtml.

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General Agreement on Tariffs and Trade (GATT)

THE GENERAL AGREEMENT on Tariffs and Trade (GATT) is a multinational agreement on rules designed to foster international trade. The GATT was established in 1947, and by the 1990s, had over 100 signatory nations. The agreement has been revised periodically since its inception through negotiations referred to as *rounds*, of which there have been seven. For most of its history, the focus of those negotiations was on the reduction of tariffs, taxes imposed on imported good. Although the GATT was a relatively weak entity where disagreements between nations were primarily settled through negotiation, the agreement did facilitate a decrease in average tariffs internationally from 40 percent to roughly 5 percent of the price of imported goods.

During the 1980s, the United States, the world's largest and most powerful economy, sought to use the GATT to open more markets to U.S. goods in order to reduce its growing trade deficit and to aid U.S.-based firms conducting business internationally. During the so-called Uruguay Round of negotiations, which lasted from 1986–93, the GATT expanded beyond its traditional focus on external tariffs on manufactured goods to include provisions on agricultural products, services, deregulation, and the protection of intellectual property rights. A significantly more powerful successor organization, the World Trade Organization (WTO), was also established during this round in order to enforce trade agreements.

While the United States was successful in adding many new provisions to the agreement, some measures met with stiff resistance from social movement organizations throughout the world. An international movement composed of environmentalists, farmers, consumers, and labor organizations has since mobilized in favor of "fair trade" in contrast to the "free trade" arrangements enshrined in the GATT/WTO. They argue that large multinational corporations reap most of the benefits from free trade agreements such as GATT, while workers and the poor suffer and domestic sovereignty is undermined.

Resistance to the free trade measures has come from several sectors. Small farmers around the world, but especially in Europe, opposed the elimination of agricultural subsidies called for in the Uruguay negotiations. Although the United States had originally supported the exclusion of agricultural goods from the GATT, costly agricultural subsidies were contributing to the U.S. budget deficit and Reagan Administration officials sought to reduce this public expense. It was also believed that larger U.S. farms would have a comparative advantage over smaller European farms in the international agriculture market, but corresponding European agriculture subsidies prevented unfettered competition. In the Uruguay Round, the United States secured the reduction, but not the elimination of farm subsidies, largely due to resistance from farmers in Europe and, to some extent, domestically.

Environmentalists, consumer groups, and some labor organizations also opposed measures included in the GATT negotiations. Free trade advocates sought to eliminate what they considered *nontariff trade barriers,* nontariff measures that in some way can serve to restrict imports or to favor domestic production. This includes laws such as those that require that products be produced with a given percentage of domestic content or policies that aid a certain industry, thus giving them an advantage over foreign producers. Some environmental regulations and health and safety measures could also be interpreted as nontariff trade barriers under GATT rules. Since an anonymous panel of free trade experts would be empowered to offer a binding ruling on challenges to such laws, critics of the trade agreement see this kind of measure as an infringement on domestic sovereignty and democratic control. In one case in 1991, the government of Mexico used GATT provisions to challenge the United States for restricting the importation of tuna caught using a technique that also caught and killed dolphins, a practice that was banned under the U.S. Marine Mammal Protection Act. The GATT panel that heard the case sided with Mexico. Free trade critics charge that import restrictions on the basis of abusive labor practices or safety concerns could also be challenged, thus threatening to undermine all manner of regulatory controls and policies. European restrictions on beef produced from hormone treated cattle and forest protection measures that ban the export of raw logs are other examples cited by critics fearful that free trade authorities could undermine domestic law.

Intellectual property rights measures included in trade agreements have also spurred controversy. The United States, a leader in the development of technology, sought greater protection for patented techniques and products, which are commonly pirated, especially in less-developed nations. Agricultural technology has been the subject of greatest conflict as corporations in the wealthy nations are patenting products derived from genetic material extracted from less-developed nations. Poor farmers in less-developed nations have protested the requirement that they pay royalties for the use of seeds made with genetic material taken, without compensation, from their own countries.

SEE ALSO: Genetic Patents and Seeds; Subsidies; Trade, Fair; Trade, Free; World Trade Organization.

BIBLIOGRAPHY. Jeremy Brecher and Tim Costello, *Global Village or Global Pillage,* 2nd ed. (South End Press, 1998); David Held, Anthony McGrew, David Goldblatt, and Jonathan Perraton, *Global Transformations* (Stanford University Press, 1999); Robert Schaeffer, *Understanding Globalization* (Rowman and Littlefield, 1997).

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General Mining Law

THE U.S. GENERAL Mining Law of 1872 was created to encourage mineral exploration and development on federal lands in the western United States, offer an opportunity to acquire clear titles to mines already being worked, and to help settle the American West. The law permitted free access to individuals and/or corporations to prospect for rocks, ores, and minerals on public lands and allowed them, after making a discovery, to stake a claim on the deposit sanctioning the development of ores and minerals from that site (originally applying to all minerals except coal).

Federal lands acquired by treaty, cession, or purchase as part of the general territory of the United States, including lands that passed out of but reverted back to federal ownership, were specifically included in the mining law administration. However, those lands acquired from a state or a private owner through gift, purchase, or condemnation are not covered by the law. Under complicated circumstances, public lands may be closed to prospecting and mineral exploration.

The General Mining Law of 1872 was the principal motivation behind the sudden growth of mineral resources in the 19th-century American West as well the associated services and industries involved in mineral production. Hard-rock minerals development included gold, silver, copper, lead, molybdenum, and uranium, with major gold and silver mining districts built under the Mining Law in California, Colorado, and Nevada. In Arizona and Colorado during the early part of the 20th century, major discoveries of porphyry copper, molybdenum, and tungsten led to extensive development and industrial growth. The law continues to support much of the West's widespread mineral development on public domain lands and although it is not as wide-ranging, it represents a major revenue generator for the United States because most hard-rock mining occurs on federal lands.

MINING CLAIMS

Once a prospector has explored for mineral and ore deposits on public domain land, he may locate a claim believed to hold that important mineral. Claimants must then pay a yearly maintenance fee of $100 per claim to hold a claim in addition to a $25 "location fee" for first-time prospectors to record their claim. According to the Bureau of Land Management (BLM) in 2000, these fees generated $24 million representing a significant drop from $31 million in 1995 after a peak of $36 million in 1997, due primarily to a drop in gold and copper prices. Once the claim has been proven as economically recoverable, and at least $500 has been added to the development of the stake, the stakeholder may file a patent application to obtain title to all surface and mineral rights.

In 1989, a claim fee of $250 per application plus $50 per claim within each application were required. If the application is approved, the claimant may purchase all surface and mineral rights for $2.50 per acre for placer claims or $5 per acre for lode claims. Placer deposits are alluvial deposits of valuable minerals found in sand or gravel and are commonly limited to 20 acres. Hard-rock or lode claims may be larger than 20 acres. Although these fees were expensive in 1872, claimed land, minerals, and ore bodies now far surpass these amounts.

The following provisions currently apply to claims under the General Mining Law: (1) there is no limit on the number of claims one person can file, (2) there is no requirement that mineral production ever begins, (3) mineral production can take place with or without a patent or any payments to the federal government, (4) claims can be held indefinitely with or without production; however, they are subject to contest if not developed.

In 2000, most of the current U.S. mining activity and mineral claims under the General Mining Law were located in only five states. Of a total of 235,948 mining claims, 45 percent were in Nevada alone and 35 percent are in Arizona, California, Montana, and Wyoming.

The freedom with which claims may be staked, the relatively low fees associated with claims, and the lack of demands in the Law for remediation of mined sites, have led to a barrage of criticisms over the last century, with movements to amend or appeal the Law on many occasions. Specifically, critics suggest that the low fees do not account for externalized environmental costs associated with mining and represent a subsidy for development of otherwise pristine lands to large mining corporations, many of which are owned and operated from outside the United States. Congressional review of the Law during the late 1990s led to a number of suggestions for revisions, but environmentalist calls for its total repeal have gone unheeded.

SEE ALSO: Bureau of Land Management; Externalities; Minerals; Mining.

BIBLIOGRAPHY. Saleem H. Ali, *Mining, the Environment, and Indigenous Development Conflicts* (University of Arizona Press, 2003); Sandor Demlinger, *Mining in the Old West* (Schiffer Publishing, 2006); David M. Stiller, *Wounding the West: Montana, Mining and the Environment* (University of Nebraska Press, 2000).

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Genetically Modified Organisms

ALTHOUGH HUMANS HAVE altered the characteristics of many other species over the years (most notably in plant and animal domestication), a watershed was reached in the early 1970s when biologists began to directly manipulate DNA. This "genetic modification" or "genetic engineering" involved altering, recombining, and transferring genes from disparate organisms. It is one of the most powerful technologies ever devised; it is also one of the most controversial because of the ethical, legal, political, economic, and biological issues it raises.

Even the basic vocabulary for the subject is contested. The term *genetically modification* first appeared in the 1970s to describe early experiments on bacteria. But by the 1990s, in response to portrayals of such creations as sinister and unnatural, some proponents began to label all domesticated crops as "genetically modified" since ancient farmers had modified the plant's genetic makeup. The term *genetic engineering*, preferred by some biologists, is resented by some engineers because of the uncontrolled aspects of the process. *Transgenic* is often used for organisms with recombinant DNA, although it is not strictly accurate in cases where an organism's own genes have been altered. Genetically Modified Organism (GMO) here refers to an organism containing genes that have been directly manipulated.

The biology of genetic modification traces to work in the 1950s showing that bacteria exchanged genetic material in the form of extrachromosomal rings called plasmids. In the late 1960s, biologists learned to use the "restriction enzymes" that bacteria use to cut up the DNA of attacking viruses; these enzymes could be wielded to cut specific genes out of DNA molecules. In 1972, Paul Berg succeeded in making a recombinant plasmid, or gene construct, containing cut sections of DNA. In 1973, a team led by Stanley Cohen and Herbert Boyer inserted a recombinant plasmid into an *E. coli* bacterium, making it the world's first GMO; this allowed the production of large numbers of the plasmids, which could then be used to modify different organisms.

HISTORY OF GENETIC MODIFICATION

The subsequent history of genetic modification cannot be understood apart from the history of intellectual property rights with which it is entangled. In 1972, corporate scientist Ananda Chakrabarty had altered a bacterium by manipulating the natural process of plasmid transfer. This work was not of particular scientific importance, and did not even involve recombinant DNA, but it became the subject of a landmark dispute over the patentability of the modified bacteria. In 1980, by a five to four vote, the U.S. Supreme Court's *Diamond vs. Chakrabarty* decision overruled the patent office's finding that, consistent with established legal principles, living organisms could not be patented. This ruling, combined with other decisions from around the same time, allowed private ownership of modified organisms and genes themselves. Several companies quickly began work to capitalize on the right to own genetically modified life forms, most notably St. Louis, Missouri-based Monsanto Company, which had started to build a biotechnology unit a few years before. Also in 1980, the United States passed the Bayh–Dole Act, which allowed results of federally funded research to be privatized, leading to a flow of licenses on genes and genetic technologies from universities to corporations.

Industrial uses of genetically modified simple organisms appeared quickly. One of the earliest was in cheese production: in 1981 a gene for producing chymosin (a key ingredient in the rennet used to solidify cheese) was inserted into bacteria, and in 1988 a genetically modified yeast was approved for chymosin production, allowing partial replacement of the rennet from calf stomachs. Pharmaceutical applications began at the same time, and in 1982 the U.S. Department of Agriculture approved human insulin produced by genetically modified bacteria.

Genetic modification of plants followed quickly. By 1983, parallel work at Monsanto and Washington University, both in St. Louis, Missouri, had succeeded in inserting an antibiotic resistance gene into plants, as had Belgian biologists. All had used a powerful new method of introducing foreign genes. *Agrobacterium temafeciens* is a natural genetic engineer, a soil bacterium that inserts its genes into plants as part of its reproductive cycle. The biologists hijacked this process, replacing the genes the bacterium intended to insert with their own genes of choice. A few years later, Cornell scientists devised a second method of introducing gene constructs into plants by using a gun-like device that shot materials into cell nuclei. Still, the process by which gene constructs became integrated into the target organism's genome remains a mystery, so biologists have to use the "brute force" method of trying to transform large numbers of cells and then isolating the genetically modified ones by killing the others. The most common way to accomplish this is to include a gene for antibiotic resistance in the construct inserted into the target organism; the cells are then exposed to antibiotics that kill off all cells except those containing the construct with antibiotic resistance gene (and therefore also the gene/s of interest). Again, developments in intellectual property law followed these scientific developments closely. The landmark Hibberd decision in 1985 extended patentability from bacteria to genetically modified plants.

Genetic modification of animals followed a different trajectory. By the late 1960s, biologists were able to inject embryonic cells from one organism into the blastocyst (early embryo) of another, and by 1980 several labs had succeeded with the direct microinjection of purified DNA into the pronuclei of fertilized mouse eggs. Following the Chakrabarty decision, academic biologists applied for a patent on a modified oyster; the ruling in 1987 by the Board of Patent Appeals and Interferences affirmed that animals too could be patented (although not humans—the rationale being that the 13th Amendment banned ownership of humans). The next year, the United States issued its first animal patent for the "Oncomouse," a mouse with an inserted gene predisposing it to mammary cancer (the patent was issued to Harvard University and promptly licensed to DuPont). Other countries have been more wary of animal patents; Canadian courts rejected the Oncomouse patent, while the European patent office issued conflicting rulings, eventually settling on a restricted patent.

The U.S. Agricultural Research Service was the first in the world to genetically engineer barley.

Therefore, by 1988, both plants and animals could be genetically modified; the resultant organisms could be privately owned; and findings from government-sponsored basic research could be licensed or sold to corporations. Numerous academic labs and corporations were experimenting with a wide range of genetic modifications of life forms. This was a historic juncture in science, and also in the industry–university relationship. It was also a juncture long anticipated in speculative fiction, which had pointedly asked whose interests would dictate what life forms would be created. In Aldous Huxley's *Brave New World* (1989), life forms were developed according to the interests of corporate sales and state control (as exemplified by the worker caste designed to love only those sports that required them to pay for transportation and sporting equipment). Development of GMOs is still in its early stages, but important patterns have emerged reflecting the interests controlling the technology.

In plants, world area of genetically modified crops was up to 90 million acres by 2005. The vast majority of genetically modified seeds were soybean, maize, canola, or cotton. By far, the most common plant modification has been herbicide resistance: a gene is inserted to counteract the effects of a particular herbicide, which can then be sprayed without affecting the crop. Herbicide resistant crops accounted for 71 percent of the global genetic modification area. By far, the most common genetically modified species is soybean, which accounted for 61 percent of the global genetic modification area. The Monsanto Company dominated global sales of GMOs with its soybean resistant to its own Roundup herbicide, and the main customers were commercial farmers who found the herbicide resistance convenient. The second most common genetic modification was insertion of a gene from *Bacillus thuringiensis* (Bt), which causes the plant to produce an insecticide. This replaced or augmented more environmentally toxic insecticides that have in some areas lost effectiveness to insect resistance. Again, most customers were large commercial farmers, but there was a growing market for Bt cotton among small farmers in India and China. After this there is a very sharp drop-off to the third-most widely used genetic modification technology, which induces virus resistance in produce in a small number of fruits and vegetables.

Development of genetically modified animals has progressed less quickly. The first commercial genetically modified animal in the United States, in 2003, was an aquarium fish made to fluoresce (banned in California as a life form genetically altered to amuse customers). Efforts are also underway to modify salmon to grow faster in fish farms.

Thus the first dozen years of GMO development have been heavily dominated by commercial interests; since GMO's require multiple genes and technologies, most of which are now owned by corporations, this situation is bound to continue. Yet much of the public discussion of GMO's centers on uses of the technology to improve nutrition in developing countries. There is a striking gap between voluminous media on theoretical humanitarian applications and the actual development of crops for such purposes. For instance, GMO-producing firms spent tens of millions of dollars advertising "Golden Rice," but years later, neither this nutritionally enhanced rice nor any other humanitarian crops had made it into farmers' fields. Humanitarian GMO's, which generally offer no major benefits to corporations except for public relations, have encountered serious problems with funding, biosafety testing, and intellectual property.

Nevertheless, laboratories continue to experiment with a wide range of genetic modifications reflecting the potential of the technology—bacteria to detoxify the environment and prevent HIV and perhaps cancer. The theoretical benefits of the technology are enormous, as is the question of whether these benefits will ever be realized.

SEE ALSO: Genetic Diversity; Genetic Patents and Seeds; Genetics and Genetic Engineering.

BIBLIOGRAPHY. Daniel Charles, *Lords of the Harvest: Biotech, Big Money, and the Future of Food* (Perseus, 2001); Mary-Dell Chilton, "Agrobacterium. A Memoir," *Plant Physiology* (v.125, 2001); Stanley N. Cohen, Annie C.Y. Chang, Herbert W. Boyer, and Robert B. Helling, *Construction of Biologically Functional Bacterial Plasmids In Vitro* (PNAS, 1973); Joesph de Vries and Gary Toenniessen, *Securing the Harvest: Biotechnology, Breeding, and Seed Systems for African Crops* (CABI International, 2001); John M. Golden, "Biotechnology, Technology Policy, and Patentability: Natural Products and Invention in the American System," *Emory Law Journal* (v.50, 2001); Aldous Huxley, *Brave New World* (Perennial Library, 1989); Clive James, "Global Status of Commercialized Biotech/GM Crops: 2005," *ISAAA Briefs* (Ithaca, 2006).

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Genetic Diversity

GENETIC DIVERSITY REFERS to a healthy and diverse gene pool for a specific species of either a plant or an animal. The term is also used to refer to the diversity of genetic material within an individual, a population, or an ecosystem. The latter is also and most often referred to as biodiversity (or biological diversity) and inevitably embraces all the levels of genetic diversity—namely genetic, species, community and ecosystem—needed to maintain the comprehensive health of an ecosystem.

Genetic diversity is important when discussing both micro- and macro-organisms. In terms of the former, public health intervention strategies to track the global spread of disease pathogens, to develop diagnostics and vaccines, and to understand the emergence of new and drug resistant vaccines are founded upon the insights provided by research into the genetic diversity of pathogens.

Individuals, species, and entire ecosystems are advantaged by high genetic diversity via their increased capacity to adapt. Such capacity is often referred to as *resilience*. Ecosystems, which are made up of many interacting species, are healthiest when species interactions are maximized or all relevant niches are filled. High genetic diversity is correlated with a healthy species and/or ecosystem in that it provides that species and/or ecosystem with the necessary materials for adaptation to environmental and physiological perturbations. Low genetic diversity is considered problematic in that it limits a specie's and/or ecosystem's ability to respond to changes.

A well known example of the dangers of low genetic diversity is the devastation that ensued when a virus infected and killed much of the potato crop of Ireland resulting in the 19th century Irish potato famine. Had there been more of a genetically diverse potato cultivation, it could have potentially averted this famine by allowing varieties resistant to the virus to continue. On an ecosystem level low genetic diversity is common in extreme environments (high latitude/altitude, overly dry) where only species with particular adaptations to those stressful environmental conditions can thrive. As global warming changes the temperature and water regimes of these areas, researchers are concerned about the native species' ability to adapt.

Biocomplexity is another term that is critical to understanding the role that genetic diversity plays in human-environment interactions, and refers to the multitude of biological, chemical, physical, behavioral, and social interactions that affect, sustain, or are modified by plants, animals and humans. Because all systems associated with life, both biological and human-made, interact and interdepend, they all exhibit biocomplexity.

ISSUES

As E.O. Wilson (and other scientists concerned abut the relatively rapid loss of biodiversity) tells us—"The human species came into being at the time of greatest biological diversity in the history of the earth. Today as human populations expand and alter the natural environment, they are reducing biological diversity to its lowest level since the end of the Mesozoic era, 65 million years ago"—humans are the biggest contributor to the genetic erosion that is imperiling life on earth. However, to the extent that humans have and continue to destroy that diversity, they also have the power to protect and enhance it.

Genetic diversity has gained a lot of attention in the last decades in almost parallel relation to two main human activities: increased destruction and/or fragmentation of natural habitat for human activities including resource extraction, settlement and food production and an increased reliance on centralized industrial agriculture. Both of these actions result from increasing human population pressure and the need to acquire more energy resources and space for human settlement and to grow more food through intensified industrial means.

Habitat loss and fragmentation result from the human drive to exploit resources and to provide areas for human settlement. Both activities permanently alter the ecosystem they invade. Resource extraction activities disrupt the ecosystem by removing plant communities and alienating resident fauna. Although often slated with the task of reclamation, resource extraction companies rarely achieve the level of species or ecosystem diversity that existed originally. In addition, genetic diversity is lost due not only to the removal of natural areas of habitation for plant and animal species but also through the consequent introduction of nonnative invasive species that enter the ecosystem and can work to highly diminish or wipe out a species.

One of the most destructive aspects of any resource extraction activity is the creation of roads into and out of an area. Most notably, roads work to fragment habitat into smaller and more isolated units, limiting the forage and breeding range of faunal inhabitants and thereby diminishing populations' genetic diversity. Similarly, roads invite the influx of nonnative plant and animal species, in some cases, the most destructive being squatters and other human populations that often overtax the biological resources in question. Roads also "fragment" a given area with their increased noise pollution and nonpoint source pollution to adjacent surface and ground water systems. These effects in turn also negatively affect resident plant and animal species.

Centralized industrial agriculture, a mode of mass producing food in monoculture environments with little or no human labor input, has also contributed greatly to the loss of genetic diversity in domestic and wild crop races. This is due to the reliance on fewer and fewer varieties of crops, chosen for such qualities as disease resistance, shelf life, and appearance. In the process of favoring a few varieties, the rest are not grown out lost. For example, in the last half century the United States alone has gone from depending on several hundred varieties of apple to less than a dozen. Similar changes have occurred in all major food crops. In tandem, industrial agriculture depends on a heavy use of fertilizers, pesticides, herbicides, and insecticides, which work to undermine the adjacent natural ecosystem, destroying more of the natural genetic diversity in the process. Genetically Modified Organisms (GMOs) are of major concern because they further threaten genetic diversity of both domestic and wild races due to their potential to invade a plants' genetic material via the same invasive characteristics that invaded the parent plant. GMOs also introduce ethical issues since they represent the first cases of the patenting of biological materials. Many multinational corporations, most notably Monsanto, have actually sued small farmers across the United States and Canada because they found canola plants in those farmers' fields that were patented GMOs belonging to Monsanto.

ACTIONS

There are many ways that humans can act to enhance genetic diversity, mostly by taking precautions to bolster biodiversity. Individuals/households can choose to purchase products grown in ways that preserve biodiversity. For example, buying certified organic produce is a way of not supporting the industrial agriculture paradigm as does buying locally grown produce at farmers markets or through a CSA (Community Supported Agriculture). Growing part of all of your own food also contributes. Communities can also be proactive by protecting local habitat from fragmentation that is threatened by unsustainable development. Although development cannot often be stopped completely, it can be planned is such a way that corridors and tracts needed to maintain healthy populations can remain. Lastly, policy makers need to be more proactive and forward-thinking by maintaining ecosystem integrity of areas designated as crucial to the perpetuation of endangered and threatened species.

SEE ALSO: Genetically Modified Organisms; Genetic Patents and Seeds; Genetics and Genetic Engineering; Seeds, Agrodiversity and.

BIBLIOGRAPHY. Cary Fowler and Patrick Mooney *Shattering: Food, Politics, and the Loss of Genetic Diversity* (University of Arizona Press, 1990); Gary Paul Nabhan, *Why Some Like It Hot: Food, Genes, and Cultural Diversity* (Island Press, 2006); Peter Pringle, Food, Inc.: *Mendel to Monsanto—the Promises and Perils of the Biotech Harvest* (Simon & Schuster Adult Publishing Group, 2005).

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Genetic Patents and Seeds

GENETIC PATENTS ON seeds refer to laws that grant private ownership of seed varieties. With recent developments in biotechnology, patent protection has been extended to include particular plant characteristics. Genetic patents have a long historical trajectory. In the United States, decreasing agricultural productivity in the early 20th century led to a series of official mechanisms establishing state support for basic agricultural research and laws to promote the interest of the agricultural seed industry. This included the Plant Patent Act of 1930, covering plant varieties that could be commercially reproduced asexually through techniques like budding, grafting, and cutting. From the 1930s on, there was increasing pressure from the agricultural industry to put stronger official laws in place. This culminated in the Plant Variety Protection Act (PVPA) in 1970, which granted proprietary rights to novel, sexually reproduced seed plants.

A decade later, key government decisions provided the legal architecture for the emergence of the agricultural biotechnology industry. These included the 1980 Supreme Court *Chakrabarty* decision, which granted patent protection for a microbe engineered to degrade crude oil and the 1985 *Hibberd* case, which established the patenting of genetically engineered plants. With the rapid development of biotechnology in the United States that followed, companies like Monsanto used the legal protection of patents to make increasingly broader ownership claims over genetically modified organisms (GMOs). To do so, they focused on securing early patents on key commercial crops and using these patents for leverage in licensing agreements.

Although adopting stricter regulations over biotechnology, western European countries were historically the first to coordinate regional patent efforts. In 1961 they established the Union for the Protection of New Varieties (UPOV), creating a framework for international plant-patent protection. UPOV has undergone three revisions (1972, 1978, and 1991). The United States joined in 1981 and from the mid-1990s through the present, membership has expanded to 61 countries. This is largely due to the General Agreement on Trade Related Intellectual Property Rights (TRIPS), created in 1994 within the World Trade Organization (WTO), requiring countries to adopt intellectual property rights as part of free trade negotiations.

CONTROVERSIAL ISSUES

Nevertheless, the patenting of seeds is controversial for numerous reasons. First, because much plant diversity originates in the global south, there are heated debates over foreign access to and the sharing of the economic benefits arising from genetic patenting. Critics assert that biotechnology companies' use of genetic patents to reap the profits from plants modified over hundreds of years with traditional breeding methods is a form of "biopiracy." Second, many fear that the enforcement of seed patents in the global South along with the continued opening of markets to subsidized agricultural imports from industrialized countries would displace subsistence farmers for industrial agricultural production. These concerns have been expressed in the International Treaty on Plant Genetic Resources for Food and Agriculture, approved at the 2001 meeting of the Food and Agricultural Association of the United Nations (FAO). Based on the Convention on Biological Diversity, this international seed treaty has the goals of protecting local farmers' rights of seed saving and sharing and ensuring that the economic benefits of patents reach local communities. Although the treaty came into force in June 2004, many countries, including the United States, have yet to ratify it. Critics fear the goals of the treaty will largely be subsumed under the mandate of the WTO.

Another controversial aspect of genetic patents on seeds are recent concerns over the legal implications of the cross-pollination of genetically modified plants with native varieties. North American farmers have already been prosecuted for patent infringement after genetically modified plants had unknowingly spread to their fields. The cross-pollination of genetically modified corn with native seedstocks in Mexico has heightened concerns that this genetic contamination, along with strict patent enforcement, could be disastrous for small-scale producers throughout the developing world. Industry efforts to prevent the transfer of genetically modified traits to wild plants and unmodified crops have resulted in even greater concerns over a method introducing a "terminator" gene into crops that eliminates seed fertility. Although touted as a means to address the problems of seed contamination, this gene could also spread via pollen, eventually destroying native seedstocks and wild plants. In this sense, the legal mechanism of patenting along with terminator technology could degrade the base of genetic material necessary for continued agricultural innovation.

SEE ALSO: Biodiversity; Biopiracy; Biotechnology; Convention on Biological Diversity; Genetically Modified Organisms; Monsanto; World Trade Organization.

BIBLIOGRAPHY. Martha Crouch, "From Golden Rice to Terminator Technology: Agricultural Biotechnology Will Not Feed the World or Save the Environment," in Brian Tokar, ed., *Redesigning Life? The Worldwide Challenge to Genetic Engineering* (Zed Books, 2002); Jack Kloppenburg. *First the Seed: The Political Economy of Plant Biotechnology, 1492–2000* (Cambridge University Press 1988); Vandana Shiva, *Protect or Plunder? Understanding Intellectual Property Rights*. (Zed Books, 2002).

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Genetics and Genetic Engineering

THE TERMS *GENES, Genetics,* and *Genetic Engineering* all refer to the molecular units of heredity and variability in living organisms. Gene comes from the German word *Pangen,* which is derived from the Greek *pan* (all) and *genos* (kind, offspring). Genes are the units of heredity that are recombined and passed through reproduction; they express characteristics in living organisms and contribute to biological variability. Genes are found in the germplasm, specifically the chromosomes, and are made of a sequence of amino acids found in an organism's DNA. In the modern discourse about genes and genetics, life is shaped by sequences of information carried by genes. This information codes the production of specified proteins or enzymes.

THE STUDY OF GENETICS

Genetics is the study of inheritance and variation. It seeks to understand the units of genetic action, heredity, mutation, and recombination. Since Darwin's work on the evolution of pigeons, finches, and earthworms, natural historians had been looking for casual mechanisms to explain evolution. The theory of natural selection proposed by both Darwin and independently by Alfred Russell Wallace posited that populations that can adapt to their environment are more likely to pass on their traits to future generations or progeny.

By 1900, natural historians had a prime candidate for the casual mechanisms of evolution when Hugo de Vries, Erich von Tschermak, and Carl Correns rediscovered the basic laws of inheritance. Gregor Mendel, an Austrian monk studying in the 19th century, developed a theory of inheritance while studying the reproduction of peas from 1857–63. According to Mendel, the variation of an organism's characteristics is the outcome of combinations and expressions of genes. For each characteristic of an organism, each individual inherits genes called alleles from each parent. Each characteristic is an expression of an alleles' molecular synthesis. If the alleles differ, some alleles will be dominant with others being recessive. The presence of a dominant allele will express that particular trait, but the recessive allele will still be in the hereditary material of the organism. For a recessive allele to be expressed all the units of heredity must be the same.

Biologists distinguish between phenotype and genotype. The phenotype of an organism is the expression of the organism's traits like eye color or leaf size. The phenotype of an organism can also be affected by its environment, such as when some plants are stunted by exposure to excess light. The genotype is all the hereditary material carried by an organism including the recessive traits not expressed in the organism. The genotype is the coded information found in almost all living cells that are passed along through heredity. The genotype codes for the expression of phenotype, and the phenotype can subsequently altered by its environment.

Soon after the rediscovery of Mendel's work, William Bateson coined the term *genetics* in 1905. Thomas Hunt Morgan incorporated much of Mendel's work into his own chromosomal theory of inheritance where chromosomes carry hereditary materials. Morgan's work suggested a sex-linked model of inheritance based on the white eye mutation in fruit flies (spp. *Drosophila*), which has become the model insect for geneticists.

APPLICATIONS AND DISCOVERIES

One early application of genetics was in plant breeding, particularly corn or maize. Here the hybridization of maize was studied at public breeding stations until it became commercially profitable for private enterprise. By the 1940s, genetics shifted from statistical breeding techniques to techniques based on molecular biology and biochemistry. Griffith's notion of the transformation principle and Avery's research showing the ability of Deoxyribonucleic acid (DNA) to transform cells pointed to the centrality of DNA and its constitutive amino acids in inheritance. They resolved a contemporary debate regarding whether proteins or amino acids contained the hereditary information.

In 1953, Crick and Watson made their famous discovery of the double helix through X-ray diffraction. The race to solve the structure of DNA was quite competitive, with all parties agreeing that the timing of the discovery was immanent. Wilkins and

Genetic engineering has been extensively incorporated into medical practice, but not without social concerns.

Franklin took the first X-ray photographs of DNA at King's College in London and shortly thereafter passed the images on Watson and Crick, helping them solve the puzzle.

The discovery of the double helix through X-ray diffraction was a critical juncture in the marriage of genetics and physics. It was another demonstration of the superiority of reductionist model of science. It soon became common to describe the process of heredity as the passage of information, messages, and code. Life itself was simply characterized as a computer program built on a cybernetic feedback system. These mechanisms oriented molecular biologists, as the profession soon began to inquire about the ways that DNA was encoded in the cell nucleus.

Genetics as a discipline emerged in elite universities such as Caltech, MIT, Harvard, and the University of California at Berkeley; research centers like Cold Spring Harbor Labs, New York; and new centers of the information economy developing in places like Santa Fe, New Mexico, California's Bay Area, and Cambridge, MA. These places boomed as private and Federal research dollars were directed to the pursuit of new molecular sciences: immunology, virology, cell biology, biochemistry and microbiology.

DNA ANCESTRY

The tools of genetics were soon extended into areas of archaeology and anthropology. Attempts to understand historic human migrations out of Africa and into the Americas often rely on studies of mitochondrial DNA. All human have two sets of DNA. The first is found in the chromosomes found in the cell nucleus, while the second freely floats in the cell in the mitochondria. Chromosomal or nuclear DNA is inherited from both parents while mitochondrial DNA is only inherited through the female lines of inheritance. This means that every parent has contributed to an individual's nuclear DNA, but mitochondrial DNA is traced only through the mothers mitochondria. Those who share the same mitochondrial DNA are a member of the same haplo-group. This provides clues to ancestry, as certain haplo-groups will always have similar ancestors.

POLYMERASE CHAIN REACTION

The polymerase chain reaction (PCR) is a significant tool for geneticists working on a wide variety of problems including those in ecology and anthropology. PCR is a chemical reaction used to copy fragments of DNA. PCR has been used to map the genomes of many species including humans. The mapping of the human genome has raised considerable controversy as questions about what to do about genetic "defects" and alterations of the gene pool are constantly raised. Other controversies involve how genetics might be used as a tool for discrimination, genetic profiling, and the role that genetics might play in determining a genetic basis for human behavior.

GENETIC ENGINEERING

Genetic engineering is the term usually reserved for these molecular modifications that use recombinant techniques. With genetic engineering, scientists argue they can more precisely manipulate the units of heredity at the molecular level. Novel assemblages of genes can made by moving genes across the species barrier, bypassing the condition of sexual compatibility previously required for genetic recombination.

Genetic engineering introduces foreign DNA into the host organism in several different ways. The most popular way is to introduce the DNA into host with a viral or bacterium invasion into the host's nucleus. This virus or bacteria is known as the promoter. Transferring genes using a bacterium involves combining the desired gene with a plasmid, which is then carried by an agrobacterium. The agrobacterium inserts itself through the cell wall depositing the desired gene in the host organism. After gene transfer both the promoter and the desired gene remain in the plasmid. These plasmids are then cultured, and in the case of plants, moved to a greenhouse where it is determined whether or not the desired gene is expressed in the plant's phenotype.

Often this is done with a marker gene, which when expressed, makes it easy to identify which plants contain the desired gene. The most common marker genes are those for antibiotic resistance so that the determination can be done early. Antibiotics kill cells without the new genes. This has raised many food safety concerns about genetically engineered foods because it is unclear whether or not the antibiotic resistance affects human health or promotes resistance. Newer marker genes include traits of phosphorescence from jellyfish, where the desired trait can be ascertained from the organism's exposure to a black light. Other genetic engineering techniques use non-viral promoters. The particle gun technique uses gold or tungsten covered pellets coated with bits of DNA that penetrate the cell wall and randomly insert themselves into the hosts DNA.

Genetic engineering is used synonymously with the term *genetic modification*. The term is used politically to denote the precision of r-DNA techniques. Scientists often argue that much of plant breeding, for example, is a form of genetic modification. By proclaiming the practice as genetic engineering, scientists invoke a sense of control that was previously unattainable in molecular biology, medicine, and plant breeding.

CONTROVERSIES AND SOCIAL CONCERNS

Genetic engineering has been extensively incorporated into medical practice. DNA techniques are used to diagnose genetic diseases and to develop medicines such as human-made insulin for diabetics, promising treatments for breast cancer, and medicines to help kidney transplant patients avoid rejecting the new organ. However, these technologies have not been without social concerns. Concerns about social justice emerge with human engineering and the way that the identification of genetic "defects" will affect insurability of some social groups.

Genetic engineering is far more controversial in agricultural biotechnology where it has become embroiled in controversies in places as ideologically distant as Geneva and Mendocino County, California. Subsequent to the containment issues raised with the early r-DNA experiments, the deliberate introduction of genetically engineered organisms [GEOs; also known as genetically modified organisms (GMOs) or transgenic organisms] into the environment set off a host of new controversies.

In 1983, the deliberate release of the "ice minus" bacterium developed by University of California biologist Steven Lindow set off a new round of local reactions in the Bay Area cities of San Francisco, Berkeley, and Oakland. Lindow planned to spray potatoes in the Tule Lake area of Northern California with an "ice-nucleation active" bacterium that would inhibit the formation of frost on the plants. These field tests were approved by the NIH's RAC. Activist Jeremy Rifkin of the Foundation on Economic Trends obtained a court injunction to stop the release, arguing before the court that the experiment posed an environmental hazard.

In 1985, Congress decided that new regulatory agencies were not necessary, and that the existing regulatory system was appropriate for handling the classes of concerns raised by ecologists and activists. Many activists and ecologists simply saw this as an effort to manage GEO introduction instead of regulate them. The Food and Drug Administration would evaluate food safety concerns; the Environmental Protection Agency (EPA) would oversee concerns about toxicity; and the Department of Agriculture's Animal and Plant Health Inspection Service would regulate problems related to increased weediness and biological invasion.

Also in 1985, the Ecological Society of America released a position statement noting the potential ecological and environmental hazards associated with introducing GEOs into the environment. They noted that the products of r-DNA technologies, genetic engineering, posed no new classes of ecological hazards. But the novelty of the new technology warranted regulatory oversight, because there is the potential for more extreme and uncertain ecological hazards. Ecological and environmental problems may follow from intrinsic qualities of the plant itself, its interaction with its environment, and/or the practices associated with its cultivation. These hazards in many cases are the extreme versions of

Big Business

Genetics research became big business with the creation of the National Science Foundation and the National Institutes of Health after World War II. Now private companies and private researchers could benefit from government research contracts. Entire industries emerged around the development of scientific research equipment and materials. The new wave of innovation in all of the life sciences was driven by the privatization of research and eventually the privatization of molecular life itself.

In 1973, a University of California, San Francisco (UCSF) molecular biologist Herbert Boyer and Stanford molecular biologist Stanley Cohen conducted the first recombinant DNA experiments, which led to the new technology now know as *genetic engineering.* Using plasmids, they cut and spliced one living organism's DNA sequence in vitro to another organism.

The significance of this experiment was clear in several ways. First, it led UCSF, Stanford, and eventually other universities, to set up university-based patent offices. Second, coupled with the rollback of public funding for higher education, it provided the universities with a private means for funding public education. Third, it set off questions about the potential hazards of r-DNA experiments. Some r-DNA experiments were using viruses as vectors to introduce the foreign DNA.

At the Gordon and Asilomar conferences of the early 1970s, Paul Berg and about a dozen other leading molecular biologists called for a temporary moratorium of certain kinds of experiments. They also recommended that the National Institutes of Health (NIH) form the Recombinant DNA Advisory Committee (RAC) to evaluate the consequences of r-DNA experiments. In 1975, a second Asilomar conference focused on biosafety concerns was called upon to preempt any ethical or social considerations of r-DNA manipulations. By 1976, the RAC recommended guidelines for r-DNA experiments that included specific containment facilities and protocols for recipients of Federal funding.

The NIH guidelines served to publicize the dangers of r-DNA. The publicity generated by legal actions by environmental groups like the Environmental Defense Fund and Friends of the Earth generated debate in the U.S. Congress and the House of Representatives about Federal regulations on r-DNA experiments. In the end, Congress decided to do nothing; however, some local jurisdictions such as Cambridge, Massachusetts, began to regulate r-DNA experiments at the local level, sending a message to scientists that the overall health and safety of the community could be the basis for the regulation of scientific experiments.

Soon the guidelines were relaxed after more scientific understanding of the safety of the experiments was garnered. No hazards had materialized, weakening the arguments of environmental and public interest groups. The RAC furthered relaxed rules to protect the proprietary considerations of corporate laboratories and rules that distinguished between large-scale and small-scale experiments at the request of Eli Lilly. By the time these changes to the RAC guidelines in 1983, almost all r-DNA experiments could be considered exempt from oversight.

conventional analogs, but the novelty of some traits makes ecological effects even more likely. If the organism became endowed through gene flow with traits that improved its fitness, the organism could act as invasive plants do.

GENE FLOW

Gene flow is the movement of genes from one place to another as when seed is transported or pollen drifts and subsequently hybridizes. If gene flow leads to introgression, the subsequent backcrossing of two hybrids, the transgene may remain in the wild or weedy population potentially increasing weediness or invasiveness if the transgene confers fitness advantages.

Gene flow also poses consequences to genetic diversity as outbreeding depression or genetic swamping could result in the extinction of wild relatives in the Vavilov centers of genetic diversity. The potential for outbreeding depression would follow if short-term fitness advantages favor the increased presence of the transgene in the population but with long-term fitness consequences over time (e.g., reduced fecundity, increased disease susceptibility). Genetic swamping would occur where the receiving plants are relatively rare and exposed to high rates of hybridization. These concerns are paramount in the case of transgenic maize in Mexico, as there are instrumental as well as intrinsic values of biodiversity at play; small farmers as well as international research institutions depend upon the diversity of wild relatives and landraces for plant breeding.

GENE FLOW AND TRANSGENIC HAZARDS

Other hazards associated with the adoption of GEOs include those to agroecosystems. Widespread use of herbicide-tolerant (HT) RoundUp Ready™ and Liberty Link® crops could lead to the rapid evolution of resistance to herbicides like glyphosate and glufosinate in weeds, either as a result of increased exposure to the herbicide, or as a result of the horizontal transfer of the HT trait to weedy relatives of crops. HT crops could change the mix of herbicides used as some become ineffective, which could result in greater levels of overall environmental harm. Since herbicides differ in acute toxicity and persis-

Mexican Maize

In 2001, a University of California at Berkeley professor and his graduate student tested maize landraces grown in Oaxaca, Mexico, the center of crop diversity for maize, and found the presence of patented transgenes despite a moratorium on transgenic maize. Their study found not only the presence of transgenes in maize landraces, but also suggested that the transgenes inherited did not exhibit the stability ensured by the crop's developers and patent holders. Their initial findings were published in a brief article in the journal *Nature*. Shortly after publication, the journal came under fire from the scientific community, particularly those supportive of the life sciences industry and from within the discipline of molecular biology. *Nature* retracted the article, questioning the researchers' methodology and interpretation of evidence. When data were subsequently submitted supporting the findings, *Nature* refused to publish them, to retract the retraction, or to provide a forum to pursue earlier editorial commentary.

Despite concerns that transgenic crops may pose threats to biodiversity, the *Nature* controversy continues to be framed as one of academic practice and integrity. The point that GE traits were found in Mexican maize landraces, a Vavilov Center of crop-wild diversity, seem to be less a concern. Opponents were noticeably silent about the permeability of the food and seed systems in response to questions from NGOs, indigenous groups, and ecologists about the adequacy of regulatory institutions to control the deliberate introduction of GEOs.

tence, loss of some herbicides may be detrimental to the environment overall.

The introduction of transgenic crops also raises concerns about insect resistance. The naturally occurring microorganism *bacillus thuringiensis* (Bt) has been used as a pesticide for several decades, as it crystallizes and blocks the passage of food into the stomach of many species of Lepidoptera, effectively killing them. Its rapid degradation when exposed to UV light keeps it outside of the EPA's oversight, allowing it to be widely used in powdered form by organic farmers. However, many studies have shown that Bt resistance can evolve rapidly in agroecosystems. Incorporating the genes that produce Bt's endotoxin into plants and subsequently planting them on such a large scale could, unless properly managed, hasten the evolution of resistance, with implications for both organic and conventional farmers. Currently, industry argues that high dose-refuge model will suppress the evolution of resistance in Lepidoptera. They argue that the high dose of Bt will kill most of the pests and that the alleles that develop resistance will be "diluted" by the presence of a non-Bt refuge harboring Bt-susceptible Lepidoptera. However, this argument rests on two assumptions. The first is that Bt resistance is a recessive trait; the second is that farmers actually plant the refuge.

The impacts of transgenic crops on biodiversity from changes in farming practices may be to the detriment of the biodiversity near and in farms. In October 2003, the Royal Society of the United Kingdom published its findings from farm scale evaluations. Two out of the three crops studied demonstrated an association between transgenic crops and practices harmful to wildlife as well as a tendency to decrease biodiversity. The report attributed the impacts to changing in spray regimes of herbicides, finding that wildlife adjacent to GE crops were subject to increased exposure to agrochemicals such as atrazine, pointing to a significant difference in agronomic practices associated with GE and conventional varieties.

Nontarget effects of GE crops could threaten both biodiversity and agronomic practices such as biological control. Plants engineered to produce toxins in mobile tissue parts such as pollen pose threats not only susceptible species that enter into areas where the crop is grown, but also to the adjacent field margins where the pollen may drift as in the monarch butterfly controversy. Researchers suggested that Bt, *bacillus thuringiensis*, which drifted onto milkweed growing in adjacent to fields of Bt corn, increased the mortality rates of monarch larva. Toxic mobile plant tissues may impact soil biota as well. Bt has been shown to accumulate in the soil through the root exudates of transgenic plants. The impact of dosing the rhizosphere with the Bt endotoxin has not been evaluated for consequences to nontarget soil organisms or to soil health. Beneficial insects used in the biological control of pests are also subject to nontarget effects. One study suggests that the green lacewing, an insect beneficial to farmers because it predates the same pest that Bt is used against, suffers greater mortality rates after consuming Bt-fed prey.

Transgenic crops conditioned to produce viral-resistance potentially can create new or more virulent viruses through two mechanisms: recombination and transcapsidation. The former can occur between the plant-produced viral genes and closely related genes of incoming viruses; the latter occurs when nucleic acids from one virus are incorporated into the protein structure of plants. Both can result in viruses that infect a wider range of hosts, demonstrate increased virulence or lead to a biological resistance "arms race." Further, some viruses play an ecological role in plant community dynamics. For example, barley yellow dwarf virus resistance has been engineered into cultivated oats to prevent yield losses. It has also been shown to suppress invasive wild oats. The transfer of viral resistance in this case may increase the invisibility of wild oats in natural communities as it alters plant competitive interactions.

BIOSAFETY

GE animals and insects pose other questions about biosafety. Transgenic salmon engineered with genes from an ocean pout grow at rates six to ten times faster, because growth hormone production, which seasonally shuts down in salmon found in the environment, does not shut off. Because of the advantages of fast growth, these fish may out-compete native fish if they are released into the ocean. Researchers at the University of Purdue developed the Trojan gene hypothesis: Under this scenario, the fish out-compete naturally occurring fish, but suffer long term deficiencies associated with the growth hormone staying turned on. The critical question in the regulation of transgenic salmon is whether salmon grown in open sea aquaculture pens will be required to be sterile, or whether growing transgenic salmon will only be permitted on land.

Biosafety ecologists agree that ecological impacts are greatly unknown. Ecological risk assessment suggests that some organisms pose threats to the environment, while others will suffer greater fitness consequences from having their phenotypic expression altered. A more modest approach to evaluating the risks of biotechnology recognizes uncertainty, complexity, and incomplete knowledge while emphasizing the precautionary principle from post-release monitoring to designing rigorous ecological risk assessment.

Activists urge that assessments of genetic engineering be accompanied by analyses of the social consequences of these novel technologies. The history of technology adoption is littered with inequality and disproportionate burdens of impacts. To this end, many activists have been successful in using biosafety as a surrogate for getting at questions about access, control, and development of new technology.

SEE ALSO: Biodiversity; Bipiracy; Deoxyribonucleic Acid (DNA); Genetically Modified Organisms; Genetic Diversity; Genetic Patents and Seeds.

BIBLIOGRAPHY. Peter J. Bowler, *The Mendelian Revolution: The Emergence of Hereditarian Concepts in Modern Science and Society* (John Hopkins University Press, 1989); Lily Kay, *Who Wrote the Book of Life, A History of the Genetic Code* (Stanford University Press, 2000); Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy* (MIT Press, 1982); National Research Council, *Environmental Effects of Transgenic Plants* (National Academy of Sciences, 2002); Paul Rabinow, *Making PCR: A Story of Biotechnology* (University of Chicago Press, 1996); Alison Snow et al., "GEOs and the Environment: Current Status and Recommendations," *Ecological Applications* 2004.

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Geographic Information Science

ORGANIZATIONS THAT HAVE a planning, research, management, operational, and/or regulatory responsibility at the local, county, state, or federal level are increasingly turning toward Geographic Information Science (GISc) technology as an approach to data organization, visualization, integration, synthesis, and modeling. GISc is an integrated set of tools, techniques, concepts, and data sets associated with a host of spatial digital technologies including Geographic Information Systems, Remote Sensing, Data Visualization, Global Positioning Systems (GPS), Spatial Analysis, Quantitative Methods, and Spatial Modeling.

GISc is routinely used in government agencies, corporations, environmental health and ecological consulting firms, planning organizations, and academic institutions. Together, and separately, GISc has gained prominence across the social, natural, and spatial sciences. As a rapidly growing computer technology, GISc supports many kinds of decision making and analyses, including environmental policy, marketing, planning, demographic analysis, resource management, ecological analyses, health care delivery, nutrition and diet, environment and health, epidemiology, and information technology. These spatial digital technologies offer the opportunity to gain fresh insights into the pattern of variables and the behavior of systems through, for example, the spatial, temporal, spectral, and radiometric resolutions of remote sensing systems that are capable of mapping a host of social and ecological landscapes; the analytical and data integration capability of Geographic Information Systems (GIS); the locational specificity afforded through GPS; the importance of data visualizations to characterize patterns and to relate scales of representation to processes influencing areal distributions recorded over space and through time; and the predictive power of quantitative models and the descriptive capacity of statistical relationships and spatial analyses.

GISc is a fundamental, spatial, and non-spatial informational framework and perspective used to understand the nature of geographic data and provide theoretical foundations for geo-spatial techniques.

GISc evolved from the computerized, geographic information systems of the 1960s and 1970s. The increased demand and availability of spatial data and spatial data analysis, together with improved computer power and algorithms and software functionality have transformed a spatial analytical perspective characterized as a simple toolbox to an information system, and now to an integrated approach to science (i.e., GISc). Central to GISc is a suite of spatial digital technologies, best exemplified by GIS, Remote Sensing, and GPS.

GIS TECHNOLOGY

GIS and the other spatial technologies operate synergistically to create a model of reality that reflects the informational requirements of the project and the data visualization needs of the user. To achieve this duality of information and presentation, paradigms of mapmaking have shifted from the communication paradigm to the analytical paradigm. This shift is marked by a departure from the physical map as the final cartographic product—in which base information has been transformed and symbology applied for graphical display—to an approach in which geographic data are stored in a computerized database to provide multiple views of the information to multiple users, and where the physical map is only one form of visualizing spatial pattern, distribution, and association. The power of the approach is based on its interactivity, integration, customization, and alternative visualizations. GIS technology offers an analytical framework for data synthesis that combines a system capable of data capture, storage, management, retrieval, analysis, and display. From a functionality perspective, GIS techniques examine spatial and nonspatial relationships through analytical tools and techniques that, in general, include attribute operations, overlay operations, neighborhood operations, and connectivity operations; represent an array of landscape perspectives through the integration of geographically registered spatial coverages; efficiently display such information through a variety of data visualization approaches for spatial and temporal pattern analysis; examine the co-occurrence of spatial and nonspatial data through database manipulations; display singular thematic coverages or composited coverages through cartographic and/or statistical approaches; and model the location and behavior of phenomena through empirical and process models.

REMOTE SENSING TECHNOLOGY

Remote Sensing is a surveillance and mapping science that is concerned with the observation and/or measurement of objects and features without having the measuring device in direct contact with the entity of interest. Remote sensing takes into account how energy and matter are interrelated at distinct spectral regions, whether collected on film or by digital sensors. Remote sensors are engineered to be sensitive to different parts of the electromagnetic spectrum (spectral resolution); map different sized objects and features (spatial resolution); and assess landscape characteristics using a quantitative range of response intensities (radiometric resolution), generally extending from 0 (low intensity of reflectance) to 255 (high intensity of reflectance). Remote sensing systems also are capable of rendering views across time (temporal resolution) as a consequence of their historical perspective of operation and their orbital specifications that periodically returns the satellite over the same geographic location for change imaging. Optical sensors are most commonly applied to landscape mapping. Optical sensors typically operate in the visible, near-infrared, and middle-infrared spectral regions of the electromagnetic spectrum, because of their capacity to discern important biophysical characteristics of the landscape including special properties of vegetation. In film products, information collected about the landscape is generally amalgamated into a single image by compositing the film layers, but in digital data sets, separate images or channels are retained for each spectral region so that the user can combine information about the landscape as appropriate.

GPS TECHNOLOGY

Finally, GPS involves the use of a constellation of 24 satellites that broadcast precisely timed signals to fixed and roving receivers to triangulate and transmit geographic coordinates for the characterization of positions recorded in the x-, y-, and z-dimensions. A host of applications rely upon

GPS technology including airplane, car, and boat navigation; ecological and engineering activities conducted in local and remote environments; and surveying and mapping for business and industry. Also important for linking people and the environment, Earth coordinates are collected at household dwelling units as part of a socioeconomic and demographic survey so that locational information are explicitly linked to household variables, land parcels associated with individuals and households are spatially referenced, and sources and destinations of migrants can be geographically described and linked to characteristics of people, places, and environment. In short, GPS technology effectively defines the "where" of a variety of studies and analyses that are conducted at local, regional, national, and international settings.

SEE ALSO: Geography; Global Positioning Systems; Land Use Policy and Planning.

BIBLIOGRAPHY. D.A. Quattrochi, S.J. Walsh, J.R. Jensen, and M.K. Ridd, "Remote Sensing: Prospects, Challenges, and Emergent Opportunities," in: G.L. Gaile and C.J. Willmott, eds., *Geography in America at the Dawn of the 21st Century* (Oxford University Press, 2004); S.J. Walsh, T.P. Evans, and B.L. Turner, "Population-Environment Interactions with an Emphasis on LULC Dynamics and the Role of Technology," in: S.D Brunn, S.L. Cutter, and J.W. Harrington, Jr., eds., *Geography and Technology* (Kluwer Academic Publishers, 2004).

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Geography

THE WORD GEOGRAPHY is rooted in the Greek and literally translates to "writing the earth." As a modern academic discipline, it is characterized by multiple traditions usually regarded as sharing a common concern for the spatial qualities and problems of the world, and the complex relationships between human beings and nature. Following a period of low academic profile, the discipline is apparently resurgent, especially as global environmental problems and issues have emerged center-stage and the spatial and scalar nature of contemporary social and economic problems has become increasingly apparent.

The foundations of the modern discipline of geography are found in other disciplines and throughout history. For example, ancient Greek writers—including Aristotle—frequently commented on the nature and order of the environment and society. During the 16th and 17th centuries, by uniting religion and academic observation of the world, theology played an important part in thinking about environment. Natural Theology, for example, assumed that since God made the world's features, studying them could enlighten humankind as to the character of God. These and other diverse bodies of academic scholarship made it possible to eventually build a discipline—geography—that is concerned exclusively with features of the natural and social world.

GEOGRAPHY AND DETERMINISM

Emerging in the 19th and early 20th century, geography used the world's regions as a basic explanatory unit on scales ranging from continents to the political and natural subdivisions of countries. At first, this regional geography purely described region's social and natural contents. Gradually, however, the interaction of the natural environment and human behavior was accorded dedication attention. Drawing on Darwin's work, the theory of Environmental Determinism, for example, argued that local environmental conditions determine the character of people and their activities. Such arguments were used to explain European "achievements" over peoples living under less ideal environmental conditions and, not surprisingly, served to reinforce European supremacy in the world. Meanwhile, other influential geographers such as the German Friedrich Ratzel and the Englishman Halford Mackinder examined the territorial growth of states and empires. In his 1904 paper *The Geographical Pivot of History* Mackinder introduced his Heartland Theory, which argued that in order to dominate the world and dictate world affairs, the world's heartland (Eurasia) must be occupied. He famously stated, "Who rules East Europe commands the heartland, who rules the heartland commands the world island, who rules the world-island commands the world." These kinds of ideas filtered into the turbulent and aggressive European politics of the era. At this time a divide was also growing between physical and human geography. The former being concerned with the working of the world's physical environment, the latter—as the above discussion of nation states indicates—being concerned with society and environment.

SPATIAL TO HUMANISTIC GEOGRAPHY

By World War II, human geography had begun to develop a scientific rationale and approach. In his 1939 book *The Nature of Geography,* Richard Hartshorne argued that geography existed purely to discover the functional spatial integration of phenomena. Based on these ideas, a growing assumption in the discipline of society being logically and geometrically distributed over space provided the theoretical basis of *spatial science,* which, as a paradigm, dominated geography until the 1970s. Assisted by emerging computer technologies in their attempts to articulate the world's various spatial orders, geographers focused their attentions on distances, directions, locations, and spatial associations. Geographers typically refer to the rapid emergence of spatial science in their discipline as the "quantitative revolution."

During the 1970s, spatial science was attacked and undermined from within the discipline. Many geographers were concerned that, through spatial science, geography was incorrectly privileging distance above all other relational features of social and economic life and moreover, in doing so, was isolating itself as an exclusive science of space. Another criticism of spatial science highlighted the abstraction of people and places in this research to dots on maps and numbers in equations. It was thought that this filtered the complexity of individuals and humanity out of geographical writing. Critics were also concerned about the assumption made in spatial science that people behave rationally, predictably, and economically. In this regard, critics emphasized people's capacity for individuality, irrationality, to follow fashions and act on their own tastes and whims.

From these critiques, a humanistic tradition grew in human geography and emphasized human agency and individuality. Humanistic geography pioneered a much more sensitive approach to the study of people, which remains in the contemporary discipline to this day. Moreover, they started to think about the complexities of places, beyond being physical locations or boundaries of human activity to being social phenomenon that facilitate human actions, interactions experiences, attachments, identities and possess symbolic meaning. The new subjects studied by humanistic geographers were diverse and included considerations of art, history, poetry, and fiction.

At the same time, in a search for explanations of fundamental social processes, a Marxist approach emerged within the discipline. This work was based on the observation that, to exist, Marx's political economy of capitalism depended on the production of a space-economy. David Harvey called it the "spatial fix of capitalism," referring to how capitalism is reliant on space, the availability of which determines its success and nature of its development. In terms of how this works out in the world, Marxist geography thought of urban space as being shaped by the unequal division of capital (owners and workers) and being contested by these respective classes.

During the early 1980s, the humanist paradigm was critiqued for its lack of theoretical depth and for its general descriptiveness. Meanwhile, Marxist geography was criticized primarily for privileging capitalism in determining societal orders to the neglect of other identities in society. Indeed, during the 1990s and into the new millennium, a growing number of human geographers have become interested in the relationship between culture and place. In a rapid disciplinary movement, postmodern theoretical perspectives and qualitative methods have been adopted by the discipline. Cultural geographers explore how language, meaning, experience, and subjectivity are related to place. Amongst geographers, these emerging interests have become known as the *cultural turn.*

MODERN GEOGRAPHY

Human geography is now composed of a number of highly overlapping subdisciplines, some of which are distinguishable by their focus on a specific type of place (for example, rural geography and urban geography), others that are more clearly distinguishable by their focus on a specific empirical subject or theme (for example, development geography, tourism geography, and health geography) and others that are more clearly distinguishable by their specific conceptual focus (for example, historical geography, feminist geography, and moral geography).

Moreover, overlapping the borders of many are recognized debates or bodies of literature (geographies of caring and emotional geographies). Meanwhile, physical geography has retained its scientific basis and approach and has escaped many of the paradigm shifts and trends outlined above. Its scope remains broad, investigating the spatial character and patterning of natural phenomenon such as vegetation, soils, landforms, climate, and various water masses. In terms of disciplinary connections, physical geography incorporates—and has obvious broad overlaps with—geomorphology, geology, hydrology, meteorology, climatology, and even oceanography.

Human and physical geography might be distinguishable, yet there are obvious overlaps, particularly in considerations of environment and society. Moreover, institutionally they are often taught together in universities and schools the world over.

SEE ALSO: Climatology; Geology; Geomorphology; Oceonography.

BIBLIOGRAPHY. M. Crang, *Cultural Geography* (Routledge, 1998); D. Gregory, *Geographical Imaginations* (Blackwell, 1994); D. Harvey, *Social Justice in the City* (Arnold, 1973); D. Harvey, *The Condition of Postmodernity: An Enquiry Into the Origins of Cultural Change* (Blackwell, 1989); R.J. Johnston, D. Gregory, G. Pratt, and M. Watts, eds., *The Dictionary of Human Geography,* 4th ed. (Blackwell, 2000); D. Livingston, *The Geographical Tradition: Episodes in the History of a Contested Enterprise* (Blackwell, 1992); E. Relph, *Place and Placelessness* (Pion, 1976).

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Geology

GEOLOGY IS THE study of the solid, nonliving earth, including earth's materials, structure, processes, and history. Earth's nonliving materials and features are the result of geologic processes. Geologists study these processes, operating today, and in doing so interpret how ancient earth materials or features formed. By determining these processes, and the time at which they occurred, geologists interpret the history of the earth. The science of geology includes the following subdisciplines: mineralogy, the study of minerals; petrology, the study of rocks and their formation; geomorphology, the study of earth surface processes and landform development; sedimentology and stratigraphy, the study of sediment and strata; paleontology, the study of fossils and ancient life; structural geology, the study of rock deformation; geophysics, physics of the earth; and geochemistry, chemistry of the earth.

To environmental science, geology provides the knowledge base for several basic areas of study. Geology includes the study of geologic time and earth history. Information about ancient (prehuman) earth and its atmosphere, hydrosphere, environments, and geologic processes, is preserved in the rock record. Geologists interpret the information in the rocks and provide analyses of earth's ancient conditions. For example, information about the Precambrian atmosphere is interpreted from mineral assemblages and fossils contained in Precambrian strata. Similarly, the long-term record of global climate change, including global warming and cooling, is preserved in the rock record.

Geologic maps portray the surface occurrence of different types of rocks. These maps are the result of careful ground-based investigations. Geologic maps provide the locations of different rocks and sediment deposits on earth's surface. They can be used to predict the suitability of various places for different types of land use, and to show the surface occurrence of mineral and energy resources.

Geologic maps are also used, sometimes in conjunction with subsurface information obtained through drilling and geophysical methods, to interpret the location and structural geometry of rocks in the subsurface. Such information is used to find and assess the occurrence of mineral and energy resources in the subsurface. In addition, these configurations, together with information about the permeability of the rocks, control the presence and movement of subsurface fluids such as groundwater, oil or natural gas. For example, the direction and speed of groundwater flow, including any contaminants, may be predicted by understanding the nature and geometry of rocks in the subsurface.

Information about the surface and subsurface occurrence of rocks, sediments, and minerals is also important to the extent that these materials interact with water or other fluids. Through the process of weathering, bedrock contributes solid and dissolved constituents to groundwater, surface water and soils. These constituents may constitute basic nutrients or contaminants, depending on the constituent and its concentration. Some subsurface materials—such as sand or sandstone—may act as a natural filter, removing particulate matter and thereby purifying groundwater.

GEOMORPHOLOGY

Geomorphology is the study of landforms and their genesis through processes such as weathering and erosion. These processes include the agents by which the earth's surface is modified by the action of gravity, running water, wind, groundwater, glaciers, and ocean waves and tides. Sedimentology is the study of sedimentary depositional processes. The history of conditions that occurred at various places on earth's surface is preserved in strata. Stratigraphy is the study of these strata and the historical conditions they represent. Paleontology is the study of fossils and the conditions under which ancient life forms existed.

Geology includes the study of the tectonic process, which is driven by the interactions between earth's tectonic plates. These interactions result in earthquakes, volcanoes, tsunami, uplift or subsidence of the land surface, and long-term deformation of rocks. Plate tectonics is a relatively young discipline, and has been understood since the 1970s. Plate tectonics has revolutionized and unified the science of geology. We now know that mountain belts, continents, ocean basins, and the earth's crust are all formed by slow plate tectonic processes that have been operating for billions of years.

Geologic hazards are a major environmental concern. These hazards include earthquakes, volcanoes, tsunami, ground subsidence, floods, and landslides. Most of these hazards are the result of an extreme case scenario of an otherwise normal geologic event. For example, rivers usually flood every year. We don't notice many of these floods because they are a normal occurrence in the yearly variation in the flow of the river. However, conditions that control river flow, such as precipitation and runoff, may be excessive and may result in an extreme flood event. A 100-year flood is the maximum flood that occurred, or is statistically estimated to have occurred, over a 100-year interval. Similarly, most earthquakes have a low magnitude and are not noticed or have minimal effects. However, the less frequent, high magnitude earthquakes have been extremely destructive, as is the case for San Fransisco.

By determining geologic processes and timing, such as in rock strata, geologists interpret the history of the earth.

Time is an important dimension in geology. All geologic information must be understood in the context of geologic time. When and over how long a period did a geologic feature (mineral, rock, landform, mountain belt, etc.) form? Some geologic processes such as floods, earthquakes, and volcanic eruptions occur over observable time spans. Each of these processes, however, is part of longer term processes that occur slowly, over thousands to hundreds of millions of years. Floods are part of the process by which river landscapes are developed. Earthquakes and volcanoes—which themselves occur quickly—are involved in the long-term formation of ocean basins, or in mountain-building. These long-term processes can not be directly observed, but must be interpreted from the record preserved in rocks. The interpretation of these processes, and the time and duration of their formation, is a major emphasis in the science of geology.

SEE ALSO: Earthquakes; Floods and Flood Control; Geographic Information Science; Groundwater; Hazards.

BIBLIOGRAPHY. Michael L. McKinney, Kathleen M. McHugh, and Susan P. Meadows, *Current Perspectives in Geology* (Brooks/Cole, 2000); Bernard W. Pipkin, Dee D. Trent, Richard Hazlett, and Paul Bierman, *Geology and the Environment,* 5th ed. (Brooks/Cole, 2008); Edward J. Tarbuck and Frederick K. Lutgens, *Earth, an Introduction to Physical Geology* (Pearson-Prentice Hall, 2005).

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Geomancy

THE TERM *GEOMANCY*, derived from Greek roots, refers to the earth (*geo*) and attempts to use attributes of the earth in a prophetic (*mantikos*) manner. Geomancy involves the use of the earth in a process of divination. A separate form of geomancy uses astrological symbols and indicators to derive the meanings to personal questions and concerns. Geomancy relates to particular times at which conditions in the cosmos are appropriate for revealing answers to the inquirer's questions. Divination is related in some contexts to the work of Carl Jung and his synchronicity concept. Jung's notion involves "meaningful coincidence" to provide explanations of the divination process, which uses a 16-symbol context similar to the system used in astrology. An African form of geomancy involves the tossing of dirt into the air and observing the pattern once it falls. A Chinese variant of geomancy uses an individual in a trance to interpret the markings on the ground. In a general sense, geomancy refers to the human ability to employ pattern recognition to determine the answers to personal questions.

Geomancy came to prominence during the Renaissance, as European cultures transitioned to the modern era. A prominent advocate of geomancy and an author on the subject was Henry Cornelius Agrippa, a 15th century philosopher. The system of geomancy involves the asking of a question of importance by an individual. In the next step, the inquirer concentrates on the question and proceeds to make a series of 16 rows of marks on the earth, continuing to do so until it feels right to stop. The resulting patterns of tracings can then be observed to determine the answer to the question posed. Geomancy in the Western world relied heavily on the attributes of astrology, and has been referred to as *astrological geomancy.* As such, the 16-element context uses Mars, Venus, Jupiter, the Moon, and other astronomical bodies in various combinations and at particular times to determine the answers to the inquirers' questions. Again, the process involves pattern recognition; in this case, the relative locations of celestial bodies at specific times.

Geomancy is related to certain forms of agriculture. The early 20th century agricultural researcher, Rudolph Steiner, wrote and lectured on the need for sustainable forms of farming, identified as *biodynamic agriculture,* which should avoid the use of artificial fertilization. He argued that fertilizers and pesticides were not inherently bad, but that the materials had "spiritual" shortcomings. Steiner believed that the world and all living matter in it were spiritual in nature and that living matter differed from dead matter. He believed that the farm was a living system and should be regulated to maintain that status. For example, a farm entity that was diseased should be treated within the context of the entire farm, and not addressed as an isolated occurrence. It is the spiritual nature of biodynamic agriculture that relates the practice to geomancy. Steiner's formula for proper farm operation extended to the use of specific forms of field preparation, weed and pest eradication, and compost development and application. An associated practice following the basic dictates of Rudolph Steiner is found in the practice of *biodynamic viticulture*. Biodynamic viticulture is practiced worldwide, and many grape growers attest to the improved quality of the grape, and the resulting wine, as a result of this belief and practice.

SEE ALSO: Animism; Fertilizer; Gaia Hypothesis; Pesticides; Religion.

BIBLIOGRAPHY. Gyorgy Doczi, *The Power of Limits: Proportional Harmonies in Nature, Art and Architecture* (Shambala, 1993); John Michael Greer, *Geomancer's Handbook* (Renaissance Astrology, 2006); Michael S. Schneider, *A Beginner's Guide to Constructing the Universe: The Mathematical Archetypes of Nature, Art, and Science* (Harper Perennial, 1995).

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Geomorphology

GEOMORPHOLOGY IS THE science of Earth's landforms, exploring such diverse questions as how rivers erode sediment, what landforms were like when humans evolved, why rock surfaces have different colors, and where floods and landslides can be avoided. Teaching and research in the interdisciplinary field of geomorphology occurs in college departments of geography, geology, civil engineering, and sometimes archaeology, soils, and hydrology.

Any point on Earth's surface can go up in elevation, remain in place, or go down in elevation through erosion. Volcanic and tectonic geomorphologists focus on the building of relief through volcanic events, faulting, or folding rocks. Eolian (wind), coastal, and glacial geomorphologists study both the buildup of relief and its erosion. Weathering and soil specialists study the transformation of rocks into smaller fragments and eventually into soils. The decreases in surface resistance to erosion eventually allows the transport of weathered fragments by gravity through mass wasting such as landslides and through water transport called fluvial processes.

The table of contents of most introductory geomorphology textbooks reveals the sorts of topics studied: weathering (rock decay), mass wasting (landslides), fluvial (rivers) processes, groundwater, tectonic (earthquake) landforms, topographic expression of folded strata, topographic expression of joints and faults, landforms developed on igneous rocks, glacial processes, glacial landforms, Quaternary climatic changes and the Ice Ages, periglacial (ground ice) processes and landforms, shorelines, and eolian processes and landforms.

In every field of science, the orientation or perspective of the researchers drives what and how they investigate questions. Geomorphology is no exception. At the start of the 20th century, geomorphologists focused on reconstructing the sequence of past events producing today's landforms. The 1960s and 1970s started a trend still dominating the field today—of focusing on studying physical, chemical, and biological processes responsible for landform changes. The reconstruction side of geomorphology remains today, exploring such arenas as how to mathematically model landform change or how climatic changes in the last few million to thousand years affected landforms.

The two dominant journals are *Earth Surface Processes and Landforms* and *Geomorphology,* although important articles can be found in dozens of other scholarly serials. Geomorphologists typically belong to one or more of the following scholarly organizations: Geomorphology Specialty Group of the Association of American Geographers; British Geomorphological Research Group; Hydrology Section of the American Geophysical Union; and Quaternary Geology and Geomorphology Section of the Geological Society of America.

Like many disciplines of knowledge, geomorphologists struggle with trying to make advances in basic knowledge of the science, while also applying existing core knowledge to solve societal and environmental problems. Geomorphologists work on such applied research as understanding the effects of building a dam, why urban growth destroys beaches, the storage of toxic chemicals in river sediments, or how environmental changes can exacerbate landslides on top of houses.

SEE ALSO: Beaches; Dams; Earthquakes; Geology.

BIBLIOGRAPHY. British Geomorphological Research Group: www.bgrg.org (cited May 2006); Geomorphology Specialty Group: www.cas.sc.edu (cited May 2006); A.S. Goudie, *Encyclopedia of Geomorphology, Vols. 1 and 2* (Routledge, 2004); Hydrology Section, American Geophysical Union: www.hydrology.AGU.org (cited May 2006); International Association of Geomorphologists: www.geomorph.org (cited May 2006); Quaternary Geology and Geomorphology Division: www.rock.geosociety.org (cited May 2006).

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Georgia (Nation)

THE NATION OF Georgia is located on the crossroads of world cultures in the Caucasus region between the Black and the Caspian Sea. About the size of the U.S. state of Georgia, the nation has a relatively small population of 5 million. In 2004, the Western-educated and U.S.-oriented Mikheil Saakashvili swept into power along with a government for national reform led by the National Movement Party. The goals of this new government have included the opening of markets, democratization, and the development of new investment. Progress in these goals has been challenged by Russian support of the two breakaway provinces of South Ossetia and Abkhazia, leading to sometimes-serious border disputes. A recent initiative for peaceful resolution of South Ossetia, however, was introduced in 2005. The restoration of peace in these regions will prevent further environmental degradation caused by constant, low intensity warfare.

Focused on raising standards of living and levels of external investment, especially in petrochemicals and pipelines, the nation of Georgia is faced with many serious environmental challenges, which will only increase if development is not managed carefully. Although a party to the Kyoto protocol, air pollution has built up to high levels in the industrial city of Rustavi. The Mtkvari river is also heavily polluted with industrial, agricultural, and human waste. As this waste is deposited into the Black Sea it further contributes to the environmental degradation of the Sea's fragile red algae ecosystem. A legacy of Soviet control and the remains of Soviet toxic dumps have led to the pollution of soil and watersheds. Closely associated with the United States in a region heavily influenced by Russia to the north and the Islamic world to the south, Georgia is in a fragile political position. The development of a sustainable environmental policy will be difficult in the light of current political and social demands. Nevertheless, further democratic empowerment and the flourishing of nongovernmental organizations may provide ways of highlighting important, short-term environmental concerns.

SEE ALSO: Black Sea; Caspian Sea; Russia (and Soviet Union).

BIBLIOGRAPHY. E. Aybak, *Politics of the Black Sea* (IB Tauris, 2001); CIA World Fact book, "Georgia," www.www.cia.gov/cia (cited April 2006); B. Coppieters and R. Legvold, eds., *Statehood and Security: Georgia after the Rose Revolution* (MIT Press, 2005).

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Geosphere

THE GEOSPHERE IS the nonliving inorganic portion of the earth, in contrast to its thin surface layer of living things called the biosphere. The geosphere is the whole inorganic earth, including the lithosphere, the hydrosphere, and the atmosphere.

The earth is roughly spherical in shape. Most of the interior of the earth is invisible to human observations. The term *geosphere* is used to point to the layers of the earth as a solid globe, as if an observer could imagine a cutaway of the earth from its central interior to the outer most limits of the atmosphere. The whole planet is in dynamic motion in terms of geological time. The core is believed to be solid dense metal surrounded by the semi-molten mantle. It has unevenly heated convection currents in the molten mantle that causes movements in the earth's crust that appear as plate tectonics on the surface.

Geologists believe that the earth's solid metal core is probably nickel, iron, and some other heavy metals. It lies at a depth of 1,800 to 3,100 miles (2,900 to 5,000 kilometers) from the surface. Above the core is the semisolid outer core. It is intensely hot, as is the core of the earth. The layer above it is the mantle. It is molten and composed of lighter elements that crystallize near the surface, becoming a layer called the *lithosphere*. It floats on the surface of the mantle, like the skin of a warm bowl of vanilla pudding. The lithosphere is the crust of the earth that forms the continents. It is rich in calcium, sodium, potassium, and aluminum. It has a lighter mass than the mantle or the crust of the ocean floor, which is chemically closer to the chemistry of the mantle, but with more silicon. Between the lithosphere and the mantle is the *asthenosphere*. It is about 110 miles (180 kilometers) thick. It is composed of the plates upon which the lithosphere rides over the mantle.

Both the ocean floor and the continents are covered by the *regolith*, which is a covering of rock much like a blanket. The soils of the earth are either formed by the regolith or by sedimentation. Regolithic erosion occurs when solid rocks rot due to chemicals, water, or wind. The *biosphere* is the thin layer of living plants and animals that cover the surface of the earth, and to a lesser degree the upper levels of the oceans.

The *hydrosphere* is the water blanket that covers much of the surface of the earth. This water blanket contains life, and is necessary for life, but it is not in itself alive. Some of the hydrosphere consists of the lakes, rivers, ponds, and other bodies of water found on the surface of the earth. The *atmosphere* as part of the geosphere is composed of gases, dust, and other particles, including floating mold spores and viruses. The atmosphere is also necessary for life.

Some natural scientists use the term *geosphere* in a restricted sense that is synonymous with lithosphere. Others use it to refer only to the solid earth—the core, the mantle, and the crust. Both of these definitions exclude the atmosphere and the hydrosphere as part of the geosphere. During the evolution of the earth, the geosphere has interacted in a variety of ways with the biosphere, as have the atmosphere, the lithosphere, and the hydrosphere. Of significance to natural scientists are the many ways these interactions of the geosphere-biosphere have happened. Geosphere interactions include the precipitation of minerals from superheated water moving toward the surface of the earth. The creation of life forms or geographical features is part of the interactions of the geosphere and the biosphere. Other interactions include how the hydrosphere has eroded the lithosphere to create sedimentary layers, or the interactions of water to change the chemistry of the lithosphere.

SEE ALSO: Biosphere; Geography; Geology; Geomorphology; Geothermal Energy.

BIBLIOGRAPHY. W.G. Ernst, *Earth Systems: Processes and Issues* (Cambridge University Press, 2000); National Research Council, *Satellite Gravity and the Geosphere: Contributions to the Study of the Solid Earth and Its Fluid Envelopes* (National Academies Press, 1997); Jurgen Schultz, *Ecozones of the World: The Ecological Division of the Geosphere* (Springer-Verlag, 1995).

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Geothermal Energy

GEOTHERMAL ENERGY IS derived from heat within the earth. Earth's internal heat is due to the residual heat that was produced when Earth formed, in addition to heat generated by radioactive decay. Earth's temperature increases with depth below the surface. The inner core has a temperature of about 4,000 degrees C. The increase in temperature with depth is referred to as the geothermal gradient. A normal geothermal gradient is 15 to 30 degrees C/kilometer. The geothermal gradient is much higher, double or triple, in areas of recent volcanic activity.

Generally, the higher the geothermal gradient, the higher the heat flow to the surface.

Generally, geothermal energy is tapped either by drilling wells into bedrock and allowing hot water and steam to flows up to turn a turbine on or near the surface. Usually the water and steam extracted is routed back into the subsurface to close the circuit and add pressure for extraction.

The world's major geothermal energy fields are associated with areas of active or recent volcanism. The Pacific Rim of Fire has many developed geothermal fields associated with subduction zone volcanism associated with the convergence of tectonic plates. Some of the popular geothermal areas include New Zealand, Indonesia, the Philippines, Japan, northern California, Mexico, and several countries in Central America

Iceland is located along the Mid-Atlantic Ridge, a divergent plate boundary. Icelanders use geothermal energy to the extent that, together with hydropower, they are able to supply electricity and heat to the entire island. Because of this, Iceland is independent of fossil fuels except as an automobile fuel.

The geothermal fields at Lardarello, Italy, are the oldest in the world. They were developed in the early 1900s utilizing dry steam. This geyser and hot spring area is associated with the recently active volcanism north of Rome. The geothermal fluids have a high content of boric acid, which is utilized along with the heat.

In areas of high geothermal gradient, the geothermal resources occur as hot or dry steam, or hot water that circulates through a permeable zone, such as Yellowstone National Park. The hot water or steam can be used as a direct source of heat or as a source of mechanical energy to turn turbines and generate electricity. Circulation is usually deep, but more recently the circulation of shallow groundwater in areas of high heat flow has been utilized.

Hot dry rocks occur in areas where magma or recently solidified magma is isolated from groundwater. Hot dry rocks require that water be pumped into the ground and recycled to extract the power. Temperatures can reach as high as 1,200 degrees C, depending on the type of magma.

Geopressurized systems are associated with areas of deep burial such as along the Gulf Coast of the United States, where the normal heat flow is trapped by insulating layers of sediment. Along the Gulf Coast, temperatures reach over 270 degrees C at depths of 4 to 7 kilometers.

Areas of normal geothermal gradient are extremely common but have a low level of energy. Geothermal heat pumps utilize lower geothermal gradient, and may therefore be useful in most areas, whether or not they are close to volcanic centers.

Geothermal energy is a relatively clean and environmentally friendly source of energy. Adverse effects occur mainly in the form of gas emissions, and thermal and chemical pollution from the wastewater. Geothermal energy is considered a renewable resource because there is no practical limit to the supply of this energy.

SEE ALSO: Geology; Geosphere; Iceland; Yellowstone National Park.

BIBLIOGRAPHY. Wendell A. Duffield and John H. Sass, *Geothermal Energy: Clean Power from the Earth's Heat* (U.S. Geological Survey, 2003); U.S. Department of Energy, Geothermal Division, *Geothermal Energy, the Environmentally Responsible Energy Technology for the Nineties* (U.S. Department of Energy, 1993).

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German Royal Forest Academy

THE GERMAN ROYAL Forest Academy (*Konigliche Forstakademie*) was the first public organization devoted to the scientific study of forestry, which began with the German Royal Forest Academy in the early 1800s. More and more students studied forestry and it spread around the world.

Noblemen have kept forested preserves for hunting and for wood products since the early Middle Ages. The dominance of forestry by hunting interests steadily declined after the mid-1800s, as the interests of German nobles turned to mining. Good-quality timber was needed to shore up mines, for smelting, and for cross ties for mine ore cars. However, it was soon recognized that the supplies of available timber affected mine profits. This gave rise to the concept of *sustainable yield*, and to the development of German forestry.

In Germany, especially in the lower mountainous areas, forests were common. Natural climate and soil conditions following the last Ice Age led to the development of these forests, dominated by the beech tree. It is very tolerant of shading by other species, such as oaks, maples, ash, cherry, popular, pine, spruce, and fir, except where the soil conditions are poor for beech trees. Other species were forced into areas of soil conditions that were excessively wet or dry, poor or very rich in nutrients, or located at high mountain elevations. By 1800 much of the original dense beech forest cover in Germany had been cleared for agriculture. Other areas had been virtually deforested. However, rural houses were usually built from wood, heated by wood, and by income derived from logging. Because there was a growing need for quality timber, afforestation programs began.

Over the following 200 years, the German forestry practice rebuilt the forests. The afforestation excluded the original beech in favor of oaks, pines, and other softwood trees. The softwoods were easier to grow and commanded a better price, but the oaks, while harder to grow, also commanded good prices. As these afforestation programs developed, large areas were in the hands of private landowners, whose interests were personal and commercial. As a consequence, timber companies own only a few German forest areas. In addition, the drive to increase timber yields and profits promoted the study of forests and forest management as a sustainable crop and as a family matter. As the 1800s progressed, the efforts to build sustainable timber lands in Germany led to the establishment of several forestry schools, the first of which was the German Royal Forest Academy established in Berlin in 1820. By 1900, forestry schools had been established in Prussia, Bavaria, Saxony, Wurtemberg, Baden, and Hesse. Several new sciences dedicated to the study of forest botany and management had also been established.

Heinrich David Wilchens became the first professor of forestry in Schemnitz, Hungary (today Banska Stiavnica, Slovakia). Other leaders who emerged to develop and spread the science of forestry included Carl Ludwig Obbarius, a forest warden in the Hartz Mountains who developed a school of forestry for one of the mining companies in Schweden. Dietrich Brandis went to India, where he laid the foundations of tropical forest management. Carl A. Schenck founded the Biltmore Forest School on the Biltmore Estate near Ashville, North Carolina. It was the first forestry school in the United States. At the time the only other scientifically trained foresters in America were Bernhard Fernow and Gifford Pinchot. Pinchot was the first chief of the United States Forest Service. Using money his father had gained from timbering, Gifford founded the Yale University School of Forestry in 1900. He was able to recruit and develop a professional cadre of foresters who were trained to engage in commercial forestry and conservation. He was also able to defeat John Muir's campaign to return vast areas to nature.

SEE ALSO: Forest Management; Forest Service (U.S.); Forests; Germany.

BIBLIOGRAPHY. Aloys Hutterman, "History of Forest Botany (Forstbotanik) in Germany from the Beginning in 1800 until 1940: Science in the Tension Field between University and Professional Responsibility," in *Berichte der Deutschen botanischen Gesellschaft* (v.100/1–4); Hans Lemmel, *Festschrift zur Hundert-Jahr-Feier der Forstlichen Hochschule Eberswalde: 1830-1930* (Verlag von Fritz Linder, 1930); S.S. Negi, *Sir Dietrich Brandis: Father of Tropical Forestry* (Bishen Singh Mahendra Pal Singh, 1991); Narendra P. Sharma, ed., *Managing the World's Forests: Looking for Balance Between Conservation and Development* (Kendal/Hunt Publisher, 1992).

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Germany

GERMANY IS ONE of Europe's most densely populated countries, with over 230 inhabitants per square kilometer. It also has a prosperous and technologically powerful economy, the fifth largest in the world. Despite its density and strong economy, both factors often compounding environmental problems, it ranks within the top 25 percent of countries categorized in the 2005 Environmental Sustainability Index (ESI). This index, developed by the Yale Center for Environmental Law and Policy and the Center for International Earth Science Information Network at Columbia University, looks at the ability of nations to protect the environment in the upcoming decades. The higher ESI score a country receives, "the better positioned it is to maintain favorable environmental conditions into the future," according to Daniel Esty. Within the European Union, Germany ranks 10th of 22 countries, and of high population density countries, in which over half the land area has a density exceeding 100 persons per square kilometers, Germany ranks second only to Japan. While Germany has a positive sustainable outlook, it has had to implement various laws in the past in order to deal with its environmental problems.

In 1970, the government issued an Emergency Program for Environmental Protection, which dealt with the control of air, water, and noise pollution, waste disposal, and the protection of nature. This program was based on three critical principles: the prevention principle, the polluter-pays principle, and the cooperation principle. The prevention principle aims at avoiding pollution and environmental risks before they occur, while the polluter-pays principle assigns the costs of pollution to the polluter who is responsible. Only when no distinct polluter can be identified will the government bear the cost. The principle of cooperation states that environmental protection is a task that must be shared equally by the government, citizens, and corporations. Also, it

Prior to the 1970s, acid rain was not taken as a serious environment threat until Der Spiegel ran a cover story in 1981 about Germany's forests dying due to acid rain. A popular call to action was likely due to the German cultural love for forests.

states that involvement by the community is crucial to the acceptance of decisions made by the governmental administration.

ENVIRONMENTAL MOMENTUM

As the environmental movement gathered strength in state politics, an amendment to Germany's Basic Law was added in 1972, which stressed the importance of environmental protection. The Basic Law, Germany's modern constitution of 1949, gave the 11 German states power to create laws concerning the environment. The amendment in 1972 added legislative jurisdiction over waste, air, water, and noise pollution to the existing duties of the federal government. This change also allowed for the creation of an environmental administration, called the Environmental Protection Division, set under the Interior Ministry. A further amendment to the Basic Law in 1994 secured environmental protection within basic institutional principles. The amendment states that the federal government has a responsibility for future generations, and therefore "it shall protect the natural basis of life" whenever a state entity takes action, according to the German Embassy in Washington, D.C.

Germany's environmental policy asserts, "protection of the environment can only be truly successful if it places equal importance on air, water and soil," as explained by the German Embassy in Washington, D.C. The ecological political party, the Green Party, have had a positive influence over Germany's environmental objectives, while impacting the phasing out of nuclear power, endorsing energy efficiency, reducing greenhouse gas emissions, and making alternative fuel sources possible. As a result, there are many examples of the government taking action to deal with the issues of clean air, renewable energy, climate protection, waste management, and the phasing out of nuclear energy.

While Germany has steadily advanced its environmental policy and management since the beginning of the 1970s, environmental problems, most noticeably air pollution, abounded in the late 1970s and early 1980s. Reliance on brown coal for electricity, heavy industrialization, and traffic harmed forests and air quality throughout Germany. Prior to the 1970s, acid rain was not taken as a serious threat to the envi-

The Bombing of Dresden

The British Royal Air Force and the U.S. Army Air Force bombed the German city of Dresden between February 12–15, 1945, destroying much of the city. It was one of the most intense bombings of a European city during World War II.

The British and the Americans decided to step up their bombing of German cities to help the Soviet Army, and had already decided to target Dresden, the old capital of Saxony, before the Yalta Conference began on February 4. One of the British concerns was to destroy the German lines of communication, and it was felt that unless Dresden was bombed, rail traffic could be diverted through the city. For this reason the railway yards in the city had been bombed twice already—on October 7, 1944, and again on January 16, 1945. The February raids were followed by two further raids on March 2 and April 17. The bombs were initially high explosives to blow off the roofs of buildings to expose the timber; incendiary bombs were dropped to set fire to the ruins. Finally, another large number of high explosives were dropped to hamper any efforts of fire brigades. The first bombing on the night of February 13 saw 1,478 tons of high explosives followed by 1,182 tons of incendiary bombs being unleashed on the city, followed by 800 tons of high explosives. Three hours later, 529 Lancaster bombers of the Royal Air Force dropped another 1,800 tons of bombs. Soon after midday on February 14, U.S. bombers dropped 771 tons of bombs, with another 466 tons dropped on February 15.

Some 78,000 houses were destroyed, along with damage to 200 factories. According to contemporary German reports, 21,271 were confirmed dead, with 35,000 listed as missing; 10,000 were later found alive. Published estimates of deaths range from 35,000–300,000. Even if the number was on the lower side, which is probable, the destruction of an historic city and the deaths of tens of thousands of civilians remain controversial. Since the war, much of the city has been rebuilt in the original style with significant aid from British and American groups.

ronment, until a 1981 cover story ran in the German magazine *Der Spiegel*. In the article, a German scientist hypothesized that Germany's forests were dying as a result of acid rain and thus the issue became highly publicized. This was a wake-up call for the German population and instilled a popular call to action, likely due to the German cultural love for forests. After German reunification in 1990, it was noted that air pollution, acid rain, and habitat degradation were particularly severe in the former East Germany. Additionally, the disparity of energy efficiency and air quality control between East and West Germany was enormous. A move away from the strong reliance on brown coal, improvements in energy efficiency, and the closing down of plants causing major pollution helped the environment recover in the Eastern states.

CLEAN AIR AND RENEWABLE ENERGY

Over the last decades, and largely in response to forest death from acid rain, Germany set up a clean air program to reduce harmful emissions output and eliminate certain elements contributing to air pollution. The program has been successful in reducing sulfur dioxide levels by more than 60 percent in the western states, and by 90 percent in the eastern states between 1995 and 2005. Further improvements will likely proliferate due to a ban in 2000 of all leaded gasoline. Recently, the EU has introduced the concept of sulfur-free fuels, which would reduce a car's fuel consumption by as much as 20 percent.

Another area in which Germany has introduced new laws pertains to renewable energies. The government under Chancellor Helmut Kohl (in power 1982–98) actively promoted the use of renewable energy through the Electricity Feed Act. This act was passed in January 1991 and regulated "the feed-in of electricity from renewable energies to the grid," according to the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. This act stated that the grid system operator was obligated to purchase the electricity at a fixed rate, a feed-in tariff. In 2000, this act was replaced by an act entitled the Renewable Energy Sources Act, which had a more expansive scope. This revised act required grid operators to feed in electricity from renewable sources as a priority, and pay the minimum fixed fee for the electricity.

Petra Kelly

The founder of the German Greens Party, Petra Kelly, was born in Bavaria in 1947 as Petra Karin Lehmann. When she was twelve she went with her parents to the United States, living there until 1970. She changed her surname to Kelly when her mother married her stepfather, an American army officer. In 1966 Petra Kelly started studying political sciences at the School of International Service, American University, Washington, D.C. Two years later, she campaigned for Robert F. Kennedy and then for Hubert Humphrey.

Moving back to Europe to study at the University of Amsterdam, Petra Kelly worked at the European Commission in Brussels, Belgium, from 1971 until 1983. During that time she became heavily involved in environmental issues and the peace movement in Germany. In 1979, Petra Kelly became a founder of *Die Grünen,* the German Green Party, and in 1983 was elected to the West German parliament, the Bundestag, for the Greens, holding her seat until 1990.

This was an important period for the environmental movement worldwide, with the Green Party in Germany holding a large number of seats in the parliament. The party was heavily opposed to nuclear power, and the increasing pollution of the environment, campaigning for a reduction in the use of private motor cars. She was the author of a large number of books about the environment and nonviolence, and had always been a great admirer of Martin Luther King, Jr.

On October 1, 1992 Petra Kelly was shot dead while she was asleep in Bonn. The body of her 69-year-old partner, the ex-N.A.T.O. general and Green politician, Gert Bastian, was nearby and it appeared that he had shot her and then turned the gun on himself. Petra Kelly's papers are now part of the Heinrich Böll Foundation.

Wind power is a renewable energy that has flourished in Germany. Currently, Germany has about 39 percent of the world's wind energy, making it the world leader in wind power generation. Since the Renewable Energy Sources Act went into effect, Germany's electricity grid operators have purchased over 500 million Euros of wind power energy. The addition of this renewable energy to the grids has had a positive environmental effect; in 2001, the use of wind power reduced CO_2 emissions by approximately 10 million tons. In addition to air pollution and renewable energies, Germany, as one of the worlds' industrialized nations, committed itself to drastically reduce greenhouse gas emissions in 1997 by signing the Kyoto Protocol. Germany has already reduced its greenhouse gas emission from 1990 levels by 18.7 percent, and the country plans to continue the reduction to 21 percent between 2008 and 2012.

ECO-TAX AND OTHER REFORMS

In 1999, Social Democrat Chancellor Gerhard Schröder, whose party governed in alliance with the Greens from 1998–2005, introduced Eco-Tax Reform. The goals of the Eco-Tax Reform included climate protection and employment generation. The Eco-Tax increased the general taxes on fuel, gas, and electricity for consumers, raised industry and farming taxes, and was to aid in the reduction of social welfare taxes from 42.3 percent to 40 percent of gross income. The Eco-Tax Reform was also put forward to decrease Germany's dependency on polluting energies and thereby create new environmental jobs. According to a study Commissioned by the German Federal Environmental Agency (UBA), the Eco-Tax Reform has helped Germany attain its goals. It cut CO_2 emissions by approximately 20 million tons and created 60,000 new jobs.

Waste management is another environmental issue that is being tackled by the German government. In 1990, German households produced over 38 million tons of waste, while commercial waste accounted for over 15 million tons. Due to the potential damage to soil and groundwater from this waste, the German Bundestag in September 1994 adopted the Closed Substance Cycle and Waste Management Act, which promoted "closed substance cycle waste management in order to conserve natural resources and to ensure environmentally compatible disposal of waste," according to Jürgen Giegrich. Waste-management laws focused on creating low-waste products and recycling, which the government hopes will eventually produce no waste at all, hence a closed cycle. Adhering to the polluter-pays principle, the waste stemming from products must be accepted for recycling by that product's seller or manufacturer. In order to accommodate this process, the Dual System was set up as a private enterprise to collect the various packaging materials. License fees permitting manufacturers and supplies of packaging material to place a Green Dot on their product finances this enterprise. The dot, while not an indicator that the product is made of recyclable material, simply tells consumers that the packaging should be recycled via the Dual System, which can be done in household curbside bins or municipal bins. For Germans, the commitment to waste separation and recycling is clearly seen by the four bins in front of every house: one blue, yellow, green, and gray, each of which is used to recycle a different type of material.

Germany's phasing out of nuclear energy has been a controversial topic. Regardless, in 1998, Germany announced its plans to phase out nuclear energy following the formation of the Social Democratic Party (SPD) and the Green Party coalition. The chief reasons for this move were the unacceptable risks connected with nuclear energy, specifically the disposal of radioactive waste and the potential for nuclear reactor meltdowns. In June 2000, a plan was announced that restricted the amount of future electricity production from power plants. A year later, the federal government and all energy suppliers using nuclear power had agreed that each nuclear reactor would be limited to producing 23.3 billion kWh at maximum operating capacity. This created a roughly 32-year phaseout period, and the last power station should go out of service in 2032. Germany operates 19 nuclear power stations, which provide about 30 percent of Germany's electricity requirements. This is up from only 12 percent in 1980.

While Germany has a long history of strong commitment toward environmental protection, it still has a long road ahead of it. Sustainability is one of the guiding principles cutting across all sections of government. The ultimate goal of this principle is to reach concord between economic growth and environmental preservation and protection, whereby sustainable development is compatible with present needs while not jeopardizing future generations. As the 2005 Environmental Sustainability Index suggests, Germany is heading in the right direction.

SEE ALSO: Acid Rain; European Union; German Royal Forest Academy; Nuclear Power; Recycling.

BIBLIOGRAPHY. Ecologic, "Effects of Germany's Ecological Tax Reforms," www.ecologic.de (February 2006); Energy Information Administration, "Germany Country Analysis Brief," www.eia.doe.gov (September 2003); D.C. Esty et al., *2005 Environmental Sustainability Index: Benchmarking National Environmental Stewardship*. (Yale Center for Environmental Law & Policy, 2005); Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, www.bmu.de (accessed February 2006); German Embassy in Washington, D.C., www.germany.info (November 2005); Miranda Schreurs, *Environmental Politics in Japan, Germany, and the United States* (Cambridge University Press, 2002); Ute Sprenger, "Return to Sender," *New Internationalist* (v.295, 1997).

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Ghana

GHANA'S ABSOLUTE LOCATION (Latitudes 4 degrees 44.2 N to 11 degrees 10.5 N and Longitudes 1 degree 12 E to 3 degrees 15.3 W) places the country—with a total area of 92,000 square miles (238,533 square kilometers)—within the tropical rain forest and tropical savanna biomes. This location provides Ghana with a specific combination of geology, climate, biota, soils, water resources, and ocean accessibility whose exploitation are critical to the economy. Export of gold earned over $600 million in 2002. Agriculture and fisheries activities currently constitute about a third of Ghana's economy and provide employment for over 50 percent of the economically active population in a population of 21.4 million people. Exports of cocoa products brought in an income of over $400 million in 2002. And products from the tropical forests earned an export income of about $170 million in 2001, and also generate activities that account for over 3 percent of the Ghanaian economy.

But Ghana faces enormous environmental challenges that are closely tied to the second aspect of Ghana's location—its relative location within the world system of core, semiperiphery, and periphery countries. Ghana's situation as a periphery/former colony, low income, dependent third world country presents a specific set of challenges. Most of the livelihoods of the people of Ghana and the incomes of local and foreign businesses depend upon the direct exploitation of the natural resource base. It is estimated, for instance, that Ghana's forests, which covered about 20 million acres (8.2 million hectares) in the late 19th century have been depleted to only 4 million acres (1.7 million hectares) of permanent forests. Another category of environmental problems in urban centers is related to the rapid population growth rate of 2.7 percent a year (1984–2000), which has fueled a rapid rate of urbanization.

To improve environmental governance, the government of Ghana established the Environmental Protection Council (EPC) in 1974 to coordinate environmental management activities. Since then, the government has more explicitly tied Ghana's development to environmental conservation. In a National Environmental Policy and its associated National Environmental Action Plan (NEAP) 1993, the government committed itself to environmental protection, which is defined as "all interventions that may be deemed necessary to maintain a high level of environmental quality, and which at the same time enhances sustainable socioeconomic development."

As part of the necessary interventions, the government established the Ministry of Environment, Science and Technology (1993), and the EPC was transformed into the Environmental Protection Agency (EPA) in 1994 to become the national environmental management institution with regulatory and enforcement functions (including those related to environmental impact assessments). Other EPA responsibilities include monitoring, setting environmental standards, research, and information dissemination. To further facilitate good environmental governance, the government of Ghana has proposed a decentralization of environmental management by assigning the local government units—the District Assemblies—with responsibilities for translating national policies and programs into local actions. Major environmental policies in Ghana include the Forest and Wildlife Policy (1994), Energy Policy (1996), Land Policy (1999), Sanitation Policy (1999), and Water Resources Policy (1999). Ghana is a signatory of various International Conventions, including the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change.

SEE ALSO: Convention on Biological Diversity; Deforestation; Urbanization; United Nations Framework Convention on Climate Change.

BIBLIOGRAPHY. Kwame Domfeh, "Managing the Environment in a Decade of Administrative Reforms in Ghana," *International Journal of Public Sector Management* (v.17/6/7, 2004); Environmental Protection Agency, www.epa.gov.gh (cited April 2006); Institute of Statistical, Social and Economic Research (ISSER), *The State of the Ghanaian Economy* (ISSER, various years).

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Gibbons vs. Ogden

IN 1824 THE idea of a *United* States of America was still very new. Perhaps the most important issue facing the nation was the relationship between the power of individual states and the federal government. While the most dramatic conflict between state and federal power would play itself out in the American Civil War, several Supreme Court decisions—including *Gibbons vs. Ogden*—slowly eroded power claims of individual states. Chief Justice John Marshall, the famous leader of the Supreme Court who established judicial review of congressional laws, was active at controlling the attempt by states to assert too much power.

At first glance, the case of *Gibbons vs. Ogden* seems like a simple dispute between two freewheeling steamboat operators at the advent of the U.S. Industrial Revolution. Steamboat commerce between New York and New Jersey was a major source of transportation and development in the early years of the 19th century. Aaron Ogden had bought a monopoly in the steamboat route that the State of New York had granted to Robert Fulton and Robert Livingston. Odgen, the plaintiff, brought a lawsuit against a rival Thomas Gibbons who had built a competing boat service between New York and New Jersey, seemingly violating the monopoly agreement granted by New York. Aaron Ogden initially won his case but the decision was appealed to the Supreme Court. Quoting Article 1, section 8 of the U.S. Constitution, which reads that Congress has the power "to regulate Commerce with foreign nations, and among the several States, and with the Indian Tribes," Chief Justice John Marshall concluded that the New York Monopoly violated the power of the U.S. Congress to regulate interstate commerce, commerce "among the several States."

The precedent set by *Gibbons vs. Ogden* has led to several important Supreme Court decisions regarding environmental policy set by individual states. Significant among these are elements of the Clean Water Act, which gives authority over wetlands to federal regulators and the Army Corps of Engineers. Dredging and filling of wetlands, under Section 404 of that Act, is restricted, except where permitted and only where the loss of wetlands is mitigated. The legal authority of the federal government here is an extension of the diverse notions that stream flows are interstate, that migratory wetland birds move between states, and that waterways, even those isolated from major rivers, are navigable. This interpretation of the Commerce Clause stemming from *Gibbons v. Ogden* has not gone undisputed in recent years, with some arguing it is an over-generous reading of the Constitution. Nevertheless, this reading stands as a cornerstone of contemporary environmental protections in the United States.

SEE ALSO: Commerce Clause; Clean Water Act.

BIBILOGRAPHY. Paul Benson, *The Supreme Court and the Commerce Clause, 1937-1970* (New York, 1970); Robert Meltz, *Constitutional Bounds on Congress' Ability to Protect the Environment* (New York, 2003); Joseph Zimmerman, *Interstate Economic Relations* (State University of New York Press, 2004).

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Gibbs, Lois (1952–)

LOIS MARIE GIBBS is the founder and executive director of the Center for Health, Environment, and Justice (CHEJ) in Falls Church, Virginia. Gibbs first rose to public prominence in 1978, as the organizer and head of the Love Canal Homeowners Association in Niagara Falls, New York. Upon learning that the neighborhood elementary school her son attended had been built on top of a leaking hazardous waste dump, she and other residents of the Love Canal neighborhood—many with severely ill children or histories of reproductive abnormalities—organized to demand government assistance with health, safety, and welfare. In August 1978, President Jimmy Carter declared a state of emergency at Love Canal; the State of New York closed the school, announced the relocation of 239 families, and initiated a project to clean up the site.

Over the course of the next two years, Gibbs and other remaining Love Canal residents gained the attention of national and international media as they confronted the miscommunication and inaction of state and federal government agencies. In May 1980, shortly after the release of studies showing evidence of increased chromosomal damage among neighborhood residents, Gibbs and other members of the Homeowners Association held two EPA officials hostage in the association office and then released them in the presence of national television cameras.

In combination with the political pressures of an election year, the event helped prompt President Jimmy Carter to order and finance the permanent relocation of Love Canal residents later that summer. The Love Canal incident also led to the passage of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980—better known as Superfund. This law established and funded a new federal program to clean up hazardous waste sites throughout the United States, and Gibbs became known as the "mother of Superfund."

Gibbs subsequently moved with her two children to the Washington, D.C., area, and in 1981 she founded the nonprofit organization Citizens Clearinghouse for Hazardous Wastes (CCHW). The initial purpose of the organization was to share information, technical assistance, and organizing strategies with other communities around the country fighting to have hazardous waste sites cleaned up quickly and thoroughly. Although this purpose remains an important part of its mission, the organization—which in 1997 changed its name to the Center for Health, Environment and Justice—now leads and coordinates a diverse set of national environmental health campaigns. Over the years, these campaigns have addressed a variety of issues, including medical waste incineration in hospitals, precautionary approaches to risk, pesticides and toxic chemicals in schools, and the manufacture of PVC products.

As the "mother of Superfund," Gibbs fought for compensation for the Love Canal incident and its cleanup.

Gibbs has written or cowritten several books, including *Dying from Dioxin: A Citizen's Guide to Reclaiming Our Health and Rebuilding Democracy* (1995) and the autobiographical *Love Canal: My Story* (1982). She has also been the subject of documentaries and the made-for-television movie *Lois Gibbs and the Love Canal* (1982). Among the many honors Gibbs has received are the Goldman

Environmental Prize (1990), the Heinz Award in the Environment (1998), the John Gardner Leadership Award (1999), and an honorary doctorate from the State University of New York–Cortland.

SEE ALSO: Comprehensive Environmental Response, Compensation, and Liability Act; Love Canal; Superfund Sites.

BIBLIOGRAPHY. Center for Health, Environment, and Justice (homepage), www.chej.org (cited June 2006); Lois Gibbs, *Love Canal: The Story Continues* (New Society Publishers, 1998); Lois Gibbs and Murray Levine, *Love Canal: My Story* (State University of New York Press, 1982); Adeline Levine, *Love Canal: Science, Politics and People* (Lexington Books, 1982); Andrew Szasz, *Ecopopulism: Toxic Waste and the Movement for Environmental Justice* (University of Minnesota, 1994).

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Glacier National Park, Montana (U.S.)

GLACIER NATIONAL PARK is located in the northern Rocky Mountains of northwestern Montana along the U.S./Canadian border, and sits astride the "Triple Divide" of North America, from where waters flow to the Atlantic, Pacific, and Arctic Oceans. The Park was formed by an Act of Congress in 1910. In 1932, Glacier Park joined with adjacent Waterton Lakes National Park in Alberta, Canada, to form the Waterton–Glacier International Peace Park, the first such entity in the world. The Going-to-the-Sun Road that crosses the Park from West Glacier to St. Mary—a distance of 50 miles—is a National Historic Landmark that took 11 years to construct, with completion in 1932. Most visitors to the Park traverse this road, crossing the Continental Divide at Logan Pass.

Glacier Park is dominated by two mountain ranges, the Lewis and the Livingston, that trend northwest to southeast through its north-south orientation. Rocks that comprise these ranges consist of several sedimentary formations. A conspicuous geologic feature of the Park is the Lewis Overthrust fault that displaced older Proterozoic rock formations over 65 kilometers to the east and over younger Cretaceous sedimentary formations. Chief Mountain, an isolated outlier at the easternmost edge of the Overthrust, is a sacred site for the Blackfeet Indian Nation that borders Glacier Park to the east.

Elevations in the park range from forested valley bottoms of nearly 940 meters to rock, snow, and ice surfaces on peaks that extend to slightly over 3,000 meters. A maritime climate on the west side supports a more diverse forest, including Douglas Fir (*Pseudotsuga menziesii*), Western Hemlock (*Tsuga heterophylla*), and Western Larch (*Larix occidentalis*); than the distinctly more continental climate and associated forest on the east-side characterized by Lodgepole Pine (*Pinus contorta*) and Trembling Aspen (*Populus tremuloides*) at lower elevations.

Both rise through a distinctive alpine tree-line ecotone, a zone of transition that ranges from the closed canopy-forest through open-canopy forest and tree islands of five-needle pines (*Pinus albicaulis* or *Pinus flexilis*), Engelmann Spruce (*Picea engelmannii*), and Subalpine Fir (*Abies lasiocarpa*); to alpine tundra, which is the signature ecosystem of the park, varying across extensive drier patterned ground to more localized wet meadows. The spatial organization and composition of the vegetation in the park is largely shaped by the two climate regimes and made heterogeneous by lithology, topography, and local disturbances that include snow avalanches, debris flows, fire, and historically widespread insect outbreaks. This diversity of vegetation also supports a diversity of wildlife, including the charismatic megafauna grizzly bear (*Ursus horribilis*) and mountain goat (*Oreamnus americanus*).

The park is a focal point for work on global climate change, given that its glacial climate history appears to be heading toward the loss of all its current glaciers. These small cirque glaciers, which have been shrinking and disappearing since the late 19th century, are predicted to be gone by the year 2050. The distinctive glacial landforms including, for instance, U-shaped valleys, cirques, horns, tarns, paternoster lakes, and moraines, will continue to attract tourists to this "Crown of the Continent."

SEE ALSO: Glaciers; Global Climate Change; National Parks.

BIBLIOGRAPHY. D.R. Butler and S.J. Walsh, "Lithologic, Structural, and Topographic Influences on Snow-Avalanche Path Location, Eastern Glacier National Park, Montana," *Annals of the Association of American Geographers* (v.80, 1990); M.P. Hall and D.B. Fagre, "Modeled Climate-Induced Glacier Change in Glacier National Park, 1850-2100," *BioScience* (v.53, 2003); S.J. Walsh, L. Bian, S.A. McKnight, D.G. Brown and E.S. Hammer, "Solifluction Steps and Risers, Lee Ridge, Glacier National Park, Montana, USA: A Scale and Pattern Analysis," *Geomorphology* (v.55, 2003).

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Glaciers

GLACIERS ARE THICK masses of ice that originate on land from the accumulation, compaction, and recrystallization of snow. Glaciers make up the cryosphere, the frozen part of the hydrosphere. The frozen water is temporarily removed from the hydrologic cycle. Glaciers occur more commonly at places on earth where temperatures are such that the glacial ice remains frozen during a sufficient part of the year, preventing the glacier from melting completely. These cold places occur at high elevations and at high latitudes.

Glaciers fall into two broad categories: alpine or valley glaciers; and continental glaciers, ice sheets or ice caps. Alpine glaciers occur at high elevations, on mountain tops. Continental glaciers occur at high latitudes, close to the poles. Alpine and continental glaciers are actually two ends of a spectrum. Many glaciers have characteristics of both.

Alpine glaciers exist on the tops of mountains, and therefore are subject to the force of gravity, which constantly pulls the glacier down the slope. As the glacier slowly moves down the side of the mountain, new glacial ice forms on the mountain top (accumulation). As the glacier reaches the higher temperatures that occur on the lower parts of the mountain, the ice melts (ablation or wasting). This system is like a conveyor belt where the glacier forms in the area of accumulation, then constantly slides down the mountain to the area of ablation where it melts and becomes outwash streams. The downslope movement is due in part to flow within the glacier, and also to sliding over the ground surface. The sliding produces significant erosion resulting from the abrasion of bedrock and the transport of the eroded material to the area of ablation where it is deposited as a moraine.

The moraine may act as a natural dam resulting in a glacial lake. Alpine glaciers are common today in many mountain belts such as the Alps, the Northern and Canadian Rockies, the Andes, and the Himalayas. An alpine glacier exists on top of Mt. Kilamanjaro (19,340 feet), illustrating that glaciers can exist close to the equator if the ground elevation is high enough.

CONTINENTAL GLACIERS

Unlike alpine glaciers, continental glaciers are not dependent on high elevations. Continental glaciers occur at high latitudes, on relatively flat, widespread areas that may cover a major part of a continent, hence the term *continental*. Today, continental glaciers exist on Antarctica, Greenland, and a small ice cap in southeast Iceland. The movement of continental glaciers is driven by flowage and sliding of the glacier outward from the area where the accumulation is the greatest. If part of the glacier moves into an area of lower latitude, ablation will occur as the glacier melts and deposits its sediment as a moraine, and the water becomes outwash streams. If the water is trapped behind the moraine, a glacial lake may form. The Finger Lakes of New York are a prime example.

The budget of a glacier is a concept relating its volume to the rates of accumulation and ablation (wastage). During cooler intervals, the rate of accumulation may exceed the rate of ablation, and the glacier will expand or advance. During warmer intervals, the rate of ablation may exceed accumulation and the glacier will shrink or recede. The terms *advance* and *recession* relate only to an increase or decrease in the mass of the glacier. They do not imply movement of the glacier. Regardless of whether a glacier is advancing or receding, alpine glaciers always move downslope, and continental glaciers always move outward from the area of maximum accumulation.

SPECTACULAR LANDFORMS

Glaciers produce distinctive landforms and landscapes that can be quite spectacular and beautiful. Landforms typically associated with alpine glaciers include horns, U-shaped valleys, hanging valleys, cirques, arêtes, and moraines (lateral, medial and end). Continental glaciers produce features such as drumlins, eskers, kettles, terminal and recessional moraines, and outwash plains. These landforms preserve the geologic record of ancient glacial conditions, and are used to reconstruct environmental conditions that existed during the Ice Age. The most recent Ice Age was first recognized in terms of the glacial landforms that are found in many places in the high northern latitudes, areas that are not glaciated today. As such, glaciers produce an important record of past climatic conditions on earth.

The occurrence and size of glaciers is directly dependent upon global temperatures. Today, glaciers cover about 10 percent of Earth's land surface. During the past 2 to 3 million years, the globe was alternately cooler and warmer, producing what is referred to as glacial and interglacial episodes of the Ice Age. During glacial episodes, alpine glaciers existed at lower elevations, and ice sheets extended further toward the equator. Some of those ice sheets were about 3 times as extensive as today. During the warmer, interglacial episodes, glaciers receded to higher elevations and higher latitudes.

Glaciers play a major role in the water available to the hydrologic cycle. Glaciers today comprise 2.2 percent of earth's total water budget, second only to the oceans, which comprise 97.2 percent. Changes in the volume of glaciers are compensated by change in the volume of seawater. During intervals of global warming, such as is occurring now, glaciers recede and sea-level rises. The opposite has occurred during times of global cooling.

SEE ALSO: Glacier National Park; Global Warming.

BIBLIOGRAPHY. Douglas I. Benn and David J.A. Evans, *Glaciers and Glaciation* (Wiley, 1998); Michael Hambrey and Jurg Alean, *Glaciers* (Cambridge University Press, 2004); Peter G. Knight, *Glaciers* (Stanley Thornes, 1999); Johannes Oerlemans, *Glaciers and Climate Change* (Balkema, 2001).

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Glacken, Clarence (1909–89)

CLARENCE JAMES GLACKEN (1909–89) was a prominent cultural geographer and a key scholar in the development of environmental history. His work in bio-historical studies during the mid-20th century ranks him with Carl Ortwin Sauer and Rachel Carson. Glacken's seminal work is his *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (1967). In this book, Glacken contends that there have been three archetypal questions posed through time about the earth and human relationships with it: Is the earth the creation of a higher power? Has the earth's physical attributes (landforms, climates, the arrangement of its landmasses and water bodies) influenced both the social nature of its human occupants and the nature of human culture? And, In what ways have humans modified the earth? The third point became a central tenet within the discipline of geography as it developed in the late 19th and early 20th centuries and continues to hold that position. The theme of human-environment interaction provides a basic premise in geographical studies.

Glacken points out in *Traces on the Rhodian Shore* that the separation of humans from their physical setting (a culture-nature conceptual disconnect) is of long standing in Western thought. Aristotle drew the distinction between entities created by humans and those found in the physical world, which are not of human origin. This separation continued until Immanuel Kant expressed the view of nature as culture, which is a notion embedded in the concept of social constructivism (the social construction of nature). This focus suggests that nature is viewed through the "cultural lens" of the individual and becomes a subjective consideration. The view of nature as culture has long been embraced within the social sciences and the humanities in which aspects of culture provide the primary reference. The precursors to the emergence of the conservation movement in Europe and the United States in the 19th and 20th centuries are traced as well in Glacken's work. The conservation movement and the subsequent environmental initiatives in the 1960s could not have occurred without the development and acceptance of a unified concept linking nature and culture.

Glacken was a highly respected member of the geography faculty at the University of California at Berkeley from 1952–76. On the occasion of his retirement in 1976, Glacken was honored with a Berkeley Citation, an award given to the most distinguished members and friends of the university for rendering notable services. Glacken also published a book in 1955 on Okinawan village life.

SEE ALSO: Carson, Rachel; Geography; Sauer, Carl.

BIBLIOGRAPHY. Peter Atkins, Ian Simmons, and Brian Roberts *People, Land and Time: An Historical Introduction to the Relations Between Landscape, Culture and Environment* (Arnold Press, 1998); Clarence J. Glacken, *The Great Loochoo: A Study of Okinawan Village Life* (University of California Press, 1955); Clarence J. Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (University of California Press, 1967).

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Glen Canyon Dam

GLEN CANYON DAM is located in Arizona on the Colorado River just south of the Utah border. The reservoir behind the dam floods hundreds of side canyons and 180 miles (290 kilometers) of the Colorado River through Glen Canyon. It is the second-highest concrete-arch dam in the United States. When briefly full, Lake Powell was the second-largest reservoir in the Western Hemisphere. According to Steve Carothers and Bryan Brown, Glen Canyon Dam was originally designed to facilitate the delivery of water from "upper basin states" (Utah, Colorado, New Mexico, and Wyoming) to "lower basin states" (Arizona, Nevada, and California) and Mexico under the Colorado River Compact of 1922. Additional purposes include flood control, water storage, environmental and recreational needs, and power generation. The dam was approved in 1956, and after construction and much controversy, the lake began to fill in January 1963. Glen Canyon Dam has the capacity to generate 1,300 megawatts if the reservoir is full (elevation of 3,700 feet [1,138 meters]). However, Lake Powell took 17 years to fill and was only at its peak volume for five years (1980–85). Consequently, average power generation has been in the range of 500 megawatts.

CONTROVERSIAL IMPACTS

Glen Canyon Dam was controversial from the beginning and remains so today. Adverse impacts for the Navajo (or Dine) people include loss of religious and cultural sites throughout the flooded canyon. In 1974 members of the Dine sued the Department of the Interior (DOI), Bureau of Reclamation, and National Park Service (NPS) over flooding of religious sites and inability to conduct ceremonies in the vicinity of Rainbow Bridge. The few people of European descent who had floated down Glen Canyon described the hundreds of side canyons and glens as the most beautiful place any had ever seen. For novelist Edward Abbey, Glen Canyon was "the heart of the Colorado Plateau." Sierra Club Executive Director David Brower led a fight to prevent the filling of the reservoir. Although not successful in stopping the project, this conflict was extremely formative in the lives of many environmental leaders and shaped the direction of the modern environmental movement.

Water released from Glen Canyon Dam flows into Grand Canyon National Park. Significant ecological impacts in Grand Canyon include artificially low water temperatures (47 degrees F), blockage of sediment, and substantial fluctuations in flows due to power generation. The river currently fluctuates daily between 8,000–20,000 cubic feet per second (cfs). Until 1963, flows varied from 3,000 in fall and winter to 90,000 cfs during spring runoff. Floods brought sediment critical for building beaches, replenishing the nutrient base on the river's shores and creating backwater habitat for juvenile fish as the water receded. Endangered fish in the river now include the humpback chub, bonytail sucker, and razorback sucker.

Drought, increased water demand, and global climate change resulted in progressively lower lake levels during the 1990s. In 2005, the lake dropped low enough to expose famous sites, including Cathedral in the Desert, sites of importance to Mormon Pioneers, and sacred sites for the Dine nation. In the face of significant ecological impacts and lower lake levels, discussions over dam removal have begun. Arguments against dam removal include loss of hydropower, recreation activities and income, inability to regulate flows, and loss of the trout fishery below the dam. Those in favor of dam removal note ecological benefits to the ecosystem of the Grand Canyon, that scarce water is lost through evaporation and seepage into the porous sandstone, and that Hoover Dam could control the Colorado River without Lake Powell, thus producing more power, while saving money and increasing habitat.

SEE ALSO: Abbey, Edward; Brower, David; Dams; First Nations; Grand Canyon; Hydropower; Native Americans.

BIBLIOGRAPHY. Steve Carothers and Bryan Brown, *The Colorado River through the Grand Canyon: Natural History and Human Change* (University of Arizona Press, 1991); Phillip Fradkin, *A River No More: The Colorado River and the West* (University of California Press, 1996); Friends of Lake Powell (homepage), www.lakepowell.org (cited April 2006); Living Rivers (homepage), www.livingrivers.org (cited April 2006); Russel Martin, *The Story That Stands Like a Dam: Glen Canyon and the Struggle for the Soul of the West* (Henry Holt, 1999); John McPhee, *Encounters with the Archdruid* (Farrar, Strauss and Giroux, 1990); Elliot Porter, *The Place No One Knew: Glen Canyon on the Colorado* (Sierra Club Books, 1963).

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Global Environmental Change

GLOBAL ENVIRONMENTAL CHANGE (GEC) refers to a multitude of environmental changes occurring at the global scale. Such changes include alterations to global bio-geochemical cycles, including carbon, nitrogen, and hydrological cycles; widespread alterations to land use and cover in multiple locations across the world with far-reaching consequences for soils, ecology, economy, and human health; and increasing losses of biological diversity globally. GEC is distinguished by some as systemic (changes that operate globally, such as global warming) or cumulative (local effects that accumulate until the overall impact is global, such as land use/cover change or biodiversity loss). Although the environmental movement faults human activity for the majority of GEC, many of the changes in question have both natural and human drivers and consequences. There is growing consensus, however, regarding the increasingly significant role that human societies have played in altering the structure and function of the planet's biosphere in recent centuries and decades.

EARTH SYSTEM SCIENCE

Much of the current research on global environmental change adopts an earth system science perspective. This perspective involves the recognition that the earth's oceans, land, and atmosphere constitute an intricately coupled system with its terrestrial and marine biota, and employs an interdisciplinary and integrative approach to studying its components, their interactions and systemic change and variability over time. Definition, characterization, and understanding of GEC are contingent upon spatial and temporal scale, since earth system processes span a range of such scales.

For instance, plate tectonic movements occur over large spatial extents (tens of thousands of kilometers) and long time scales (millions of years). On the other hand, seasonal variations in primary productivity in a temperate deciduous forest biome occur over a spatial extent of hundreds of kilometers and relatively short time scales (months). The definition of a system's mean behavior depends upon the choice of spatial and temporal scale over which to average

Human activities can interrupt the global hydrological cycle—the movement of water—through a number of activities.

that behavior; thus affecting conclusions about system change or variability. A change in a system is generally perceived as unidirectional, sometimes irreversible, whereas variation implies some form of oscillation or fluctuation around a mean value. Systems differ with regard to their stability (ability to retain system characteristics such as structure and function in the face of an externally induced perturbation), or resilience (a measure of a system's ability to return to its initial state following a perturbation). In addition, systems may be characterized as approximating an equilibrium state (homeostasis), typically involving negative feedbacks, or a non-equilibrium state characterized by stochastic and/or nondeterministic processes of change.

The International Geosphere–Biosphere Program (IGBP) was founded in 1986 by the International Council of Scientific Unions (ICSU). The IGBP constitutes an international, interdisciplinary scientific approach to pose and answer questions about the nature of the earth system and its biogeochemical cycles, its structure, function, and response to human-induced alterations (forcing functions); whether we can or should return to the system state preceding current episodes of human-induced system forcing, such as greenhouse-gas emissions led climate change; and how human societies and economies can achieve such challenges. The IGBP helps coordinate and synthesize research that elaborates key aspects of the earth's hydrological and biochemical cycles, quantifies rates and patterns of change within them and identifies critical drivers and consequences of those changes.

THE HYDROLOGICAL CYCLE

An important component of the earth system is the hydrological cycle—the movement of water through the distinct spheres of the earth—including the lithosphere, atmosphere and surface, and groundwater. This movement of water is driven by solar energy and the processes of evaporation, transpiration, precipitation, surface runoff, infiltration, and subsurface flow, and may be accompanied with changes of phase (solid ice or snow, liquid water, and gaseous water vapor). Approximately 97 percent of the earth's water is stored in oceans, 2 percent in ice caps and glaciers, and the remainder in ground and surface water reservoirs, the atmosphere, and the earth's biota. Most of the water in the atmosphere derives from evaporation, the solar-driven conversion of water from terrestrial or marine water sources into water vapor.

A smaller portion of the atmosphere's water derives from plant transpiration, the loss of water through leaf stomatal openings after it is drawn up from the soil by plant roots by the process of osmosis. Taken together, evaporation and transpiration (evapotranspiration) account for a large part of water loss from vegetated ecosytems and watersheds; however, the kind of vegetation greatly influences evapotranspiration rates. Water vapor in the atmosphere undergoes condensation in water droplets or ice/snow crystals and may move to different locations in the atmosphere by the process of advection. It may be precipitated over oceans or land. Precipitation over land results in surface runoff, some degree of water infiltration into the soil depending upon soil properties, and storage in artificial or natural reservoirs, as well as subsurface flow. Human activities can interrupt the global hydrological cycle through a number of activities, including: surface and groundwater withdrawals for basic water supply for increasing populations in urban and rural areas, agricultural diversion of freshwater, the construction of artificial reservoirs such as dams, and land cover changes such as deforestation and reforestation that alter evapotranspiration and condensation rates. Over half of the earth's freshwater is estimated to be directly or indirectly used by humans. Some functional aspects of the water cycle remain incompletely understood. Water vapor, clouds, and rainfall, for instance, alter local and regional rates of atmospheric heating and cooling, exerting an important influence on circulation and precipitation and, therefore, regional and global climate. Such dynamics are not well captured in global climate models.

NITROGEN

Nitrogen is an essential element in amino acids and proteins, a component of nucleic acids such as DNA and RNA and of chlorophyll, thereby playing a critical role in the photosynthetic pathway. Approximately 78 percent of the earth's nitrogen is found in the atmosphere in gaseous form. In order for living organisms to be able to use nitrogen, however, it must first be converted to a usable form, or *fixed*. Some nitrogen fixation from the atmosphere occurs in lightning strikes [approximately 10 teragrams (Tg) per year globally; 1 Tg = 1,012 g, or roughly 1 million U.S. tons]. Biological nitrogen fixation (approximately 100 Tg) is completed by free-living and symbiotic bacteria that convert gaseous nitrogen into ammonium ions, and subsequently into nitrite and nitrate ions through nitrification. Symbiotic bacteria form mutualistic associations with specific plant species such as legumes, living in root systems, fixing nitrogen in return for carbohydrates and able to increase nitrite and nitrate concentrations in their immediate soil environment. The large-scale agricultural cultivation of legumes thus releases nitrogen into soils (approximately 30 Tg). Nitrogen is also fixed naturally in marine environments (approximately 5–20 Tg). Nitrogen is fixed industrially during the production of ammonia fertilizer (approximately 80 Tg) and released in the combustion of fossil fuels (approximately 25 Tg). It is now estimated that the rate of human-driven fixation of nitrogen through fertilizer production, legume cultivation, and fossil fuel combustion exceeds that of natural pathways (Vitousek 1994). Additional nitrogen may be released by humans through land conversions such as biomass burning and the draining of wetlands.

Much of this excess fixed nitrogen finds its way into groundwater through the process of leaching following rainfall or irrigation. Increased concentrations of nitrogen, a limiting nutrient in many ecosystems, may lead to eutrophication, precipitate dramatic changes in ecological structure, composition, and function. For instance, increased nitrogen may favor the dominance of nitrogen-demanding species, thus reducing species heterogeneity and richness. It may increase productivity and biomass in certain ecosystems. It may drive local declines in abundance and distribution of particular species by affecting populations of consumers, predators, symbionts, decomposers, and parasites in addition to those of primary producers, and even drive species extinctions and forest diebacks, such as in Europe.

THE CARBON CYCLE

The carbon cycle is likely the most debated aspect of the earth's changing biogeochemistry, and most significant to debates over climate change and global warming. The carbon cycle consists of movements between the principal carbon reservoirs: terrestrial biota, sediments (including fossil fuels), the ocean, and the atmosphere. The carbon budget denotes the exchange of carbon among the reservoirs, the balance of inputs and outputs to each reservoir and, thus, whether a reservoir acts as an effective source of sink of carbon in the global cycle. Atmospheric carbon is predominantly in the form of carbon dioxide, which forms approximately 0.04 percent of the atmosphere, and is a greenhouse gas akin to methane and chlorofluorocarbons (CFCs). Carbon is fixed (sequestered) from the atmosphere through the process of photosynthesis or primary production; productivity rates are highest in young, growing forested ecosystems.

Accurate records of atmospheric concentrations of carbon dioxide maintained since 1957 at Mauna Loa, Hawaii indicate two principal patterns. An annual fluctuation reflects the seasonal growth pattern of northern forests, and is superimposed upon a steady upward trend over the longer term. Atmospheric carbon dioxide (CO_2) concentrations over the past 2,000 years have been recreated by analyzing air bubbles trapped in the Greenland and Antarctic ice caps. The ice core data fit smoothly into the dataset beginning in 1957, and indicate that global carbon dioxide concentrations were relatively constant until the 19th century. A sharp upswing in concentrations since the 1800s coincides with the Industrial Revolution and the dramatic increase in the combustion of fossil fuels for power plants and internal combustion engines. Industrial metabolism is one of the most significant proximate (immediate) anthropogenic sources of GEC. Radiocarbon dating confirms that most of the CO_2 increase is attributable to fossil fuel consumption [approximately 10 petagrams (Pg) per year globally; 1 Tg = 1,015 grams], and not deforestation-related CO_2 release. The missing carbon sink problem arises because the rate of increase in atmospheric CO_2 (approximately 3.5 Pg) does not match that of fossil fuel combustion.

CHANGING CONCENTRATIONS

Changing global concentrations of methane (increase of over 30 percent since preindustrial period) and CO_2 (increase of approximately 150 percent since preindustrial period) track well with fluctuations in mean annual and or longer-period averaged temperatures, indicating support for greenhouse-gas driven global warming. Global mean surface temperature has increased by 0.6±0.2 degrees C since the late 1800s, and is projected by climate models to increase by 1.4 to 5.8 degrees C from 1990 to 2100. Other explanations for observed warming trends hypothesize that the warming is part of natural variation or upswing following the conclusion of the Little Ice Age, or forced externally by solar radiance. Direct data on global temperatures from thermometer readings date to the mid-1800s; temperatures prior to that period are reconstructed from proxies such as width of tree rings, amount of snowfall over glaciers, and isotope records in various glacial and reef systems and calibrated with recent observational data. These longer-term data indicate a warming during the Medieval Warm Period (10th to 14th centuries), and a cooling during the Little Ice Age (14th to 19th centuries), although the global nature of these trends is in question.

Other research has used the Vostok ice core data to examine the anomalous (increasing instead of declining or stabilizing) trends in CO_2 and methane concentrations in the Holocene interglacial period relative to the previous three interglacial periods in the past 400,000 years, linking these trends to the only difference in climate forcing during that time, the human-led clearing of land for agriculture. Ruddiman also made the controversial suggestion that cooling during the Little Ice Age was too large to be accounted for by external (solar/orbital) forcings, but was driven by forest regrowth after outbreaks of bubonic plague.

DEBATE OVER GLOBAL EFFECTS

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 by the World Meteorological Organization and the United Nations Environment Program to assess the risk of human-induced climate change, its potential ecological and human impacts, and options for adaptation and mitigation. The general objectivity of the IPCC's assessments—which are primarily conducted through the analysis and compendium of peer-reviewed scientific publications—and the IPCC's emissions scenarios in particular have been questioned by some climate scientists who regard the panel as unduly influenced by political considerations and/or prone to overstate the rate of change in global temperatures.

The effects of increased atmospheric concentrations of CO_2 have inspired much lively debate, owing in no small part to the complexity of the earth system and difficulty of representing it realistically and precisely in climate models. In particular the regional variations in projected effects of climate change are large, making global generalizations suspect or less than useful from a policy perspective. Besides increasing global mean temperatures, other commonly considered effects of climate change include sea level rise and changes in rainfall patterns. Global warming trends are projected to cause melting of polar ice sheets and the expansion of water in the oceans, leading to rising sea levels. Models predict that a warming of 1.5–4.5 degrees C will lead to a rise in sea level of 15–95 centimeters. Positive feedback loops can exacerbate the consequences. For instance, melting ice sheets result in reduced albedo, increasing absorption of solar radiation by darker ocean waters and leading to further warming of the oceans and melting of ice sheets. Increased global mean temperatures may release methane trapped in Siberian peat bogs formerly under permafrost, increasing greenhouse gas concentrations and causing further global warming. Increased respiration from terrestrial ecosystems as a response to increased temperatures may release CO_2 to the atmosphere in another positive feedback. Global warming is projected to increase global mean precipitation over the 21st century, though regional variations are significant. According to the IPCC, global climate models project increases in winter precipitation in northern latitudes and over Antarctica, while lower latitudes will experience both increases and decreases in distinct regions, as well as increased variability from year to year in those regions. Another postulated effect of climate change is a link to increased frequency and intensity of extreme events such as hurricanes, although those results are highly debated in the climate science community.

Additional effects pertain to the impacts of climate change on ecosystems, human economies, and health. The effect of increased CO_2 on terrestrial biota, and the feedback effects to the global climate system, was the overall focus of the IGBP's Global Change in Terrestrial Ecosystems (GCTE) research effort that came to a close in 2003. GCTE focused

Deforestation: Desecration and Disease

The ecological consequences of deforestation may extend to loss of watershed protection and altered quantity and quality of flow in freshwater and coastal ecosystems. Increased erosion and runoff following deforestation may lead to nutrient enrichment and siltation in downstream areas, including coral reef ecosystems. Land cover may serve as sources or sinks for atmospheric CO_2, and changes to it can therefore affect the global carbon cycle. Tropical forests, for instance, are often cleared for agriculture or pasture development by burning.

Aside from the loss of a carbon sink by removal of the forest, the act of burning releases greenhouse gases into the atmosphere. Land use changes have been linked to increasing concentrations of atmospheric CO_2 in recent years and even dating back to the Holocene. Biomass burning also releases other greenhouse gases such as methane and nitrous oxide, and release aerosols that alter local and regional energy balance and affect air quality and human health across large areas. Changing land covers often create conditions for the spread of pathogens and vectors for crop, livestock, and human diseases. Global increases in morbidity and mortality due to parasitic diseases have increased with land use and associated changes. Deforestation, for instance, may increase proximity of humans and associated livestock to disease vectors and create progressively larger parasite reservoirs.

Deforestation can also aid the proliferation of small puddles of neutral pH water as opposed to the acidic water typically found under canopies. Such conditions favor the incidence and growth of disease vectors such as anopheline mosquitoes (malarial vector), sandflies (*leishmaniasis*), snails (*schistosomiasis*) and other species. Altered patterns of human migration and settlement often accompany or follow deforestation, bringing in migrant incomers to communities of local/indigenous groups. Migrant populations may serve as reservoirs of diseases native to their former homelands, to which local populations may not be adapted. On the other hand, migrants may become exposed to forest-dwelling parasites at the increasing forest edge areas, while indigenous populations may remain immune or resistant to such pathogens, or may have knowledge of behaviors and practices that diminish their exposure.

specifically on ecosystem physiology and the drivers of terrestrial carbon fluxes and pools; changes in ecosystem structure and the relations between vegetation dynamics and landscape pattern and process; impacts of climate change on food production systems and major crops such as wheat and rice; and the relationships among biodiversity and ecosystem function, including ecosystem resilience and stability with respect to natural and human-induced disturbances. Increased CO_2 concentrations may cause a fertilization effect, increasing carbon sequestration rates in terrestrial ecosystems. The efficiency of response to the higher CO_2 levels varies by photosynthetic pathway; C3 plants stand to gain a relative advantage over C4 plants, with significant implications for community and competitive dynamics. Plants with rapid growth rates stand to gain more than slower-growing species; yet, they would produce leaf tissue with lower nutrient content under such circumstances, with consequences for the health and abundances of herbivore populations and other members of the trophic system as well as system nutrient cycles overall.

Changing regional climate regimes (CO_2 enrichment, temperature, and precipitation) can have significant impacts on regional economies by affecting agriculture, forestry, and other production-related human activities and resource management systems. Despite predicted global increases in agricultural yields due to CO_2 fertilization effects and increased efficiency of water use, scenarios vary by crop and region. Northern latitudes may experience greater benefits to agricultural in general, and economies that are dependent on rain-fed agriculture will be more vulnerable because of the possibility of prolonged droughts. The effects of climate change on weed development and pest outbreaks can further affect agricultural yields and viability.

Increased temperatures can affect human health directly through reduced cold-related or increased heat-related health problems and mortality. Climate change can significantly affect the abundance and distribution of vectors of infectious diseases such as malaria, dengue, and rift valley fever. Such effects are likely to be felt disproportionately in less-developed countries that tend to be located in lower latitudes and are less equipped economically and administratively to prevent and/or respond to health crises.

POLICY RESPONSE

The policy response to climate change has focused on two main courses of action: mitigation and adaptation. Mitigation strategies aim at reducing the extent or rate of global warming by reducing fossil fuel use and greenhouse gas emissions through conservation and alternative energy sources such as solar, hydrothermal, and wind energy. Mitigation has also focused on increasing CO_2 uptake or carbon sequestration, including mechanisms for emission trading and carbon taxes.

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is the international policy instrument to deal with climate change. Countries that ratify the treaty commit to reducing their emissions of greenhouse gases—including CO_2—or participate in carbon taxes (a tax on CO_2 emissions) and/or emissions trading. Emissions trading is a market mechanism for dealing with global reductions in greenhouse gases that allows the financial exchange of rights to greenhouse gas emissions between countries that expect to emit more than their allocated share under the Kyoto protocol with those that are under their allocated emissions quotas. The protocol was negotiated in the late 1990s and came into force in 2005 after ratification by Russia.

ADAPTIVE STRATEGIES

Adaptation to global warming, on the other hand, focuses not on reducing or stopping the change itself, but on blocking or responding to the change in a manner that reduces its negative effects on human or natural systems. Adaptation thus refers to the process of reducing the vulnerability to the negative effects of environmental change. The U.S. National Academy of Science (NAS) as well as the IPCC caution that adaptive strategies need to complement efforts at mitigation. Adaptation can be either engineered (planned) or endogenously generated; human societies have adapted to environmental changes in the past several centuries through population resettlement, changes in resources use patterns.

Adaptive strategies might include different modes of agricultural production, including alternative choices of crops and crop varieties, irrigation practices, policies that foster increased food security, the building of higher-capacity stormwater systems and levees in coastal/urban areas, increased use of air conditioning, improved building codes and land use planning, access to appropriate insurance mechanisms, and public health infrastructure to accommodate the negative human health impacts of GEC. Notably, developing nations that are lacking in resources, adaptive capacity, and strong institutions are also the most vulnerable to the effects of GEC and global warming.

HUMAN IMPACT

By overwhelming consensus, changes to the earth's biophysical (land) cover as a result of intensifying and diversifying human land uses constitute the most significant component of GEC. Land cover refers to the biophysical condition of the land: its soils, water, and vegetation; while land use refers to its intended human use. Thus, one type of land cover, such as a forest, may accommodate multiple uses such as forestry, recreation, and wildlife conservation. The same land use, on the other hand, may give rise to land covers that are distinguishable from one another, as when agriculture within a forested landscape uses plots in different stages of fallow rotations, generating fields of crops as well as various stages of secondary succession. Land use/cover change (LUCC) affects multiple biomes and ecosystems, including soils, forests, grasslands, wetlands, terrestrial, marine, and coastal areas, as well as global biogeochemical cycles and global climate. Most anthropogenic LUCC to date has been a consequence of the expansion and intensification of agriculture and pasture, and by forces of urbanization. Over 32 percent of the earth's surface is currently under productive use by humans.

Over the past 300 years, global extents of forests and woodlands have declined by over 18 percent and that of grasslands and pasture by approximately 1 percent. The world's croplands, in the meantime, have increased by over 466 percent in that period. Urbanization has also increased dramatically over the past centuries and decades. The Population Reference Bureau (2006) estimates that 47 percent of the present population of the world is urban; this population occupies 1 percent of the earth's surface and 6 percent of its settled lands. The biophysical transformations associated with urban form have large-scale implications for surface runoff, alterations to regional climate (temperature and precipitation regimes) and air quality.

Smog, such as that over Mexico City, contributes to increased atmospheric concentrations of CO_2.

Changes to land uses and covers can have significant consequences for ecosystems, climate, and human societies, often reaching far beyond the areas directly transformed. The reduction and fragmentation of habitat along with altered disturbance regimes results in changes to local ecosystem structure and function, declines in species and genetic diversity, and increases in the spread of invasive species. Invasive species often share physiological and life history traits that enable them to take advantage of LUCC as well as other aspects of GEC, such as increased CO_2 concentrations and nitrogen deposition. Invaders and exotic species can have devastating ecological as well as economic impact; for instance, an estimated 42 percent of the species listed as endangered or threatened in the United States are at risk primarily because of exotic invaders. The 50,000 invasive species present in the United States collectively cause annual environmental and economic damages in the order of $120 billion. Habitat fragmentation due to LUCC also leads to altered biophysical environments in proximate areas, generating new areas of edges, or ecotones, between the contrasting environments. In 1988, the area of deforestation in the Amazon basin was exceeded by the area within a 1-kilometer distance of existing deforestation, testament to the rising significance of edge effects and their ecological consequences.

Changes in land cover, such as deforestation, can alter solar reflectance patterns by reducing albedo, thereby altering local climate by increasing local temperatures and decreasing humidity. Such increases in regional temperatures in areas of LUCC can influence regional climate and vector populations; for instance, temperature can affect rates of mosquito development, feeding, and infection and incubation times. Urbanization has also been linked to increased average surface temperatures (the urban heat island effect) and decreased diurnal ranges in temperature over urban areas. A 0.27 degrees C (later corrected to 0.35 degrees C) per century increase in surface temperatures was found over all meteorological stations located at heights below 500 meters in the United States, attributable to urbanization and other land use changes. Using two sets of decadal comparisons over 1960s–70s and 1980s–90s, they further found a statistically significant difference in mean temperature increases between urban and rural stations, with urban stations reporting the larger increase in mean temperature.

INTERNATIONAL RESEARCH PROGRAM

In recognition of LUCC's far-reaching impacts and of the necessity of an interdisciplinary approach to the problem, the IGBP and the International Human Dimensions Program (IHDP) jointly founded the international research program on LUCC. The LUCC program initiated and consolidated research on empirical studies of changing land cover patterns, case-study derived understanding of the land use dynamics underlying the changing land covers; the development of regional/global datasets and protocols for land cover classifications; an analysis of scalar dynamics (e.g., how cover and use patterns and their drivers vary across scales), and the use of this information in regional and global models of LUCC and GEC.

PROXIMATE AND DRIVING FORCES

LUCC researchers often decompose anthropogenic activity implicated in land change into two broad suites of factors: *proximate sources* and *driving forces*. Proximate sources of LUCC refer to the immediate human activity and intended land use(s) causing alterations to the earth's land cover; these include, for example, agricultural or urban expansion, conversion of grasslands, forests, woodlands or other ecosystems to pasture, land cover changes due to the expansion of infrastructure—such as for road construction—and draining or filling of wetlands for development.

Driving forces, on the other hand, underlie such proximate sources of LUCC and emanate from fundamental social, political, economic, and cultural dynamics. Demographic, technological, socioeconomic, political/institutional, and cultural factors encompass the broad suites of driving forces that may act directly at local scales, or prevail at national/global scales but indirectly affect local areas.

POPULAR EXPLANATION

One popular explanation of GEC impacts dates to the 1971 formulation of the IPAT hypothesis (Environmental **I**mpact = **P**opulation **A**ffluence **T**echnology) by Paul Ehrlich and John Holdren. When treating the earth as a closed system, the IPAT formulation may serve as a shorthand proxy for explaining GEC at the global scale as a function of population size, per-capita consumption levels (affluence or poverty), and technological efficiency and appropriateness. The empirical validity of IPAT often breaks down at regional and local scales of analysis, however, since environmental transformations at these scales are the results of human agents operating within social structures, and involve complex effects of policies, markets, tenure, and other institutions as well as cultural beliefs and practices.

Economic driving forces of LUCC thus include market penetration and growth, relationships between production and consumption, growth in industrial and other sectors, and trade, foreign exchange and other indices of links to international markets and policies. Policy/institutional forces encompass land tenure and property regimes, state and local policies governing resource access, land management and economic development, and include policy instruments such as credits and subsidies, as well as considerations of policy failures. Technological factors include the technical and managerial strategies employed in production in agricultural, forestry, and other land use sectors, including concerns of efficiency and the allocation of labor and capital to the production process. Cultural factors pertain to a household, group or population's attitudes, values and beliefs; and demographic factors include population increase and density, age structure, and other variables.

The static formulation for IPAT does not take into consideration flows of materials, energy, people and economic resources between linked social and environmental systems. Furthermore, several suites of driving forces may interact at multiple scales, structuring how environmental resources are produced and consumed, and generating complex pathways to land transformations. In 2002, H.J. Geist and E.F. Lambin, for instance, undertook a meta-analysis of 152 subnational case studies of tropical deforestation (a significant proximate source of GEC) and found regional patterns of interacting causal drivers, contradicting the conventional wisdom that previously faulted population growth (driving force) and shifting cultivation (proximate source) as the main culprits. Economic factors were most frequently cited driving forces at the global scale when case studies from Asia, Africa, and Latin America were pooled, followed in order by institutional/policy, technological and sociocultural factors, with demographic factors cited least frequently. These global "average" trends, however, belie important regional differences. Institutional/policy factors are most frequently cited in case studies focused in Asia, while demographic factors prevail in African case studies, and economic factors dominate in studies based in Latin America.

GOING FORWARD

The LUCC program concluded in 2005; however, its insights and evolving research questions now inform the newly established Global Land Project (GLP). The GLP is the latest IGBP–IHDP collaborative project on linked human–land systems, and merges the agendas and insights from over a decade of research on the relationship of GEC to terrestrial ecology (GCTE) and to dynamics and models of LUCC. The use of models has been particularly instrumental in the understanding and prediction of the dynamics and impacts of LUCC/GEC. While models span a wide range of purposes, analytical techniques and disciplinary/methodological traditions, they can be combined to test and formalize various theories in order to improve our explanatory and predictive power, ability to be generalized, accuracy, and precision. Challenges to present and future modeling approaches to studying land change include the integration of social and natural factors and interactions at multiple scales, the incorporation of qualitative information in models, and overall integration of epistemological, conceptual, and methodological integration in modeling linked social-environmental systems.

SEE ALSO: Carbon Cycle; Carbon Dioxide; Climate; Climate Modeling; Climatology; Deforestation; Disease; Global Warming; Hydrological Cycle; Industrial Revolution; Population; Weather.

BIBLIOGRAPHY. J.S. Dukes and H.A. Mooney, "Does Global Change Increase the Success of Biological Invaders?" *Trends in Ecology and Evolution* (v.14, 1999); P. Ehrlich and J. Holdren, "Impact of Population Growth," *Science* (v.171, 1971); Food and Agriculture Organization of the United Nations (FAO), *1989 Production Yearbook* (FAO, 1990); H.J. Geist and E.F. Lambin, "Proximate Causes and Underlying Driving Forces of Tropical Deforestation," *Bioscience* (v.52, 2002); Global Land Project (GLP), *Science Plan and Implementation Strategy* (IGBP Secretariat, 2005); Intergovernmental Panel on Climate Change (IPCC), *Principles Governing IPCC*

Work, www.ipcc.ch (cited, May 2006); Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2001: The Scientific Basis*, www.grida.no/climate (cited, May 2006); National Research Council (NRC), *The Role of Terrestrial Ecosystems in Global Change* (National Academy Press, 1993); D. Pimentel, R. Zuniga, and D. Morrison, "Update on the Environmental–Economic Costs Associated with Alien-Invasive Species in the United States," *Ecological Economics* (v.52, 2005); Population Reference Bureau (PRB), *2005 World Population Data Sheet*, www.prb.org (cited May 2006); W. Ruddiman, "The Anthropogenic Greenhouse Era Began Thousands of Years Ago," *Climate Change* (v.61, 2003); D.A. Saunders, R.J. Hobbs, and C.R. Margules, "Biological Consequences of Ecosystem Fragmentation: A Review," *Conservation Biology* (v.5, 1991); B.L. Turner, W. Clark, R.W. Kates, J.F. Richards, J.T. Mathews, and W.B. Meyer, eds., *The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere Over the Past 300 Years* (Cambridge University Press, 1990); B.L. Turner, R.E. Kasperson, and W.B. Meyer, et al., "Two Types of Global Environmental Change: Definitional and Spatial Scale Issues in Their Human Dimensions," *Global Environmental Change* (v.1, 1990); B.L. Turner, D. Skole, S. Sanderson, G. Fischer, L. Fresco and R. Leemans, *Land-Use and Land-Cover Change: Science/Research Plan* (Royal Swedish Academy of Sciences, 1995); P.M. Vitousek, "Beyond Global Warming: Ecology and Global Change" *Ecology* (v.75 1994).

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Global Environment Facility (GEF)

THE GLOBAL ENVIRONMENT Facility (GEF) is a multilateral financial mechanism that promotes international cooperation around the protection of the global environment. It grew out of a concern for global environmental problems in the 1980s, particularly a growing awareness of transboundary environmental problems and recognition that efforts to improve matters would be costly. Today, GEF is the single largest grant-making institution for global environmental programs. It has allocated some $5 billion for more than 1,500 projects in 140 countries.

Projects are developed and financed through three implementing agencies: the World Bank, United Nations Environment Program (UNEP), and United Nations Development Program (UNDP). Executing agencies that implement projects on the ground include regional development banks and a number of UN specialized agencies. Governance structure of the GEF is centered around the GEF Council, a group composed of 32 representatives from member states who meet biannually to review, comment upon, and reject or accept GEF projects, future business plans, work programs, and policies. The GEF Assembly, composed of all GEF 176 member states, meets every three or four years to review and approve general policies, operations, and amendments to the founding GEF Instrument. GEF operations are coordinated by a Secretariat in Washington, D.C. The GEF has been applauded for its unique structural flexibility and strong ability to adapt in a changing environment.

FOCAL AREAS AND PROJECTS

The GEF promotes environmentally beneficial projects in developing countries through six focal areas: Biological Diversity, Climate Change, International Waters, Ozone Depletion, Land Degradation, and Persistent Organic Pollutants. The GEF acts as the financial mechanism for the following global conventions and international agreements: the United Nations Framework Convention on Biological Diversity, the United Nations Framework Convention on Climate Change, the Montreal Protocol, the United Nations Framework Convention on Combating Desertification, and the Stockholm Convention on Persistent Organic Pollutants.

The GEF provides concessional financing to cover the incremental costs necessary to achieve global environmental benefits in the six focal areas. Incremental costs are calculated by subtracting the costs of any national or local benefit from the total cost of the project to identify the cost of creating global environmental benefits that the recipient would otherwise have no incentive to fund. Cofunding is expected to cover the "national" benefits of the project. According to the GEF publication *Achieving the*

Millennium Development Goals: A GEF Progress Report, the institution's work reflects the "current thinking within the conservation movement," emphasizing management of ecosystems and cooperation with the "human communities found there." This signals a shift among all focal areas from a technological emphasis to an approach that considers both economic and life systems.

The First Decade of the GEF: Second Overall Performance Study (2002) of the GEF found that the institution's biodiversity program, specifically, made "significant advances in demonstrating community-based conservation within protected areas, and, to a lesser extent, in production landscapes." As the financial mechanism for the UN Convention on Biological Diversity, the GEF recognizes intrinsic and global benefits of biodiversity, and funds incremental costs that may otherwise dissuade countries from protecting biodiversity. Yet, the biodiversity program has received criticism for overly ambitious goals and inadequate local participation and its inability to address the root causes of biodiversity loss.

Global climate change impacts a wide array of consequences across a wide spectrum of communities; accordingly, the GEF pursues a synergistic model to address the consequences of climate change. It utilizes market development, sustainable business models, and demand-side incentives to complete projects that remove barriers to efficiency and conservation, promote alternative energy, reduce implementation and long-term costs of alternative energies, and support sustainable transport. For example, the Poland Efficient Lighting Project relied on the GEF's manipulation of market forces to subsidize the production of energy-efficient fluorescent lamps, thereby increasing the percentage of households that use energy-efficient lighting.

Action-oriented, on-the-ground projects with replicable schemes characterize the GEF's International Waters projects. Unencumbered by a global convention, the GEF can exhibit a high degree of autonomy in this area. The majority of the International Waters portfolio is dedicated to regional projects, in which education and dialogue are emphasized with the hope that future problems can be addressed collaboratively by neighboring countries. Recent research on these projects found success in building scientific knowledge and creating linkages across social, economic, and environmental issues but found less success in the GEF's ability to enhance the contractual environment and build national capacity.

Although the Ozone Program is the smallest of GEF programs, the impact of ozone-depleting substances (ODS) on earth's protective ozone layer is no small matter. The GEF is not officially linked to the Montreal Protocol, which limited the production of ODS; nevertheless, it has secured $138 million over the last 10 years to help countries with economies in transition to begin phasing out the use of ODS. Only countries that have ratified the protocol are eligible for GEF support.

Land degradation has deep links to global environmental change, among them the threat to biodiversity, the ability to induce climate change, and the disruption of hydrological cycles. GEF projects cut across focal areas to combat desertification and deforestation, with sustainable land management as the ultimate goal. The land degradation program exhibits greater recognition of poverty and economic development than other focal areas but lacks ingenuity: the GEF's *Second Overall Performance Study* noted that land degradation activities lack innovative approaches to policy and technological components, with projects tending to rely on old technologies and approaches.

Living organisms absorb persistent organic pollutants (POPs) through food, water, and air and accumulate these harmful compounds in their tissues. Exposure to POPs may affect immune and reproductive systems and neurobehavioral development and is connected to birth defects, cancers, and osteoporosis. As the financial mechanism for the Stockholm Convention on Persistent Organic Pollutants, between 2001 and 2004 the GEF funded more than $141 million POPs projects. The majority of the more than 150 projects center on implementation of the convention, and include the destruction of obsolete stockpiles of POPs.

THE GEF IN TRANSITION

Presently, officials at the GEF are preparing its fourth replenishment cycle. Since the GEF's first funding cycle in the mid-1990s, the United States, the GEF's largest single shareholder, has been holding down

GEF funding levels. Most recently, it required the GEF to adopt a new resource allocation framework as a condition of continued U.S. financial support. According to Raymond Clémençon, this controversial framework "allocates GEF funds to recipient countries according to their global environmental relevance and ties resource allocation to performance-based indicators." Under this new framework, to be implemented beginning in July 2006, countries will be ranked by a Benefits Index and a Performance Index. The highest-ranked countries in each focal area will get individual country allocation. The remaining countries will be placed into groups with collective access program funding. Undoubtedly, the new framework will change how the GEF conducts business. It is expected to seriously alter competition among project proposals. Indeed this change in the GEF's funding allocation structure, coupled with changes in GEF focal areas, will provide fertile ground to further investigate GEF projects and programs—and this institution's broader impact on the global environment.

SEE ALSO: Biodiversity; Convention on Biological Diversity; Desertification; Global Warming; Land Degradation; Montreal Protocol; Ozone and Ozone Depletion; United Nations Environment Programme; United Nations Framework Convention on Climate Change.

BIBLIOGRAPHY. Raymond Clémençon, "What Future for the Global Environment Facility?" *Journal of Environment and Development* (v.15/1); Eric Dewailly and Christopher Furgal, "POPs, the Environment, and Public Health," in David Leonard Downie and Terry Fenge, eds., *Northern Lights against POPs: Combatting Toxic Threats in the Arctic* (McGill-Queen's University Press, 2003); Andrea K. Gerlak, "One Basin at a Time: The Global Environment Facility and Governance of Transboundary Waters," *Global Environmental Politics* (v.4/4, 2004); A. Gerlak and L. Parisi, "An Umbrella of International Policy: The Global Environment Facility at Work," in Dennis L. Soden and Brent S. Steel, eds., *Handbook of Global Environmental Policy and Administration* (Marcel Dekker, 1999); Global Environment Facility, *Achieving the Millennium Development Goals: A GEF Progress Report* (Global Environment Facility, 2005); Global Environment Facility, *The First Decade of the GEF: Second Overall Performance Study* (Global Environment Facility, 2002); Global Environment Facility (homepage), www.gefweb.org (cited June 2006); Global Environment Facility, "Land Degradation," www.gefweb.org (cited June 2006); Global Environment Facility, *Operational Strategy* (Global Environment Facility, 1996); Korinna Horta, Robin Round, and Zoe Young, *The Global Environment Facility: The First Ten Years—Growing Pains or Inherent Flaws?* (Environmental Defense and Halifax Initiative, 2002); Helen Sjoberg, *From Idea to Reality: The Creation of the Global Environment Facility* (Global Environment Facility, 1994); Charlotte Streck, "The Global Environment Facility—A Role Model for International Governance," *Global Environment Politics* (v.1/2, 2001).

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Globalization

THE TERM *GLOBALIZATION* refers to the increased interconnectedness of people and environments around the world through the transfer and exchange of capital, ideas, money, labor, and commodities. Globalization encompasses global integration through investment and capital flows between nations; the emergence of new political territories; the diffusion of information and technologies; and the movement of cultural identities and practices around the globe.

Globalization therefore describes a transformation in the spatial organization of social, political, and economic relations between global actors. The term *globalization* is also a rhetorical tool used in public discussions about the state of global economic, social, and environmental conditions. The term is used by a variety of ideological positions including both pro-globalization and alter-globalization (oftentimes labeled anti-globalization) activists. Globalization is thus a set of distinct material patterns and processes as well as a debated ideological perspective on world affairs—including the changing relationship between humans and the environment.

The interface between globalization and the environment is multifaceted, and can be viewed as how the process of globalization—most prominently global economic development—affects natural environments and the social groups who use them; and the dramatic globalization of environmentalism—particularly manifest in the context of regional and global political governance.

IMPACTS ON THE ENVIRONMENT

One of the major events precipitating economic globalization was the Bretton Woods Conference of 1944, where number of institutions were formed that would eventually change the face of global trade, finance, and production. Perhaps the most important legacy from the Bretton Woods conference was the formation of the General Agreement on Tariffs and Trade (GATT), which eventually led to the formation of the World Trade Organization (WTO) and the subsequent lowering of barriers to trade between nations. Other important agencies created to manage global financial transactions and development projects include the International Monetary Fund (IMF) and the World Bank. Free-trade policies, increased privatization of social services, and reduced government regulation comprise neoliberal economic policy reforms. The opposite of protectionism, economic liberalization paves the way for corporations and governments to conduct business throughout free trade regions with minimal tariffs and government intervention.

Companies participating in free trade are often referred to as transnational corporations (TNCs) with headquarters, production, manufacturing, and resource extraction facilities spread horizontally around the world. Many private companies seek to establish comparative advantages with competitors by pursuing sourcing efficiencies. Raw materials, labor, and capital are efficiently "sourced" by moving assembly abroad to developing nations through foreign direct investment and the offshoring of jobs. Production costs are reduced primarily through offshore conditions characterized by cheaper labor inputs, less severe tax regimes, and lower environmental corporate performance standards—including less stringent noncompliance penalties. The process by which corporations, spurred

"Seattle" and Other Battles

The net effects of globalization on the environment are disputed. Globalization and its negative impacts on the environment are core elements of the alter-globalization activist movement. Perhaps the most famous (or most infamous, depending on the perspective) demonstration was the 1999 WTO protests in Seattle, Washington. Protests like "The Battle in Seattle" are notable because they mark a point of convergence between various social and environmental interest groups advocating in concert for "fair trade" over "free trade." Some of the major environmental concerns voiced by these groups include:

Globalization brings accelerated economic growth and structural change to various regions of the world, which is predicated on increased resource use, extraction, and degradation—practices that are enabled by free trade policies and the pursuit of sourcing efficiency.

Neoliberal development, poverty, and environmental destruction cannot be separated. Globalization and structural adjustment programs transform deeply rooted land use practices and exacerbate preexisting levels of financial debt in ways that further impoverish developing nations and undermine the livelihoods of subsistence land users—resulting in a downward spiral of poverty-induced resource depletion and environmental degradation.

Because developing countries compete to attract international investments from developed nations, and structural adjustment agreements tie the hands of national governments in an effort to liberalize trade, there is little incentive or regulatory infrastructure to impose strict environmental standards.

Globalization applies a wedge between the consuming core and the producing periphery, also known as "distancing," which diminishes the ability and desire of consumers to understand the consequences of their consumer choices.

by competition with other firms, seek to increase profit margins through the pursuit of ever-cheaper labor and less costly environmental standards has been labeled as downward harmonization or "race-to-the-bottom" economics.

Some groups suggest that globalization and responsible environmental stewardship are not mutually exclusive. The WTO clearly states this position in the Doha Ministerial Declaration of 2001, "We are convinced that the aims of upholding and safeguarding an open and nondiscriminatory multilateral trading system, and acting for the protection of the environment and the promotion of sustainable development can and must be mutually supportive." The WTO and other free trade advocate positions include:

Development and free trade bring wealth, which is a necessary ingredient for alleviating poverty and protecting the environment.

Private and market interests are more likely to curb environmental degradation than cumbersome and oftentimes corrupt state-run enterprises.

Globalization generates international pressures for reform through transboundary information sharing, leading to the formation of an increased scientific and global environmental awareness.

Globalization will diffuse product standards, capital, and technologies from nations with high environmental regulations to those with low regulations. NAFTA, and other free trade agreements, will lead to "upward harmonization" or the rise of environmental standards to the highest common denominator.

Advocates of free trade point to Mexico's ability to formulate substantive environmental laws and effective implementing regulations, standards, and institutional infrastructure since the inception of NAFTA. Supporters also refer to the 2001 Sustainability Index released at the World Economic Forum to show how the top-ranking countries such as the United States, European Union (EU) nations, and Canada contain liberalized trade policies. According to this index, nations like Libya and Saudi Arabia that rank near the bottom of the sustainability index tended to be those who isolated themselves economically through trade restrictions.

The environmental movement's popular use of global imagery has been criticized for obscuring poverty issues.

GLOBAL ENVIRONMENTALISM

Many environmental issues are international because of their geographical scope. Just as investments and information travel between political boundaries, so too do natural systems such as water, air, and migratory wildlife. Environmental issues such as global warming are truly international in scope. The burning of fossil fuels, which releases greenhouse gases into the atmosphere in one nation can, as numerous predictive simulation models suggest, "force" climatic shifts in other regions of the planet.

Other environmental issues, while not necessarily global in scope, encompass a set of international actors. Acid rain in Canada resulting from sulfur dioxide and nitrogen oxides pollution in the United States Midwest is a transboundary, international environmental issue. So too is the impact of water diversions on the upper Mekong River in China upon lower Mekong basin nations such as Cambodia and Vietnam. These cases illustrate how many environmental issues cross national boundaries due to the spatial reach of the natural system and social causes and consequences in question.

While the scale of the environmental system in question is a useful way to measure its international status, it is perhaps more instructive to measure the relationship between globalization and the environment in terms of how the environment is researched and managed in an increasingly global format. Today numerous international organizations, accords, and protocols on the environment exemplify the globalization of environmentalism in scientific, managerial, and activist capacities. Some environmental problems are endemic to local or regional environments—including isolated cases of water security, infectious diseases, and species extinction. Yet because of the globalization of environmentalism these have become issues of global concern. Environmental governance has broadened over the past 35 years in the form of multiregional and international organizations and commissions to bring awareness and action to diverse environmental issues.

INTERNATIONAL GOVERNANCE

International environmental governance occurs in a variety of overlapping categories: stipulations in international free trade agreements; international accords, frameworks, and agendas, also referred to as multilateral environmental agreements (MEAs), resulting from global conferences or "summits;" intergovernmental organizations; and the dealings of transnational nongovernmental organizations (NGOs). Regional and global governance has led to the diffusion of various environmental ethics, principles, and management strategies that uphold various discourses including sustainability, ecological modernization, and conservation.

Free trade is organized within formally agreed-upon regional economic blocks such as the North American Free Trade Agreement (NAFTA), the common market of the EU, and Mercosur (Mercado Comun del Sur or the Southern Common Market), the latter of which enables free trade between various South American nations. These economic policy arrangements signify a new form of governance where the nation-state is no longer the paramount broker of economic affairs, instead deferring to the authority of international governing bodies. Regional economic blocks contain a number of important policy dimensions, one of which is how to address environmental concerns in the face of transforming economic relations. The diminishing role of traditional political entities like the nation-state to govern environmental affairs represents a form of political deterritorialization, while NAFTA, the EU, and Mercosur mark the reterritorialization of new regional, political entities.

The North American Free Trade Agreement, through the formation of the North American Agreement on Environmental Cooperation (NAAEC) and the Commission for Environmental Cooperation (CEC), contains provisions for enhancing compliance with environmental laws and regulations and evaluating the environmental effects of NAFTA. The EU and Mercosur also contain transnational governing bodies similar to that of the CEC. For example, under the EU, the European Environment Agency serves as a clearinghouse for scientific information and policy recommendations. Mercosur also contains internal environmental protocols as part of the Treaty of Asunción. These wide-ranging protocols include frameworks for regional, sustainable, and cooperative management of shared ecosystems and the provision of mechanisms to enhance enforcement and participation.

Environmental stipulations associated with free trade agreements usually remain subordinate to MEAs. Principle 12 of the Rio Declaration on Environment and Development states that international agreement is preferable to national programs when tackling transboundary or global environmental issues. Significant MEAs include accords that manage wildlife issues and biodiversity. Examples include the 1946 International Convention for the Regulation of Whaling; the 1971 Ramsar Convention on Wetlands of International Importance; the 1973 Convention on International Trade in Species of Wild Fauna and Flora (CITES); and the 1979 Bonn Convention on the Conservation of Migratory Species. A number of other MEAs are intended to protect atmospheric resources. These agreements include the 1979 United Nations Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution; the 1985 Vienna Convention for the Protection of the Ozone Layer, leading to the 1987 Montreal Protocol; and the 1992 United Nations Framework Convention on Climate Change, leading to the 1997 Kyoto Protocol. Issues pertaining to marine environments, chemical use, waste management, desertification, and forest conservation are all addressed by a variety of MEAs. Together these agreements create an international framework for governing specific activities that influence regional and global environments.

OTHER MEAS

Other MEAs are formulated as part of global conferences or "summits." The 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (commonly referred to as the Earth Summit) was a watershed in the formulation of a global environmental consciousness among international delegates. The summit also advanced an international movement to manage the global environment by linking environmental degradation, poverty, and excess consumption around the world. Using the common language of sustainable development, 172 governments produced a number of important international frameworks for governing the environment, including Agenda 21 and the Rio Declaration on Environment and Development.

Some MEAs are not binding or enforceable and instead represent a collectively agreed-upon set of ethics and best practices. The Brundtland Commission report "Our Common Future" advocating sustainable development and the 1992 Earth Charter declaring a unified set of environment, global justice, peace, and democracy principles both articulate and prescribe global environmental ideologies. Each represents an attempt to organize the core ethics and principles of environmentalism along global lines.

Intergovernmental organizations (IGOs) help facilitate the organization and enforcement of MEAs. Perhaps the most prominent IGO is the United Nations Environment Program (UNEP). UNEP coordinates environmental activities and encourages sustainable development through a series of protocols and conferences around the world. For example, UNEP worked with the World Meteorological Society to create the International Panel on Climate Change. UNEP also played a crucial role in the organization of the 1992 Earth Summit and the 2002 World Summit on Sustainability.

NGO INVOLVEMENT AND CRITICISMS

Many environmental movements and management plans are initiated by transnational NGOs such as Greenpeace, Worldwatch Institute, World Wildlife Fund (WWF), Nature Conservancy, and Friends of the Earth. While the headquarters of these NGOs are typically based in a single locale, transnational NGOs are usually comprised of a complex network of subheadquarters located around the world. By definition, these organizations keep government money at arm's length in order to maintain a consistent institutional agenda and serve as a counterbalance to government action.

Over the past 20 years, transnational environmental NGOs have increased their level of involvement in global-scale accords and protocols. For example, the Earth Summit on sustainable development included the active involvement of over 2,400 NGOs in both monitoring and consulting capacities. These organizations also serve as advocacy groups for particular ideological positions on the environment—often participating in public demonstrations or "counter conferences" to protest and draw public attention to perceived government or IGO misconduct.

The environmental movement has used a variety of icons and slogans to capture the connection between societies and environments around the world. The formation of an international Earth Day, the effective use of global imagery in environmental advertising, the metaphor of "Spaceship Earth," and the slogan "think globally, act locally" are all examples of how environmental discourse has been advanced through an appeal to a shared global environmental consciousness.

Despite the popularity of these images and slogans, they are subject to critiques, especially from those questioning the role of power in representing the global environmental movement. For example, critics ask, who speaks for the globe and who defines a global problem? Others argue that the picture of earth seen from outer space obscures and in effect erases the uneven terrain of poverty-induced social and environmental disharmony around the world. Still others have argued that global images used to appeal to the public are deeply misleading. For example, representations of third world environments found in first world brochures and advertisements misinform the public because they present so-called "pristine" areas as devoid of people, even when those areas contain a long history of settlement and land use by indigenous and other local populations.

Others have critiqued the role of power in shaping the actions of the global environmental movement. These critiques suggest that global environmental governance is at best a way of ordering the world and prioritizing behavior in ways consistent with the concerns and expertise of powerful nations. At worst, the globalization of environmentalism is a form of neo-imperialism that gives developed countries an open passport to intervene and manage resources around the world for their own benefit.

SEE ALSO: Brundtland Report; Convention on International Trade in Species of Wild Fauna and Flora; General Agreement on Tariffs and Trade; Greenpeace; International Monetary Fund; Kyoto Protocol; Montreal Protocol; Nature Conservancy; North American Free Trade Agreement; Race-to-the-Bottom; Rio Declaration on Environment and Development; Spaceship Earth; Trade, Fair; Trade, Free; United Nations Conference on Environment and Development (Earth Summit); United Nations Environment Program; United Nations Framework Convention on Climate Change; World Bank; World Trade Organization; World Wildlife Fund; Worldwatch Institute.

BIBLIOGRAPHY. John Dryzek, *The Politics of the Earth: Environmental Discourses* (Oxford University Press, 1997); David Held, Anthony McGrew, David Goldblatt, and Jonathan Perraton *Global Transformations: Politics, Economics and Culture* (Stanford University Press, 1999); Anup Shah, Global Issues (homepage), www.globalissues.org/ (cited June 2006); Mathew Sparke, *The Blackwell Dictionary of Globalization* (Blackwell, 2006); Mathew Sparke, *Introduction to Globalization: The Ties That Bind* (Blackwell, 2006); United Nations Environmental Program (homepage), www.unep.org (cited June 2006).

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Global Positioning Systems (GPS)

A GLOBAL POSITIONING (GPS) system is a radio-based, real-time navigation and positioning system with a global coverage that provides the exact position on the earth surface in almost any meteorological condition. It is formed by three components: satellite constellation, control centers, and a receiver.

There are various Global Navigation Satellite Systems (GNSS): NAVSTAR, GLONASS, and EGNOS, precursor of the European Galileo. However, the system that coined the term and first developed the concept was NAVSTAR (NAVigation Satellite Time and Ranging). It was developed by the Department of Defense of the United States in 1978 and became completely operative in 1994. It was initially conceived for the military, though it was eventually opened for civilian use. Its constellation of 24 satellites, which hold a highly precise atomic clock, orbit at 12,000 miles (20,000 kilometers) above the Earth in six orbital planes with four satellites, each at an inclination of 55 degrees, making two complete orbits in less than 24 hours.

The geostationary satellites of the system emit a continuous signal with information on the exact time it has been sent out, which allows a receiver to calculate the distance to each satellite in real-time by calculating the time invested to arrive. When at least three satellites of the constellation are simultaneously visible, the receiver calculates (by triangulation) its local position in geodesic coordinates (x, y, z) in the WGS84 Geodetic datum; with the distance to a fourth satellite height or vertical position that can be further calculated.

The control segment is a network of five stations around the world that permanently monitor, estimate the satellites orbit and position (or ephemeredes) the status of their clocks and the conditions in the ionosphere that affect signal transmission. This operation is coordinated by the Master Control Station at Colorado Springs, Colorado.

The GPS satellite transmits the signal at two frequencies: L1 (1575.42 Megahertz), and L2 (1227.60 Megahertz) or carrier frequencies. The signal is altered as it travels through the atmosphere, interfering in system accuracy. An L1/L2 receiver can compare both signals and correct the alteration. In nondifferential mode, both L1 and L1/L2 receivers will obtain the same horizontal accuracy; while in differential mode, L1/L2 receivers will perform better since they can determine and correct the atmospheric-, ionospheric-, and tropospheric-propagation error. L1 and L2 are modulated by the Precise/Protected code (or "P code") and the Course Acquisition code (or "C/A code"). L1 frequency carries the C/A code used for the standard positioning service (SPS), a service available without restrictions, and the P code used for the precise positioning service (PPS), a restricted service, while L2 frequency only carries P code.

The receiver holds a clock that calculates the difference between the time received from the satellite and the actual time, which allows it to calculate the distance to it, the positional sphere. The finest measurement is obtained when the satellites are 120 degrees to each other and the fourth in the vertical.

Signal quality was degraded by introducing digital noise to prevent military use by foreign countries with two security systems, Selective Availability (SA) and Antispoofing. SA is a process that limits accuracy to the SPS by changing information on satellite orbit data and/or clock frequency. SA was deactivated on May 1, 2000. Antispoofing (AS) is the encryption process of the P code, used for precise positioning, replaced by the Y code.

The Differential GPS (DGPS) performs a differential correction of the received signal to improve GPS accuracy. A base station with a known position tracks the satellites and receives the signal at the same time as the mobile receiver, calculates the error for each satellite, and allows the correction of the unknown locations collected. The correction can be accomplished in real-time, sending the information to the receiver or in post-processing, to obtain centimeter accuracy. Two modes are available, as single station or Local Area DGPS (LADGPS), and a network of stations or Wide Area DGPS (WADGPS).

SEE ALSO: Geographic Information Science; Satellites; Science and Technology Studies; Technology.

BIBLIOGRAPHY. Ahmed El-Rabbany, *Introduction to GPS: The Global Positioning System* (Artech House, 2002); Bernhard Hofmann-Wellenhof, Herbert Lichtenegger, and James Collins, *Global Positioning System: Theory and Practice* (Springer, 2001); Elliott D. Kaplan and Christopher Hegarty, eds., *Understanding GPS: Principles and Applications* (Artech House, 2006); Bradford W. Parkinson and James J. Spilker, eds., *Global Positioning System: Theory and Applications* (AIAA, 1996).

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Global Warming

THE TERM *global warming* refers to a warming in the earth's climate. Global temperatures have changed throughout earth's history; however, in common usage, the term *global warming* refers to the anthropogenic (human induced) warming that results from an increase in atmospheric concentrations of certain gases due to the burning fossil fuels since the Industrial Revolution. This phenomenon is also called the greenhouse effect, and is a specific case of the more general term *global climate change* (which also refers to climate cooling both human induced and otherwise). Average global temperature has risen 0.6 ± 0.2 degrees C over the 20th century. The Intergovernmental Panel on Climate Change (IPCC) reports that most of the warming observed over the past 50 years is attributable to human activities. IPCC also reports that the 1990s were the warmest decades and 1998 was the warmest year since 1861.

How does this happen? The earth surface absorbs energy from the sun and radiates it back into the atmosphere. An increase in "greenhouse gases," including carbon dioxide (CO_2), methane (CH_4), ozone (O_3), chlorofluorocarbons (CFC's), Nitrous oxides (N_20) and sulfur hexaflouride (SF_6) form a layer of insulation that traps the earth's outgoing heat, much as air is trapped inside a greenhouse. The increased concentration of these gases traps more heat and causes the earth's overall temperature to become warmer.

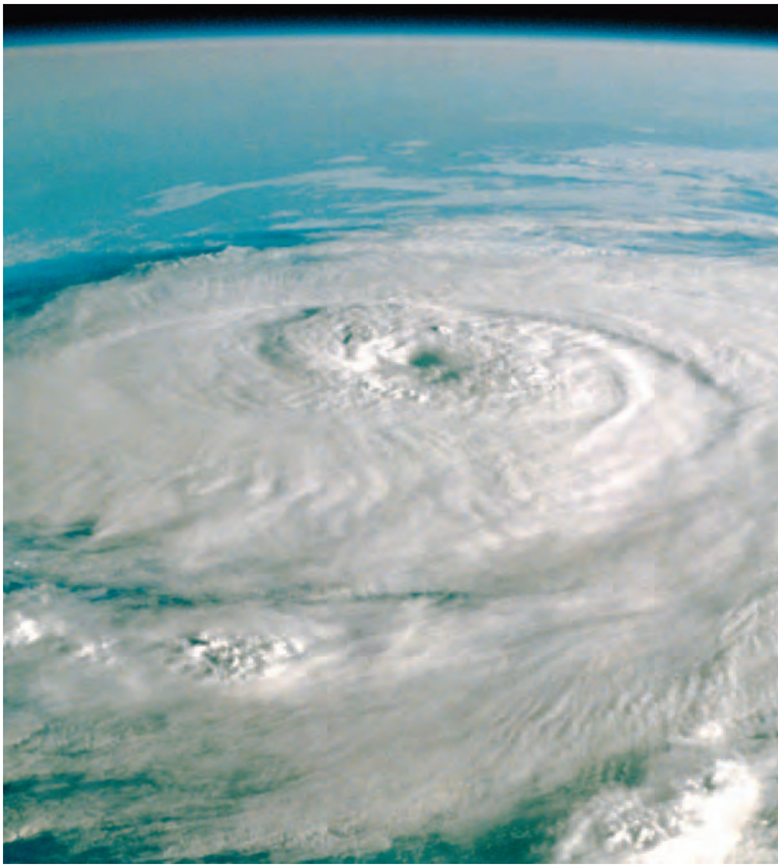
The atmospheric concentration of greenhouse gases has increased over the last century due to industrial and agricultural activity. The most significant greenhouse gas by volume is carbon dioxide. Carbon dioxide is released into the atmosphere through the burning of fossil fuels (oil, natural gas, and coal) in vehicle exhaust, coal-fired power plants and industrial processes. Since the late 1950s, measurements made at the Mauna Loa Observatory in Hawaii record an increase in carbon dioxide concentrations within the atmosphere. Data from Mauna Loa and other sources indicate that atmospheric carbon dioxide concentrations in the atmosphere are now the highest in 150,000 years. Similarly, methane concentrations have increased as a result of the production and transportation of fossil fuels, rice paddy farming, livestock production, changes in land use from wetlands, and emissions from municipal solid waste landfills as organic waste decomposes. Nitrous oxide is released from agricultural and industrial activities, and the combustion of both and fossil fuels and solid waste. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), are greenhouse gases that are not naturally occurring, which are generated in a variety of industrial processes.

PHYSICAL CONSEQUENCES

Climate change is predicted to produce a wide variety of physical impacts to atmosphere, land and oceans including increases in overall global mean temperature, increases in storm severity, sea level rise, changes in ocean currents, glacial retreat, drought, and increased fire and hurricanes. Reduced winter snow pack will result in lower flows to river streams during summer. Climate models analyzed by the IPCC predict that between 1990 and 2100, global temperatures may increase by between 1.4 and 5.8 degrees C. The IPCC estimates that the combined effects of ice melting and sea water expansion from ocean warming are projected to cause the global mean sea level to rise by between 0.1 and 0.9 meters between 1990 and 2100. Because a high percentage of the human population lives along the coast, these increases in sea level will have enormous social impacts. For example, in Bangladesh, a half-meter increase in sea level puts some 6 million people at risk from flooding.

As a result of these widespread ecosystem disruptions, ecological productivity and biodiversity will be altered, leading to an increased risk of extinction for species already at risk. IPCC reports that "the stresses caused by climate change, when added to other stresses on ecological systems, threaten substantial damage to or complete loss of some unique systems and extinction of some endangered species." Changes in climate are more pronounced in the northern and southern most latitudes. In September 2005 it was announced that global warming is melting the ice in Antarctica faster than had previously been thought. Over 13,000 square kilometers of sea ice in the Antarctic Peninsula appears to have been lost over the last 50 years.

Climate change is predicted to produce a wide variety of impacts, including more frequent and severe hurricanes.



SOCIAL CONSEQUENCES

Social consequences from these physical changes are predicted to be widespread and potentially catastrophic as water shortages, decreased agricultural productivity, extreme weather events, and the spread of diseases take their toll. Flooding, severe storms, and drought will lead to increase in environmental refugees. The World Health Organization (WHO) estimates that already there are some 150,000 deaths per year connected to weather events. IPCC reports that climate change will produce human health threats ranging from heat stress and loss of life in floods, to indirect effects induced by expansion in the ranges of disease vectors such as mosquitoes and waterborne pathogens. Social impacts of climate change are exacerbated by other forms of environmental degradation including ozone depletion, population growth, and air and water contamination.

The people who are most affected by the global warming are least responsible for the emissions that cause the problem. This disproportionate relationship between who creates the problem and who pays the price is played out both globally and within the United States. For example, low income people living in tropical countries will be most at risk. Thus, in addition to being a major environmental problem, global climate change is a highly significant global environmental justice issue.

Climate change is an issue of global environmental justice on at least four dimensions. Wealthy industrialized countries of the Northern hemisphere contribute disproportionately to the pollution of the common global airshed. Low-lying geography and weaker infrastructure mean that consequences of global climate change will be worse for people who are poor, especially those in the poorer nations of the Southern hemisphere. People who are poor within the United States have less access to health care, may be less able to move rapidly from affected areas (mostly people without cars were left behind in the flooding of New Orleans). On an international level, poor nations that have weaker infrastructure are less able to respond in crises. People living in these places are even more affected by health or financial burdens. In terms of intergenerational equity, those alive today are negatively altering the

Impact on First Nations

Already the First Nations people who inhabit northern latitudes worldwide are experiencing disproportionate burdens of the impacts of a changing climate. Not only are the physical and ecological impacts of climate change most extreme in northern latitudes, but arctic indigenous people rely directly on plants, animals, and features of weather and climate for survival.

For example, the Inuit in Nunavut, Canada, rely on the ringed seal as a staple food source year-round. It is the only marine or terrestrial species that can meet their nutritional needs. Ringed seals and polar bears depend upon stable sea ice for breeding. Over the past 30 years, the average extent of sea ice has declined by 15–20 percent. Modest climate change scenarios project an acceleration of this melting with a nearly ice-free Arctic Ocean within the next 100 years. As the Arctic Climate Impact Assessment describes, "To hunt, catch, and share these foods is the essence of Inuit culture. Thus the decline in ringed seals and polar bears threatens not only the dietary requirements of the Inuit, but also their very way of life…Because ringed seals and polar bears are very unlikely to survive in the absence of summer sea ice, the impacts on indigenous communities that depend on these species is likely to be enormous."

earth's atmosphere and climate, reducing its capacity to sustain life for generations to come. Finally, there are issues of equity and justice regarding international negations. These often center around the question of equitable global distribution of green house gas emissions as related to economic development. Nations such as China and India are expanding their economies, doing so increases their fossil fuel emissions. Climate treaty negotiations have favored industrialized nations in terms of both outcome and process.

GOVERNMENTAL SOCIAL RESPONSES

Social response to information in climate change has ranged from the development of international agreements, relatively weak social movement activity in affluent Western nations, stronger social movement organizing from people on low lying South Pacific islands and in the Northern arctic, attacks on climate scientists and media spin, and the announcement of insurance companies that the increased claims due to global warming will bankrupt the insurance system in the not too distant future.

Due to the enormous ecological, social, and economic consequences of climate change the global regulation of greenhouse gases is highly politically charged. This is in part because nations from around the world have very different levels of carbon dioxide emissions and negotiating power. In addition to national governments, oil companies and environmental organizations are involved in negotiations. Issues of contention have included extent of overall emissions by each nation, process for emissions reduction, and the degree to which nations meet targets by using "carbon-removal" methods such as planting forests versus reducing actual emissions. International collaborative efforts on climate change began as far back as 1979 when the World Meteorological Office, the United Nations Environment Program (UNEP), and the International Council for Science held the first World Climate Conference in Geneva. This was followed in 1988 by the establishment of the IPCC, which was set up to assess scientific and social information about human-induced climate change. The IPCC released its first report in 1990. In response, the UN General Assembly launched a negotiating process to establish an agreement among industrialized nations to act to reduce their emissions of greenhouse gases.

In 1992, the UN Framework Convention on Climate Change was adopted at the World Conference on Environment and Development in Rio de Janeiro. The nations who signed the convention agreed to develop national inventories of greenhouse gas emissions, establish national programs to reduce emissions, and mitigate climate change. The Convention also required that the developed countries and countries with economies in transition (the "Annex I countries") reduce their greenhouse gas emissions to their 1990 levels by end of 2000. This was expressed as a voluntary, not binding, commitment. The convention was ratified by the United States and came into force in 1994.

It soon became clear, however, that voluntary commitments alone were not leading to emissions reductions. Negotiations for a new agreement that specified binding reduction targets culminated in a session held in Kyoto, Japan in December 1997, which became known as the Kyoto Protocol. Under the Kyoto Protocol industrialized nations are committed to legally binding reductions in greenhouse emissions between 2008 and 2012. Included are provisions for emissions trading among nations and so called "clean development mechanisms," which encourage industrialized nations to transfer technology to developing countries that would reduce emissions.

Conflict over many issues, especially the responsibility of China and India for greenhouse emission reduction, was so significant that only in the final hour did nations reach agreement. The Kyoto Protocol went into effect on February 16, 2005, ten years after initial negotiations began and without the ratification of the world's largest emitter of greenhouse gases, the United States (the United States is a signatory only). Ratifying the Kyoto Protocol would require the United States to reduce greenhouse gas emissions by 7 percent below its 1990 levels by 2012. The Clinton Administration announced it would not send the treaty to the Senate for ratification. In 2001 George W. Bush announced the rejection of the Kyoto Protocol on the basis that it was too costly for the U.S. economy. A highly criticized plan by the Bush Administration focuses on voluntary reductions in emissions, tax credits for emissions reductions, and increased research and development for new energy technologies. This plan allows for a 12 percent increase in greenhouse gas emissions by 2012 and has provided no mechanism for ensuring that this target will be met. There is, however, growing awareness in the United States Congress that action is needed to curb greenhouse gas emissions. Many U.S. states have enacted legislation and adopted policies that effectively reduce emissions of greenhouse gases while preserving economic viability. These include implementing renewable portfolio standards and mandatory greenhouse gas reporting.

PUBLIC RESPONSE

Despite the seriousness of the global warming, a notable pattern of meager public response in the way of social movement activity, behavioral changes or public pressure on governments is visible in all Western nations. Public "apathy" with respect to global warming has been identified as a significant concern by environmental sociologists, social psychologists working in the area of risk perception, and environmental writers. A number of studies have shown that Americans in particular know little about global warming.

Existing research assumes that a lack of information about the causes of global warming is the limiting factor in the public's failure to respond—an orientation that Harriet Buckeley calls the "information deficit model." Other explanations for the lack of action in the face of such a serious environmental and social problem target the problem from another angle: the desire and ability to avoid unpleasant emotions of guilt and helplessness may lead to denial about the global warming. Clearly, knowledge is necessary to generate public response, but is knowledge sufficient? There is evidence that fear about the future, feelings of helplessness about the ability to make change, and guilt due to knowledge of responsibility through fossil fuel consumption are barriers that discourage people from even thinking about global warming, much less trying to fix it. For privileged people, environmental and social justice problems such as the global warming are increasingly distant in time or space or both. At least in the short term, the people who are benefiting from the fossil fuel consumption are not the ones living on low lying islands or trying to survive off ringed seal in the Northern Arctic. Social inequality helps to perpetuate environmental degradation making it easier to displace visible outcomes and costs across borders of time and space, out of the way of those citizens who are most politically able to respond.

SCIENTIFIC UNCERTAINTY

How much certainty is there concerning the existence, causes, and consequences of global climate change? These are questions asked frequently by members of the American public. While climate modeling is complex and there are some scientists who disagree that human actions have played a significant role in increasing global temperatures, there is probably a greater degree of scientific consensus on the basics of the global warming than any other current scientific issue. There is more significant uncertainty regarding predicting future climate scenarios. The IPCC addresses the question of certainty throughout its 2001 report by rating predictions with low, medium or high confidence. A joint statement by scientists on the issue of climate science noted that, "There will always be uncertainty in understanding a system as complex as the world's climate. However, there is now strong evidence that significant global warming is occurring...The evidence comes from direct measurements of rising surface air temperatures and subsurface ocean temperatures and from phenomena such as increases in average global sea levels, retreating glaciers, and changes to many physical and biological systems. It is likely that most of the warming in recent decades can be attributed to human activities. This warming has already led to changes in the Earth's climate." They further note that, "The scientific understanding of climate change is now sufficiently clear to justify nations taking prompt action."

There is now evidence that the generation of uncertainty has been actively produced by those who stand to benefit from continued fossil fuel consumption, namely the oil and gas industry. In 2000, environmental sociologists McCright and Dunlap describe how conservative think tanks mobilized to challenge mainstream climate science by launching an attack on science, arguing that global warming will have substantial benefits if it occurs, and warning that proposed action to ameliorate global warming would do more harm than good. They examined how these countermovement organizations aligned themselves with prominent American climate change skeptics known for their affiliations with the fossil fuels industry. They conclude that a major reason the United States failed to ratify the Kyoto Protocol was the opposition of the conservative antienvironmental movement.

Journalist Ross Gelbspan, once a climate skeptic himself, has described the influence of fossil fuel industry on American media framing of global warming, documenting how oil companies have influenced science, policy decisions, and produced a sense of uncertainty in the American media and minds of America public.

SEE ALSO: Greenhouse Effect; Intergovernmental Panel on Climate Change (IPCC); Kyoto Protocol.

BIBLIOGRAPHY. Anil Agarwal and Sunita Narain, *Global Warming in an Unequal World: A Case of Environmental Colonialism* (Centre for Science and Environment, 1991); A. Agarwal, S. Narain, et al., "The Global Commons and Environmental Justice-Climate Change," *Environmental Justice* (Transaction Publishers, 2002); Tom Athanasiou and Paul Baer, *Dead Heat: Global Justice and Global Warming* (Seven Stories Press, 2002); Paul Baer, John Harte, Barbara Haya, Antonia Herzog, John Holdern, Nathan Hultman, Daniel Kammen, Richard Norgaard, and Leigh Raymond, "Equity and Greenhouse Gas Responsibility," *Science* (v.289, 2000); Harriet Bulkeley, "Common Knowledge? Public Understanding of Climate Change in Newcastle, Australia," *Public Understanding of Science* (v.9, 2000); Edward Elgar, S. Raynor, E.L. Malone, et al., *Ethics, Equity and International Negotiations on Climate Change* (Cheltenham UK and Northampton, MA, 1999); Ross Gelbspan, *The Heat Is On: The High Stakes Battle Over Earth's Threatened Climate*, (Addison-Wesley, 1997); Ross Gelbspan, *Boiling Point: How Politicians, Big Oil and Coal, Journalists, and Activists are Fueling the Climate Crisis—and What We Can Do to Avert Disaster* (Basic Book, 2004); S.J. Hassol, *Impacts of a Warming Climate* (Cambridge University Press, 2004); Bruce Johansen, *The Global Warming Desk Reference* (Greenwood Press, 2002); Aaron M. McCright and Riley E. Dunlap, "Challenging Global Warming as a Social Problem: An Analysis of the Conservative Movement's Counter-Claims," *Social Problems* (v.47, 2000); Aaron M. McCright and Riley E. Dunlap, "Defeating Kyoto: The Conservative Movement's Impact on U.S. Climate Change Policy," *Social Problems* (v.50, 2003); Kari Marie Norgaard, "'People Want to Protect Themselves A Little Bit' Emotions, Denial and Social Movement Non-Participation The Case of Global Climate Change," *Sociological Inquiry* (v.76, 2006); Kari Marie Norgaard, "'We Don't Really Want to Know' The Social Experience of Global Warming: Dimensions of Denial and Environmental Justice," *Organization and Environment* (v.19, 2006); Pew Center on Global Climate Change, *Climate Change Activities in the United States, 2004 Update* (Pew Center on Global Climate Change, 2004); Eugene Rosa, "Global Climate Change: Background and Sociological Contributions," *Society and Natural Resources* (v.14, 2001); D. Victor, *The Regulation of Greenhouse Gases: Does Fairness Matter? Fair Weather? Equity Concerns in Climate Change* (Earthscan Publications, 1999).

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Gobi Desert

THE VAST AND formidable Gobi Desert covers an area of nearly 500,000 square miles across southern Mongolia and northern China. The Gobi, one of the world's largest deserts, also holds the distinction of being the northernmost desert on Earth. Located centrally within the Eurasian Continent, this region experiences wide seasonal temperature extremes, with daily average July temperatures reaching 113 degrees F, and average daily January temperatures dropping to negative 40 degrees F. The Gobi's continental location is also largely responsible for its aridity. Great distances from the oceans translate into little moisture and precipitation reaching this desert. In addition, the Gobi desert is bounded by mountain ranges, including: the Tien Shan and Altay to the west, the Hangayn to the north, the Greater Khingan Range to the east, and the Yin and Pei Mountains to the south. Nearly encircled by mountains, the Gobi Desert's aridity is exacerbated by the loss of potential moisture as orographic precipitation empties on the windward edge of the mountains, leaving the region largely in an expansive rain shadow. Total annual precipitation varies across the desert, with yearly totals amounting to less than three inches in the west, to slightly more than eight inches in the east and northeast. The precipitation in the eastern- and northeastern-most areas of the Gobi occurs primarily in the summer during isolated, monsoon-like downpours.

Despite being sparsely populated by nomadic herders in Mongolia and more sedentary farmers in China, the Gobi Desert has a number of notable interrelationships with human society. The first European explorer of the region is thought to have been Marco Polo during his journey across Asia in the 13th century. Russian and British geographers and explorers mapped much of the region during the late 19th century. Perhaps the most famous expedition to the Gobi desert occurred in 1922 by a group of scientists led by Roy Chapman Andrews and sponsored by the American Museum of Natural History. The group located thousands of fossilized dinosaur remains, including nesting sites, dinosaur eggs, and skeletal *Proceratops* remains showing nearly all stages of the dinosaur's life cycle from newly hatched baby dinosaurs to old-aged adults. Later explorations in the 1990s reaffirmed the Gobi's place as one of the world's premier dinosaur fossil grounds.

Today, the Gobi Desert's unique ecosystem is threatened by the possible extinction of native fauna and a troubling rate of desertification and expansion of lifeless desert. Conservation efforts aimed at protecting the endangered wild Bactrian camel and the Gobi brown bear led to the establishment of Mongolia's Great Gobi Strictly Protected Area in 1975. Numbers of remaining Bactrian camels may be as low as 300, and Gobi bears may number less than 50. Other rare and endangered species include the Asiatic wild ass and Przewalski's horse. The negative human impact on the Gobi desert region can be seen with the growing problem of desertification, the overall expansion of desert conditions into former grasslands. Increasing human populations and unsustainable overgrazing by livestock have removed a steadily increasing amount of grasses and other vegetation, upsetting the delicate ecosystem balance, and resulting in the continuing expansion of the desert. Gobi desertification has triggered giant dust storms that have carried sand and dirt to China's heavily populated centers in the east, and as far away as South Korea and Japan.

Przewalski's Horse

Przewalski's Horse, otherwise known as the Asian Wild Horse or the Mongolian Wild Horse, is found in the Gobi Desert and is the closest living wild relation to the domestic horse.

Nikolai Mikhalyovich Przewalski (1839–88) was a Russian geographer and explorer who crossed the Gobi Desert in the 1870s and then traveled in Turkestan, before returning to the Gobi Desert in the 1880s. It was during this second trip that he tried to find the horse, having heard stories about it—it was endangered even in those days—and eventually was able to describe one. A number were found by Carl Hagenbeck in the late 1890s and many were captured for zoos around the world. The last herd was spotted in 1967, and the last horse in 1969.

With many of the horses dying in Russian zoos during World War II when they were killed by the Germans, and the horses in the United States also not surviving captivity well, in 1945 the only two captive populations were in Munich and Prague zoos. However, soon some started being caught for other zoos, contributing to a lessening of their numbers in the wild. In 1977, the Foundation for the Preservation and Protection of the Przewalski Horse was founded by Jan and Inge Bouman, who have been encouraging zoos around the world to allow their horses to be transported to other zoos for mating, to overcome problems over inbreeding.

This was successful, and in 1992 sixteen horses were released back into the wild. The area where they live is now the Hustai National Park southwest of Ulaanbaatar, Mongolia's capital, and their status in the wild has changed from being "extinct" to "endangered."

SEE ALSO: Deserts; Endangered Species; Extinction of Species.

BIBLIOGRAPHY. Roy Chapman Andrews, "Explorations in Mongolia: A Review of the Central Asiatic Expedition of the American Museum of Natural History," *The Geographical Journal* (v.69, 1927); John Man, *Gobi: Tracking the Desert* (Yale University Press, 1999); George Schaller, "Tracking the Gobi's Last Wild Bears and Camels," *International Wildlife* (v.25, 1995); Donovan Webster, "China's Unknown Gobi: Alashan," *National Geographic* (v.201, 2002).

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Gold

GOLD IS A yellowish, soft, transition metal with the atomic number of 79 and an elemental symbol of Au. Gold has had enormous social and economic significance worldwide. Gold has been the standard for many currencies. The majority of the world's gold comes from South Africa, while two-thirds of gold consumed in the United States comes from Nevada and South Dakota.

So-called gold rushes occurred across the western United States and Canada throughout the second half of the 19th century. These mass migrations produced enormous social and environmental consequences. By far the most famous was the California Gold Rush (1848–58), which drew gold-seekers from Mexico, China, Germany, and many other nations of the world. About 125 million troy ounces of gold were extracted, a value of more than $50 billion by today's standards. Although there was much wealth to be made, mining was a dangerous activity. It is estimated that up to 30 percent of miners died of disease, accidents, or violence.

Social, political, and environmental impacts of the California Gold Rush include the systematic genocide of American Indians, mass worldwide and internal immigration, California statehood (1850), the devastation of river ecosystems with hydraulic mining, the contamination of waterways with mercury, and the growth of major cities including San Francisco (whose population exploded from 1,000 residents in 1848 to 20,000 just two years later). In 1852, at the height of California Gold Rush, 20,000 of the 67,000 immigrants were from China. By 1880, Chinese constituted 22 percent of California's mining population, making them the largest single nationality engaged in gold mining. However, mortality, racially motivated violence, and the Chinese Exclusion Act reduced the Chinese population in California from 75,132 in 1880 to 45,753 in 1900.

The highest price of the California Gold Rush was paid by California Indian people. With more than 100 unique ethnic groups and several hundred politically autonomous nations, California Indians are extremely diverse. However, within two decades of the gold rush, California Indian populations plummeted by 90 percent. This period has been called the California Indian Holocaust. Indian people were killed both by individual miners and systematic, state-sponsored violence as gold mining gave way to further white settlement. In 1851 and 1852, the state of California spent $1 million per year to exterminate native peoples. California offered "Indian hunters" bounties of $5 per head. Population estimates vary, but in all accounts the genocide affected over 100,000 Indian people. Many tribes lost 90–95 percent of their populations in just a few years.

Gold was extracted using hydraulic placer mining. This technique was both highly effective and enormously destructive of the environment. Forests and hillsides were washed away as highly pressurized water flushed mud into rivers. An estimated 12 billion tons of mud and soil were washed into rivers, including thousands of acres of the best farmland in the state. The Sacramento, Yuba, and other rivers of the Sierra Nevada were so overloaded with silt that they could not carry normal rainfall, resulting in severe flooding. Farmers and city residents launched a campaign against hydraulic mining. After a significant political struggle, hydraulic mining was outlawed in California in 1884.

Because of its value and its continued usefulness in computers, aircraft, and communications technology, among others, gold continues to be harvested and traded today. While a significant proportion of gold is mined by small operators (perhaps one-quarter), contemporary gold mining occurs in large scale mining operations, run by prominent multinational companies. Beyond the difficult and dangerous labor conditions associated with production, environmental concerns include the disposal of "overburden," the mineral material through which the mine is dug. Another related problem is the disposal and management of cyanide used to dissolve and extract the mineral from the surrounding rock, which can potentially leach into soil and groundwater, presenting a risk for drinking water and for ecosystems connected to the aquifer. Environmental regulation of mining internationally varies. The Surface Mining Control and Reclamation Act in the United States is designed to address many of the environmental risks associated with gold mining, though the overall effectiveness of the act is debated.

SEE ALSO: Floods and Flood Control; Mercury; Mining; Native Americans; Soil Erosion.

BIBLIOGRAPHY. Pratap Chatterjee, "The Gold Rush Legacy: Greed, Pollution and Genocide," *Earth Island Journal* (v.13/26, 1998); Chag Lowry, ed., *Northwest Indigenous Gold Rush History: The Indian Survivors of California's Holocaust* (Indian Teacher and Educational Personnel Program, 1999); Carolyn Merchant, *Green versus Gold: Sources in California's Environmental History* (Island Press, 1998); Jack Norton, *Genocide in Northwestern California: When Our Worlds Cried* (San Francisco: Indian Historian Press, 1979); Kevin Starr and Richard J. Orsi, *Rooted in Barbarous Soil: People, Culture, and Community in Gold Rush California* (University of California Press, 2000).

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Golden Rice

GOLDEN RICE IS the common term for rice genetically modified to produce beta carotene (the compound that the human body converts to vitamin A) in the endosperm. This invention represented a breakthrough in genetic engineering, and it also played a significant role in public relations campaigns to frame global debates on biotechnology. The impetus behind Golden Rice was the desire to mitigate Vitamin A deficiency among poor Asian populations with rice-based diets. Rice actually contains moderate levels of beta carotene in the bran, but this is commonly removed by polishing—the process of mechanically removing the bran from the endosperm to improve storability and taste.

The search for a biotechnological solution to this problem was led by Ingo Potrykus, a German biologist who had founded the Institute of Plant Sciences at the Swiss Federal Institute of Technology in 1985. Here he began work on nutritional enhancement of rice through genetic modification. By 1992, he had established a productive collaboration with Peter Beyer at the nearby University of Freiburg. Turned down for corporate funding, he and Beyer secured funding from the Rockefeller Foundation's Food Security program. Over the next eight years, they succeeded in introducing three genes (two from daffodil and one from the bacterium *Erwinia*) that produced the four enzymatic reactions making up the carotenoid biosynthetic pathway in the rice endosperm. The modified rice had a yellow endosperm (hence the name) and contained very small amounts of beta carotene. The invention was only a prototype; the level of beta carotene was too low to have an impact on nutrition, and the altered pathway was working only in one strain of rice used for experimentation. Nevertheless, the engineering of a biosynthetic pathway represented a significant advance in molecular biology.

The project also suggested promise for humanitarian biotechnology, but major problems with intellectual property were soon discovered. The development of genetically modified plants, especially with complex multi-gene transformations, invariably uses multiple patented genes and technologies along the way. Researchers routinely gain access to these technologies through contracts allowing restricted use for research but not for release. When the Rockefeller Foundation commissioned an "Intellectual Property Audit" to identify the patented technologies used in developing the Golden Rice prototype, the finding was that 70 technologies—owned by 32 companies and universities—had been used; any of these could potentially block the eventual release of Golden Rice. Although the number of technologies under patent protection in the target countries was much smaller, this was still a serious obstacle.

SAVING "A MILLION KIDS A YEAR"

In January 2000 the Potrykus–Beyer team described their accomplishment in *Science*, and in July *Time* magazine featured Potrykus on its cover with the claim that his rice could "save a million kids a year." The timing of this publicity was crucial. Reeling from Europe's rejection of genetically modified foods, the biotechnology industry had begun to promote its products on the basis of the potential to feed the hungry, and it had just started a $250 million public relations initiative called the Council for Biotechnology Information. The CBI seized Golden Rice as the centerpiece of an advertising campaign that included network TV and full-page newspaper advertisements. Tens of millions of dollars were spent by industry touting an invention that had resulted mainly from a noncorporate investment of $1.5 million.

The Golden Rice publicity led to developments with the intellectual property problem. Monsanto, which dominated commercial crop genetic modification, agreed to relinquish its rights on the viral promoter used in Golden Rice development (a promoter is a DNA segment that regulates gene activity); Monsanto then issued a press release that led many newspapers to credit Monsanto with the invention. A broader solution to the problem of patents was later achieved through a deal allowing free distribution of Golden Rice to poor farmers if and when it was released, while the Zeneca Corp. retained commercial rights.

The years following the original announcement brought some improvement in the Golden Rice construct. Molecular biologists at Syngenta (the descendant of Zeneca) replaced the Monsanto viral promoter and one of the daffodil genes what it called Golden Rice 2, greatly raising the level of beta-carotene. Halting progress was made in transferring the engineered trait into rice cultivars (using both genetic modification and backcrossing) in India, Phillipines, Taiwan, and the United States. As of 2006, the only field trial had been in Louisiana using a "golden" version of American rice. It was hoped that Golden Rice cultivars of agronomic value to Asian populations would be available by 2010.

Thus, several years after the invention was announced, Golden Rice had played no role in combatting malnutrition and indeed was still far from being available in a useful form, but it was still playing a significant role in the debates on crop genetic modification. While biotechnology firms and their allies continued to tout the invention, critics charged that Golden Rice was surrendered to the commercial and PR interests of the biotech industry; that the project and its publicity obscured the real causes of malnutrition such as loss of biodiversity; and indeed that it was a "hoax." Nutritionists pointed out that a simple increase in consumption of beta carotene would have little impact on undernourished children, as they often suffer from protein energy malnutrition and intestinal infections that impede the conversion of beta carotene to vitamin A. The editor of *The Lancet* suggested that "seeking a technological food fix for world hunger may be... the most commercially malevolent wild goose chase of the new century," and even officials at the Rockefeller Foundation complained about the claims being made for the invention it had sponsored. These charges pertain more to the commercial and rhetorical uses of Golden Rice, however, than to the original project itself, which was noncorporate and which was conceived by the Rockefeller Foundation only as one part of a broad-based initiative to improve food security.

SEE ALSO: Food; Genetically Modified Organisms; Genetic Patents and Seeds; Malnutrition.

BIBLIOGRAPHY. Peter Beyer, Salim Al-Babili, Xudong Ye, Paola Lucca, Patrick Schaub, Ralf Welsch, and Ingo Potrykus, "Golden Rice: Introducing the ß-Carotene Biosynthesis Pathway into Rice Endosperm by Genetic Engineering to Defeat Vitamin A Deficiency" (J. Nutr, 2002); Marion Nestle, "Genetically Engineered 'Golden' Rice Unlikely to Overcome Vitamin A Deficiency," *Journal of the American Dietetic Association* (v.101, 2001); Jacqueline Paine, C.A. Shipton, S. Chaggar, R.M. Howells, M.J. Kennedy, G. Vernon, S.Y. Wright, E. Hinchliffe, J.L. Adams, A.L. Silverstone, and R. Drake, "Improving the Nutritional Value of Golden Rice Through Increased Pro-Vitamin A Content," *Nature Biotechnology* (v.23, 2005); RAFI (Rural Advancement Foundation International), "Golden Rice and Trojan Trade Reps:

A Case Study in the Public Sector's Mismanagement of Intellectual Property," *RAFI Communique* (v.66, 2000); Glenn Davis Stone, "Both Sides Now: Fallacies in the Genetic-Modification Wars, Implications for Developing Countries, and Anthropological Perspectives," *Current Anthropology* (v.43, 2002); Gary Toenniessen, "Crop Genetic Improvement for Enhanced Human Nutrition," *J. Nutr.* (v.132, 2002).

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Golf Courses

GOLF COURSES ARE areas of land reserved for the playing of golf, which is a sport invented in Scotland in the 15th century. The rules of the game, and hence, regulation of the size and configuration of courses did not occur until the 18th and 19th centuries. Each course now consists of 18 holes, generally measured out in long thin strips between approximately 90–550 meters long. The prepared part of the hole is called the fairway and the grass is kept comparatively low to facilitate play. The hole itself is surrounded by a patch of ground known as the "green," which is a heavily watered and maintained area made as level as possible. Golf course management can represent an intensive use of resources, particularly water resources, which may be expensive to obtain locally and for which local people may have a regular need. As golf has become an important international phenomenon, there has been increasing demand for new courses as part of tourist destinations. Land occupied by golf courses, when denied to local people, generally drive up property prices and this can be problematic for local people who cannot compete with the often internationally influenced economy. This is especially true when land resources are limited, as, for example, on island chains such as Mauritius or Hawaii, where most goods have to be imported and are therefore expensive, and the local economy has become integrated into the tourism industry. In addition, the need to maintain the courses in close to pristine condition has led in some cases to the heavy-handed treatment of flora and fauna through chemical pesticides, and this too can have implications for the wider environment.

Golf course management can represent an intensive use of resources, particularly water resources.

It is not known exactly how many golf courses there are internationally and how many people who play golf. About 50 million people play golf on 25,000 courses around the globe. Some courses represent valuable habitat for local animal species, although these are more likely to be suppressed if they might adversely affect the quality of the course. In recent decades, the game's popularity has increased greatly due to the rise in participation of people from East Asia, notably Japan and South Korea; it is anticipated that this increase will be intensified by the rise of new players in China and India, which are countries that also consider playing golf to be part of an elite, desirable, bourgeois corporate culture with an element of conspicuous consumption attached. As a result, more land is likely to be sequestered in desirable climactic zones of those countries, and further land used in tourist destination countries such as Thailand and the Philippines. Frequently, ethnic minority people inhabiting the desired land are marginalized by this change in use. Long-established golf courses may occupy valuable land and be surrounded by residential areas that have grown since their initial creation. In such cases, the use of the courses as additional housing land can outweigh the societal value of the courses. One example of municipal governments attempting to reclaim the privately owned land is in Caracas, the capital of Venezuela, where the city mayor, inspired by the policies of President Hugo Chavez, has launched an attempt to expropriate the courses and put them to public use.

Research into the impact of climate change on golf participation suggests that, depending on the location concerned, the golfing season will be lengthened or curtailed as the particular local conditions change. This will affect the demand and supply factors for existing golf courses and will have implications for future land use. This is likely to lead to increased tension between private land rights and societal need for usable land.

SEE ALSO: Mauritius; Venezuela; Water Demand.

BIBLIOGRAPHY. Duncan Campbell, "Caracas Golf Clubs in a Hole as City Bids to Build Homes on Greens," *The Guardian*, www.guardian.co.uk (cited August 31, 2006); Michael J. Hurdzan, *Golf Course Architecture: Evolutions in Design, Construction, and Restoration Technology,* 2nd ed. (Wiley, 2005); Daniel Scott and Brenda Jones, "The Impact of Climate Change on Golf Participation in the Greater Toronto Area (GTA): A Case Study," *Journal of Leisure Research* (v.38, No.3, Third Quarter, 2006); M. R. Terman, "Naturalistic Golf Courses as Wildlife Habitat," *Landscape and Urban Planning* (v.38, No.3, November 1997).

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Goodall, Jane (1934–)

BASED ON HER primate research in the Gombe Game Reserve in Africa, Jane Goodall is the world's leading authority on chimpanzees and is considered a great conservationist. She was born in London, England, in 1934. When she was 11 years old, she decided she wanted to travel to Africa and possibly live there. In her early 20s, she found herself in Nairobi, Kenya, working as a secretary. About a year after her arrival, she met Louis Leakey, who was interested in studying apes and their relationship to humans. Both Leakey and his wife, Mary, began collaborating in their studies with Goodall. Leakey thought Jane would be the perfect person to begin a study of the great apes on the Gombe National Reserve in Tanzania, because she was not formally trained in ethology or primatology.

In 1960, Goodall arrived at the Gombe National Reserve and began her research, eager to develop a relationship with the chimpanzees. But after a few weeks of observation, she was discouraged because the chimpanzees would not let her get within 50 yards of them. This changed the day a male chimp wandered into her camp and began stomping and screaming after seeing a banana on a table. Eventually, the chimpanzees learned to accept the young researcher. They allowed her to follow them, and they would greet her with a touch or a kiss. She was able, through careful observation, to find commonalities between humans and chimpanzees.

Goodall married Hugo van Lawick in 1964 and they had one son, Hugo. She later divorced Lawick and entered into a second marriage to Derek Bryceson. Unfortunately, Bryceson died of cancer only five years later.

Jane Goodall received her Ph.D. from Cambridge University in 1965. Over the past four decades, Goodall has made a number of significant observations of chimpanzees at the Gombe reserve. She observed, and was the first person to record in 1960, that chimpanzees were meat eaters and to document chimpanzees making tools, the first recorded instance of tool-making by nonhumans. In 1964, Goodall noted that chimpanzees engaged in deliberate planning and used man-made objects for various purposes. In 1966, it was noted that chimpanzees could contract AIDS. During the 1970s, Goodall observed chimpanzees expressing awe, engaging in war and cannibalism, creating coalitions, and transferring a member to another group. In 1987, she observed a chimpanzee adopting an adolescent. In 1994, she observed chimpanzees engaging in short-term monogamous relationships and modeling tool-making behaviors of chimps in another community. One year later, she witnessed chimpanzees chewing on a medicinal plant believed to relieve stomach pain. Goodall has taught the public that chimpanzees are able to express emotions, engage in affection, and have personalities.

Today, Goodall is active in promoting conservation and bringing attention to the similarities between chimpanzees and humans. She travels 300 days per year talking to audiences about their ability to help other people, the environment, and animals. With regard to chimpanzees, she has set up halfway houses for injured and orphaned chimps in the wild. She advocates the ethical treatment of chimpanzees in research, lab settings, and zoos.

In 1977, Goodall founded the Jane Goodall Institute (JGI), a global nonprofit organization that focuses on empowering people, including youth, to make a difference. The JGI promotes creating healthy ecosystems and sustainable livelihoods for all living creatures, and focuses on nurturing and educating new generations of active, committed citizens throughout the world. The "Roots and Shoots" program, founded in 1991, is an example of the institute's efforts. The program ultimately encourages care and concern for animals, the environment, and the human community.

Throughout her long professional career, Goodall has written a number of children's books, books for adults, and scholarly articles. Her most recent children's book is *Rickie and Henry: A True Story* (2004). Her most recent adult book is *Harvest for Hope: A Guide to Mindful Eating* (2005). She has earned 27 honorary degrees and has received 79 awards for her work.

SEE ALSO: Animal Rights; Chimpanzees; Ecosystems; Leakey, Louis and Mary; Organic Agriculture; Pesticides; Sustainability; Vegetarianism.

BIBLIOGRAPHY. Jane Goodall Institute (homepage) www.janegoodall.org (cited June 2006); "Jane Goodall," Women's Intellectual Contributions to the Study of Mind and Society, www.webster.edu; Dale Peterson, *Jane Goodall: The Woman Who Redefined Man* (Houghton Mifflin, 2006).

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Gore, Al (1948–)

ALBERT ARNOLD GORE, Jr. is an influential American politician and statesperson who served as vice-president and was influential in the development of the Internet, as well as being a leading voice in the campaign for preservation of the environment.

Gore followed in the footsteps of his father, a politician, in the Democratic Party after completing his education and serving as a volunteer in the Vietnam War as a reporter. He entered the House of Representatives in 1976 and then took a seat in the Senate in 1984, serving the state of Tennessee. In 1988, he tried but failed to secure the Democratic nomination for president, which was secured by Michael Dukakis. In 1998, William J. "Bill" Clinton selected him as his running mate. Gore was subsequently for two terms vice president, the 45th of U.S. history.

Selected to run for president in the 2000 election, Gore was defeated only by court action after having won a majority of the popular vote across the country and as a result of intensely controversial vote-counting procedures in the state of Florida. Speculation continues as to whether he will make a further attempt to be elected Democratic president. He has earned a reputation in his political career for earnestness, attention to detail, and mastery of policy. However, he was not able to project himself as a popular communicator.

Since 2000, Gore has concerned himself to a considerable extent with the environment, to which he has given voice throughout his political career. In *Earth in the Balance*, first published in 1992, Gore expressed the opinion that human society was plunging the earth headlong into a total environmental catastrophe. While he argued that it was possible for capitalism and democracy combined to bring about solutions to the problems that have been caused, the type and nature of change required significantly outweighed the political will available to necessitate change. Consequently, it would be necessary for a groundswell of public opinion to emerge to demand radical political change.

While Gore has positioned himself in political life as a moderate, and while he has not often called for radical change, his more recent efforts have begun to assert more radical strategies. In *An Inconvenient Truth*, (2006), Gore outlines in detail the many forms of proof of global climate change, its causes, and likely implications. The book was accompanied by a multimedia campaign led by Gore, aimed at persuading those remaining members of the public of the facts and the science of environmental change (it became a widely viewed film in 2006). This campaign was aimed at stirring public consciousness and encouraging a mass movement determined for change, raising questions about source of the inertia that maintains the status quo. He has also spoken out against President George W. Bush's foreign policy, specifically with respect to Iraq. He personally commanded an attempt to rescue people from New Orleans in the wake of Hurricane Katrina.

SEE ALSO: Bush, George W. Administration; Clinton, William Administration; Policy, Environmental.

BIBLIOGRAPHY. Sidney Blumenthal, *The Clinton Wars* (Farrar, Straus and Giroux, 2003); Al Gore, *Earth in the Balance: Ecology and the Human Spirit* (Houghton Mifflin, 2000); Al Gore, *An Inconvenient Truth* (Rodale Books, 2006).

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Grand Canyon

THE GRAND CANYON, carved out by the Colorado River, is in the Grand Canyon National Park in Arizona, and is probably the most famous gorge in the world. The Grand Canyon is a total of 277 miles (446 kilometers) long, ranging in width from 0.25 miles (0.4 kilometers) to 15 miles (24 kilometers) wide. From a geological perspective, it is believed that the Colorado River basin, including the Grand Canyon, dates back some 40 million years, with the Grand Canyon being anywhere between 2–6 million years old. This makes the erosion caused one of the most complete geological features in the world. At the place known as the Vishnu Schist at the bottom of Inner Gorge, the erosion has exposed the last two billion years of the history of the Earth.

In spite of the exposure of such a long period of time in the rocks, not many plant or animal fossils have been found, because until relatively recently (in geological time) the only flora and fauna in the area were algae, mollusks, corals and only a very few invertebrates. There are currently many animals throughout the Grand Canyon, including badgers, bobcats, chipmunks, coyotes, foxes, rabbits, rats, and squirrels. Some of the plants include willows and cottonwoods. However, as the climate is dry and there can be periods of water shortages, many drought-resistant plants grow there, including agave, tamarisk, yucca, and many different types of cacti. On the North Rim and the South Rim of the Grand Canyon, there are many fir trees, pine trees, and also scrub oak, mountain mahogany, and sage bushes.

FIRST SIGHTINGS

The first recorded sighting of the Grand Canyon by a European was when García López de Cárdenas went through it in 1540, although Native Americans lived there for many centuries beforehand, with settlements still visible within the walls of the canyon. It is probably for this reason that the Hopi guides leading the Spaniards did not show them how to enter the canyon itself. Remains from the prehistoric period and early artifacts have been located there. The next European visitors were two Spanish priests and some Spanish soldiers who were exploring the area around southern Utah.

The next reported sighting of the Grand Canyon was when James Ohio Pattie and some trappers reached the area in 1826. The next verified visitor was Jacob Hamblin, a Mormon missionary who was sent by Brigham Young in the 1850s to establish the location for a river crossing in the Canyon; he mapped Lee's Ferry and Pierce Ferry in 1858. Other parties of U.S. government surveyors, explorers, and mineral prospectors followed. These included the John Wesley Powell River Expeditions and the Brown-Stanton River Expedition. The former involved extensive mapping of the Grand Canyon, with information being published on its botany, ethnology, geography, and geology. Theodore Roosevelt visited it on many occasions and urged for its inclusion in a national park. The Grand Canyon National Park was established in 1919, covering 1,904 square miles (4,931 square kilometers). The park was enlarged in 1975 to include the Grand Canyon National Monument, the Marble Canyon National Monument, and other nearby protected areas. Four years later the park was designated as a World Heritage site, and is now connected by a 215-mile (346 kilometer) paved road and a transcanyon trail stretching 21 miles (34 kilometers). There are still five Native American tribes living nearby.

By the 20th century, with road access, the Grand Canyon had become an important tourist site, and from then was regularly visited by tourists from all over the world. This gradually became regulated, but on June 30, 1956, the Grand Canyon became the site of what was then the worst commercial aviation disaster in North America when a TWA Lockheed Super Constellation and a United Airlines Douglas DC-7, both having left Los Angeles International Airport, collided above the canyon, killing all 128 crew and passengers from both planes. Wreckage from the crash fell into the eastern part of the canyon.

There are now about five million visitors to the Grand Canyon each year, with 83 percent from the United States. Some 3.8 percent of visitors come from the United Kingdom, 3.5 percent from Canada, 2.1 percent from Japan, 1.9 percent from Germany and 1.2 percent from the Netherlands, with 4.5 percent from the rest of the world.

From the 1870s until 2001, approximately 600 deaths have taken place at the Grand Canyon, of which 242 were from plane or helicopter crashes (including the 1956 collision); 79 from drownings in the Colorado River; 65 from heat stroke, heart attacks, dehydration, hypothermia, and other environmental causes; 50 from falls, including by photographers who were trying to get views of the Canyon from new angles; 47 from suicides; 25 from freak accidents such as lightning strikes or rock falls; 23 from murders; and seven caught in flash floods.

It was not long before athletes started to run across the canyon with a one-way trip known as "rim-to-rim," taking between five and seven hours, and the round trip, known as the "doublecross" or

García López de Cárdenas

García López de Cárdenas was born in Llerena in southwestern Spain, and went to the Americas with the expedition of Francisco Vasques de Coronado that set out from modern-day Mexico in 1540. When the party reached Cíbola, Cárdenas was sent to lead a special mission to try to locate a large river, which they had heard about from some local Indians.

Instructed to return after 80 days, Cárdenas headed north accompanied with Pedro de Sotomayor, who described this mission led by Hopi Indian guides. They marched north for 20 days but had many difficulties in finding the river. However, in spite of this failure, Cárdenas and his men found the Grand Canyon, reaching it at the South Rim between Desert View and Moran Point. When they located the canyon, Pablo de Melgrossa, Juan Galeras, and another soldier descended a third of the way into the canyon, but had to stop when they ran out of water. Subsequently, it has been speculated by historians that the Hopi guides deliberately did not lead them into the canyon itself, which they must have known about. Although the description of the Grand Canyon survived, the Spanish found no gold or evidence of great wealth, and hence nobody returned to the area for many years.

It seems likely that another conquistador, Hernando de Alarcón had explored the Colorado River some months earlier, but he did not record the visit; it was not until 1776 that any further Europeans reached the Grand Canyon. On that occasion, Fathers Francisco Atanasio Domi'inguez and Silvestre Vélez de Escalante, two Spanish priests, along with some soldiers, reached North Rim when traveling from Santa Fe to California.

the "rim-to-rim-to-rim," taking anywhere between 11 and 14 hours. The man with the record for the north to south crossing is Allyn Cureton of Williams, Arizona, who also holds the doublecross record with a remarkable time of under eight hours.

SEE ALSO: Climate; Colorado River; Drought; National Parks; United States, Southwest (Arizona, Nevada, New Mexico, Utah).

BIBLIOGRAPHY. Jennifer Denniston, Amy Marr, and David Lukas, *Grand Canyon National Park* (Lonely Planet, 2004); Thomas M. Myers and Michael P. Ghoglieri, *Over the Edge: Death in the Grand Canyon* (Puma Press, 2001); Stephen J. Pyne, *How the Canyon Became Grand* (Penguin Books, 1998); Paul Schullery, *The Grand Canyon, early impressions* (Colorado Associated University Press, 1981); George Wuerthner, *Grand Canyon: A Visitor's Companion* (Stackpole Books, 1998).

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Grasslands

GRASSLANDS ARE AREAS of land that are dominated by one or more forms of grass, which is a family of plants that also includes cereals. Grasslands are one of the most common forms of land cover of the nonsubmerged land of the world. The intensification of agriculture in many parts of the world has significantly increased the proportion of land that is considered grassland. Natural grasslands are less prevalent, but still extensive, and have formed in areas in which climatic conditions in terms of water resources are not so beneficial as to permit the creation of forests, but are not so harsh as to lead to the formation of deserts.

The most important grassland areas are the steppe lands of central Asia and southern Russia, extending down to the Indian subcontinent. This area saw the emergence of a stream of nomadic peoples including the Huns, Mongols, Bulgars, and Scythians who, stimulated largely by climate change, launched waves of invasion and conquest over the settled peoples who occupied the surrounding ground. Other areas of grassland include the wide swathe of territory extending from west to east Africa that helped stimulate the creation of temporal states. The large area of central-northern Australian grassland is very lightly inhabited, although it provides a natural home for sheep. In the United States, the prairie is a form of grassland that extends through much of the central section of the country down to the southeastern coastline. This area has long formed a destination for settlers who wish to own land, and represents the center of the intensive agricultural system that sustains the rising population of the country.

Grasslands generally merge into similar forms of land cover at their margins, becoming savanna, scrubland, or other types as the climatic and water resources conditions vary. In some cases, these conditions can prevent grasslands forming in otherwise favorable conditions. For example, extensive flooding can inhibit the growth of larger plants while permitting grasses to flourish for most of the year. Climate change has also been influential in determining the extent of grassland and unanticipated change in status could be disastrous. The extensive burning of original forest by early settlers created the grasslands of the South Island of New Zealand, which sustain the nation's sheep industry. Fire is a regular occurrence in grassland during hot conditions, and these fires are capable of running out of control and threatening human habitation, given the close proximity with which people live to agricultural areas. Burning of stubble or abandonment of previously worked agricultural land might also change the nature of existing or potential grassland. The suitability of grasslands for supporting animal husbandry and cereal crops means that grassland management and manipulation have been studied in considerable depth, and productivity levels have been increased considerably.

Because of development and other land cover transformations from human occupation, grasslands are increasingly in decline throughout the world, especially in North America. The concomitant loss of floral and avian biodiversity that depends on these ecosystems represents a serious, and largely underappreciated, global ecological crisis.

SEE ALSO: Agriculture; Fire; Grazing; Prairie.

BIBLIOGRAPHY. Robert F. Barnes, Jerry C. Nelson, Michael Collins, and Kenneth J. Moore, eds., *Forages: An Introduction to Grasslands Agriculture* (University of Iowa Press, 2002); Kees KleinGoldewijk and Navin Ramankutty, "Land Cover Change over the Last Three Centuries Due to Human Activities: The Availability of New Global Data Sets," *Geo Journal* (v.61, 2004); Richard Manning, *Grassland: The History, Biology, Politics and Promise of the American Prairie* (Penguin, 1997).

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Grazing

GRAZING IS THE consumption by animals of herbaceous vegetation at its place of growth, whether in pasture or on rangeland. In its noun form, *grazing* refers to the land where this takes place. The term shares etymological roots with *grass;* technically, grazing is a subset of herbivory and is distinct from browsing, which involves woody or brushy plants rather than grasses and forbs. In common usage, however, this distinction is often overlooked, with grazing employed as a synonym for herbivory, perhaps because many animals are both grazers and browsers. Grazing animals are diverse, including both wild and domesticated species and several taxa, including birds such as geese, insects such as grasshoppers, and mammals ranging from mice to kangaroos to elk. Here again, common usage often deviates from strict definitions, applying the term more narrowly to domesticated livestock, including some species that are technically browsers, such as goats.

Grazing animals and grasses coevolved, each adapted to the other. The animals developed digestive systems capable of converting herbaceous plant material into energy, and the grasses developed the capacity to withstand periodic defoliation and even benefit from it. Grasses' growth points are generally at or near ground level, beyond the reach of the animals' bite; removal of older leaves and stems can enhance grass growth (by allowing greater sunlight to reach growth points and because younger leaves are more efficient); animals can spread and fertilize grass seeds, and their hooves can increase seed-soil contact for germination. New growth on recently grazed grasses can in turn attract grazing animals. In some systems, grazing can benefit grasses indirectly by altering competition with other kinds of plants. On the other hand, overgrazing can occur, such that these symbiotic interactions break down. Compared to predator–prey relations, ecological theory regarding plant–herbivore interactions is poorly developed.

Whereas unfenced animals can vacate denuded areas, fenced animals may consume beyond the land's capacity.

Grazing animals also coevolved with humans; their interactions can be broadly classified as hunting, pastoralism, and ranching. The domestication of certain grazing species between 10,000 and 4,500 years ago, marking the transition from hunting to pastoralism, dramatically augmented human capacities for settlement and agriculture. In landscapes where crop agriculture was marginal, domesticated grazing animals made human inhabitation possible where it otherwise might not have been. The domesticated animals gained enhanced food provision (to varying degrees) and protection from nonhuman predators, while humans gained a reliable source of traction, transportation, manure for fuel or fertilizer, milk, blood, meat, skins, wool, and so on. The evolutionary sequence of plant and animal domestication is a subject of debate, but it is clear that they were complementary in their overall effect for both humans and the plant and animal species involved.

The relationship of grazing animals to grazed plants is among the most complex in ecology, notwithstanding its apparent simplicity and an enormous body of research on the subject. Although patterns are evident at numerous scales, exceptions are abundant and relationships across scales are exceedingly complex. One prominent expert, S.J. McNaughton, cautions that "no straightforward generalizations are possible regarding the immediate effects of herbivores on plant growth and resource allocation. Consequences of tissue damage are under the complex control of plant genetics, intensity and frequency of herbivore effects, plant developmental stage at the time of herbivore impact, plant tissues that are affected, and the modifying effects of such other environmental factors as light, nutrients, temperature, and water."

This inherent complexity is compounded by domestication and especially, in the rangeland context, by the advent of ranching, which exerts evolutionarily unprecedented rigidity in the spatial distribution of grazing through the exclusive allocation of land. Where this is achieved through fencing, the mobility of animals (with or without human herders) is curtailed to an area that may be several orders of magnitude smaller than the coevolutionary norm. Whereas unfenced animals track grass growth through space and time, vacating denuded areas, fenced animals may be forced to consume different plants, and more of them, than the plants (and, in extreme cases, the animals themselves) can withstand. In spatially heterogeneous and temporally variable landscapes—including a large portion of the world's rangelands—even very large ranch properties are generally too small to match the scale of the processes that drive plant–herbivore interactions.

It is not surprising, then, that grazing has been so politically contentious in the western United States, where the transition to ranching stretched over seventy years, from the Civil War to the Depression. Overcapitalization, insecure land tenure, and unfamiliarity with such highly variable climate together triggered widespread degradation during that period. The discipline of range science, born largely at government behest to respond to the crisis, was constrained by political and economic exigencies to work within a fence-and-lease reform strategy. The ecological theories and management prescriptions that emerged over the first half of the 20th century were derived from research in temperate sites such as the Great Plains and proved poorly suited to drier and more variable settings such as the Great Basin and the Southwest. During the Cold War, these prescriptions were exported throughout the world in international "development" projects, and in the past quarter-century, the desultory results of such projects have helped to provoke strong critiques of the conventional, equilibrium model of rangeland ecology and management.

SEE ALSO: Cattle; Deer; Domestication; Land Degradation; Livestock; Overgrazing; Ranchers; Sheep.

BIBLIOGRAPHY. R.H.J. Behnke et al., eds., *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas* (Overseas Development Institute, 1993); T. Ingold, *Hunters, Pastoralists and Ranchers: Reindeer Economies and Their Transformations* (Cambridge University Press, 1980); S.J. McNaughton, "Compensatory Plant Growth as a Response to Herbivory," *Oikos* (v.40, 1983); S.J. McNaughton, "Grazing as an Optimization Process: Grass–Ungulate Relationships in the Serengeti," *American Naturalist* (v.113/5, 1979); M. Vavra et al., eds., *Ecological Implications of Livestock Herbivory in the West* (Society for Range Management, 1994).

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Great Barrier Reef

THE LARGEST CORAL reef system in the world, the Great Barrier Reef, is located in the Coral Sea off the east coast of Queensland in northeast Australia, and was selected as a World Heritage Site in 1981. As coral is a living organism, it has been said that the Great Barrier Reef is the single largest organism in the world, although others argue coral is merely a collection of millions of small organisms. As a result, there have been some suggestions that the Great Barrier Reef could more appropriately be named the Great Barrier Reef Systems.

The Great Barrier Reef is believed to have started growing on top of an older platform about 18,000 years ago, at which time the sea level was about 330 feet lower than it is today. A few of the islands along the reef have old upraised coral rock as much as 25 feet above the low water mark. The Reef extends from the mouth of the Fly River in Papua New Guinea, down to Lady Elliot Island in Queensland. In the northern region the reef forms a continuous line along the edge of the continental shelf, and by the time one reaches the southern region, the reefs are well distributed over the marginal shelf. It stretches a total of 1,616 miles, and has been divided by scientists into about 3,000 separate reefs and 900 islands. As a result of this, there is a certain degree of reef diversity within a complex geological framework.

HAZARDOUS—AND WONDEROUS

Since its first discovery, the Great Barrier Reef has long been a recognized hazard for shipping. The HMS *Endeavour* of Captain James Cook ran aground on the reef on June 11, 1770, sustaining much damage. In 1789, when Captain Bligh was put in a longboat after the mutiny on the HMS *Bounty*, he had to be careful to steer his craft so that it did not hit the reef—a feat that he managed, making it one of the most remarkable open boat voyages in history. Unfortunately, the avenging HMS *Pandora* commanded by Edward Edwards was not so lucky. It hit the reef on August 29, 1791, and went down with a large loss of life—including some of the mutineers. The wreck was discovered in November 1977, and has been the subject of extensive archaeological work.

The first detailed scientific study of the Great Barrier Reef was in 1843 when J. Bette Jukes, a naturalist on HMS *Fly* compiled a survey. Since then there have been further studies and surveys, with the Great Barrier Reef Committee formed in 1922 to sponsor and also conduct its own investigations into the nature and the origin of reef. In 1928–29, the Royal Society in London conducted a large number of biological and geographical surveys, and a marine biology station was established on Heron Island, subsequently run by the University of Queensland. Another research station was subsequently built on Lizard Island, and run by the Australian Museum. James Cook University, which conducted the work on the HMS *Pandora*, runs the third research station on Orpheus Island.

The Great Barrier Reef Marine Park Authority was established in 1976 under the auspices of the Great Barrier Reef Marine Park Act 1975, which allows for no drilling or mining activity within the areas declared to be parts of the National Park. The Great Barrier Reef is now managed by the Great Barrier Reef Marine Park Authority, in conjunction with the Government of Queensland. They have conducted extensive surveys and introduced zoning restrictions on all of the reef area.

The reef supports many different species, including 30 different species of whales, dolphins, and porpoises, including the Indo-Pacific Humpback Dolphin, the Humpback Whale, and the Dwarf Minke Whale. There are also a large population of dugongs and six different species of turtles: the Flatback, Green Sea, Hawksbill, Leatherback, Loggerhead Sea Turtle, and the Olive Ridley Turtle. There are also about 17 different species of sea snakes, 150 different species of echinoderms, 350 different species of corals, 1,500 different species of fish (including the Clownfish, Red Bass, and Red-Throat Emperor), and some 5,000 different species of mollusks, 10,000 different species of sponges, and 500 different species of marine algae and seaweed. The terrestrial flora is limited to about 30–40 species.

The Great Barrier Reef is a major tourist attraction in Australia, and income from tourists generates as much as $5 billion each year. Estimates of the number of tourists have been put at two million, although this certainly involves some "double-counting" of tourists visiting one or more sites. Voyages to the reef involve viewing from ships, glass-bottomed boats, helicopters, and airplanes. Many others enjoy scuba diving around the reef. When Indonesian President Abdul Rahman Wahid was asked about his biggest regret at losing his sight, he replied that it prevented him from seeing the Great Barrier Reef.

Although much of tourism is controlled, there are also worries about the sheer numbers of visitors; some irresponsible people have damaged the reef. The Queensland government response has not been to ban or limit visits to the reef, but to better police and regulate them.

SEE ALSO: Australia; Coral Reefs; Drilling (Oil and Gas); Marine Science; Mining, National Parks.

BIBLIOGRAPHY. Isabel Bennett, *The Great Barrier Reef* (Lansdowne, 1971); James Bowen, *The Great Barrier Reef: History, Science, Heritage* (Cambridge University Press, 2002); Edgar Frankel, *A Bibliography of the Great Barrier Reef* (Australian Government Publishing Service 1977); W.G.H. Maxwell, *Atlas of the Great Barrier Reef* (Elsevier, 1968); Eric Worrell, *The Great Barrier Reef* (Angus & Robertson, 1966).

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Greece

KNOWN AS THE "cradle of democracy," Greece won its independence from the Ottoman Empire in 1829 and subsequently began adding neighboring islands and territories to its holdings. After a repressive military dictatorship ended in 1967, Greece began moving toward democracy and abolished the monarchy in 1974. Greece joined the European Community (EC) in 1981. Despite rich national resources that include lignite, petroleum, iron ore, bauxite, lead, zinc, nickel, magnesite, marble, salt, and the potential for developing hydropower, Greece is underdeveloped relative to other nations in the European Union.

Bordering the Aegean, Ionian, and Mediterranean Seas, Greece has 8,479 miles (13,676 kilometers) of coastline. As a result of the temperate climate, the country experiences mild, wet winters and hot, dry summers. Major environmental concerns include extensive air and water pollution, and human resources are sapped by the sex trafficking and forced labor. A 2006 study by Yale University ranked Greece 19th of 132 countries in overall environmental performance, and the United Nations Development Program (UNDP) Human Development Reports rank Greece 24th among nations of the world in overall quality-of-life issues.

Much of the land area of Greece is mountainous, and some ranges extend into the sea, forming peninsulas and island chains. Destructive earthquakes are common, and the combination of winter and autumn rains and mountainous terrain results in significant flooding and soil degradation as 100,000 tons of soil is redeposited on lower levels. The practice of mixed herding, in which sheep and goats are raised together, has further contributed to land degradation as protective vegetation is stripped. Additional damage occurs during the approximately 1,000 fires that take place in Greece each year, some intentionally set. By the end of the summer of 1990, for instance, 1,358 fires had occurred. Consequently, the government established its first forest protection program.

The population concentration in urban areas has led to major air pollution. Around Athens, for example, a smoggy cloud known as *nephos,* composed of sulfur, nitrogen oxide, hydrocarbons, and dust, poses a constant health threat and sends hundred of people to hospitals. In 1987, a heat wave combined with *nephos* to cause several hundred deaths. In 1991 and 1993, Greeks were advised to stay off the streets of Athens when ozone levels soared. The greatest sources of the pollution have traditionally been steel works, cement factories, chemical industries, and refineries in conjunction with automobiles and central heating plants. In 1991, the government began promoting the use of environmentally friendly cars and moved toward eliminating all gasoline containing butane.

Water pollution has also presented a major challenge in Greece, particularly around the Saronic Gulf where waters were filled with sludge created by improper disposal of toxic metals and oil products. Before treatment systems were built in 1981, sewage effluents were released untreated into the gulf. Although tourism is essential to the Greek economy, the waters of the *Athens Riviera* became so polluted at one point that tourists were discouraged from bathing in the sea.

Oil tankers that pass through the Mediterranean each day are responsible for discharging some 650,000 tons of residues into the waters, and Greece works with 16 other nations to monitor this situation. To cut down on water pollution, toxic substances used in marine paint and pesticides effluents have been banned. Particular attention has been paid to the loggerhead turtle and the monk seal, which are threatened with extinction. Greek wildlife is also threatened by hunters who kill migrating birds as well as wild animals. Of the 255 bird species endemic to Greece, seven species are now threatened, and 13 of the 96 mammal species are in danger of extinction. The government has protected only 3.6 percent of the land.

During the latter part of the 20th century, a new commitment to environmentalism resulted in the passage of National Law 1650/86 and the adaptation of EC environmental regulations and directions. The Hellenic Ministry for the Environment, Physical Planning, and Public Works was given the responsibility of overseeing programs and policies designed to protect and improve the environment while continuing to promote the industrial, tourism, and agricultural sectors. In addition, the government established a system of fines so that polluters are forced to pay for the problems they create; the government also set up precautionary measures and instituted technological interventions to prevent pollution before it occurs.

Greece has expressed its commitment to the global environment by participating in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Sulfur 94, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands. Agreements on Air Pollution–Persistent Organic Pollutants and Air Pollution–Volatile Organic Compounds have been signed but not ratified.

SEE ALSO: Extinction of Species; Fire; Land Degradation; Polluter Pays Concept; Pollution, Air; Pollution, Water; Tourism.

Thessaloniki Fire of 1917

Nearly a third of the Greco-Turkish city of Salonika (modern-day Thessaloniki) was destroyed in a massive fire in August 1917, leaving as many as 70,000 people homeless, and resulted in the total reconstruction of the city.

The city of Salonika traces its origins back to 316 B.C.E., being named after the sister of Alexander the Great. Close to Byzantium, its has long been one of the major ports in the Eastern Mediterranean. It was a part of the Ottoman Empire until 1912 and was a multicultural trading entrepot with the population including many Sephardic Jews, Greeks, Turks and Bulgarians. Although Greece was neutral in World War I, it allowed Allied soldiers to land in Thessaloniki. A provisional Greek government based in the city supported the allies.

A subsequent enquiry found that the fire on August 18, 1917, started when a spark from a kitchen fire fell on some straw in the house of refugees. The lack of concern by the neighbors let the fire take hold, and fanned by a strong wind, it started spreading to other houses. Soon the fire was raging all around the main government building, the Diikitirio, which was only saved by employees being able to douse it in water. However, many other parts of the city were not so lucky. Most firefighting teams were privately owned by insurance companies, and their equipment was either old or nonexistent.

Allied soldiers were urged to help, with the French creating a “fire break” around the Diikitirio, but leaving soon afterwards; and the British using two fire engines to great effect. Soon afterward, several French soldiers were caught looting jewelry and were executed.

With a third of the entire city destroyed, Allied soldiers helped build temporary houses for many. Large numbers of residents left the city permanently. Charities around the world raised money as some insurance companies tried to claim that the fire was caused by German arsonists making it an “Act of War” that would have excluded them from liability. They eventually paid all policies completely.

BIBLIOGRAPHY. CIA, "Greece," *The World Factbook,* www.cia.gov (cited March 2006); Danae Diakoulaki, ed., *Environmental Signals* (Athens: National Center for the Environment and Sustainable Growth, 2003); *Europe Regional Reports: Chemicals,* www.umweltbundesamt.at/en/ (cited March 2006); Hellenic Ministry for the Environment, Physical Planning, and Public Works, "National Report," www.minenv.gr (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); E.M. Pantelouris, *Greece: Perspective 2000* (Blueacre, 1994); UNDP, "Human Development Reports: Greece," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Greece," *Little Green Data Book* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Green Chemistry

RELYING EXTENSIVELY ON nonrenewable petroleum feedstocks, conventional industrial chemistry disseminates a cocktail of synthetic chemicals throughout the global environment, presenting substantial risks to humans and other organisms. In contrast, the emerging field of green chemistry develops chemicals to be benign. Rather than presuming to keep human and ecological exposures to chemicals within levels of toxicity deemed "acceptable," practitioners of green or sustainable chemistry aim to make chemicals that are inherently safe.

Principles of green chemistry include: Design chemical products that have little or no toxicity and that break down to innocuous substances after use so that they do not accumulate in the environment; use renewable feedstocks, such as corn and soybeans; design syntheses so that the final product contains the maximum proportion of the starting materials, with few atoms wasted; minimize use of solvents, separation agents, or other auxiliary chemicals—when these chemicals are necessary, use innocuous chemicals such as water; and increase energy efficiency by manufacturing at ambient temperature and pressure.

Examples of green chemistry in commerce include substitution of supercritical carbon dioxide for perchloroethylene (perc) as a solvent in professional dry cleaning. Water has replaced petroleum distillates in paint. And manufacture of ibuprofen no longer creates cyanide and formaldehyde as hazardous wastes.

No one knows exactly how far chemists and chemical engineers can go in learning to do their work with far less environmental harm. However, historians and sociologists studying technology find that technical systems usually are far more malleable than would first appear; and many green chemists suggest that the main barriers to chemical greening are economic and political rather than scientific.

Some of these barriers lie within the traditional field of chemistry itself. The American Chemical Society now houses the Green Chemistry Institute, but premier chemistry conferences still devote little attention to environmental sustainability. While the American Institute of Chemical Engineers code requires members to "serve their communities…and alert authorities to business practices that endanger health and environment," environmental sustainability is not a central part of the organization's goals. Most university chemistry and chemical engineering departments do not offer courses on green chemical design/production or require students to study toxicology.

Pfizer now has a vice president for green chemistry, DuPont is making more than 10 percent of its products from corn and other renewable feedstocks, and the carpet industry is learning how to make its products biodegradable. Nevertheless, the inertia of "brown" chemistry is evident across industry—for example, in aggressively expanded production of vinyl siding, doors, and windows despite significant toxic releases over the material's life cycle (such as in fires).

Governments also are moving slowly. The Toxic Substances Control Act has failed to keep dangerous new chemicals off the market since enactment in 1976. The U.S. government has refused to sign the Stockholm Convention on Persistent Organic Pollutants and has assisted chemical industry efforts to undermine the European Union's new unified regulatory system for chemicals. Meanwhile, only 7 percent of U.S. federal spending on chemical research and development is devoted to green chemicals, and with the partial exception of Greenpeace, environmental groups have been slow to take up the cause.

Altogether, green chemistry has great potential and dovetails with other environmental thinking, including cradle-to-cradle design, the Natural Step, clean production, and life-cycle assessment. Activating that potential would require some combination of pressure from environmentalists, improved coverage in the media, taxes on toxic chemicals, subsidies for green chemical research and development, and changes in university curricula. In the meantime, "brown" chemistry continues to prevail.

SEE ALSO: Green Production and Industry; Greenpeace; Life-Cycle Analysis; Maize; Petroleum; Soybeans; Sustainability.

BIBLIOGRAPHY. Albert Matlack, *Introduction to Green Chemistry* (CRC, 2001); Joe Thornton, *Pandora's Poison: Chlorine, Health, and a New Environmental Strategy* (MIT, 2001); U.S. Environmental Protection Agency, "Green Chemistry," www.epa.gov (cited March 2006); Edward J. Woodhouse and Steve Breyman, "Green Chemistry as Social Movement?" *Science, Technology, and Human Values* (v.30/Spring, 2005).

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Green Consumerism

THERE IS SOMETHING that all of the following have in common: driving a hybrid car; eating organic and/or local food; building with certified "sustainably produced" wood; joining the "back to the land" movement; boycotting Shell Oil, Esso, and Nestlé; using nonchemical housecleaning products; investing in "ethical" stock portfolios; recycling aluminum cans and glass bottles; sourcing electricity from wind or solar energy; purchasing energy-efficient washing machines, refrigerators, and lightbulbs; and swaddling a child in cloth reuseable diapers.

While disparate activities, at a general level, these are different forms and means of *green consumerism*. *Green consumerism* works from the recognition that the Earth's resources are limited, environmental damage is directly and indirectly related to the exploitation of these resources, and consumer power and choice can be utilized to produce positive environmental change. It is argued that the market signals of green consumer demand encourage the sustainable production of goods and services by businesses and governments. This is characterized as (mostly well-off) consumers "voting" for environmental responsibility with their money. Green consumption has become an increasingly powerful but loosely organized movement in the last decade; to paraphrase Julie Guthman, a researcher on California organic food, the production and consumption of organic salad mix has done more to reduce pesticide use than all the organizing around pesticide reform.

Green consumerism is a broad and bewildering term given the vast nature of its forms, means, and meanings. It is closely allied with the concepts of *sustainable consumption* and, these days, the growing movement for *ethical consumption*. These are both subsets of green consumption: sustainable consumption includes a concern for social justice, and ethical consumption incorporates moral responsibility and care. All three are often used interchangeably, leading to potential confusion in policy and popular discussions. Clearly, however, green consumerism has shifted academic and popular debates around the even broader concept of *sustainable development*; how to make consumption greener, more sustainable, and more ethical has moved to the forefront of the problems and policies for sustainable development.

Coming out of the environmental movements of the 1960s and 1970s and gaining serious traction in the 1990s, the demand for and production of green commodities has expanded rapidly. One of the earliest statements was the publication of the wildly popular *50 Simple Things You Can Do to Save the Earth* (1989) in the United States. Published simultaneously in the United Kingdom (UK) was *The Green Consumer Guide: From Shampoo to Champagne—High-Street Shopping for a Better Environment,* which begins, "Every day, whether we are shopping for simple necessities or for luxury items, for fish fingers or fur coats, we are making choices that affect the environmental quality of the world we live in." Newer writings include *The Newman's Own Guide to the Good Life: Simple Measures that Benefit You and the Place You Live* (United States) and *The Good Shopping Guide* (UK), with the publishing trend spreading to *The Ethical Consumer* magazine (UK) and to the Internet. In addition, almost all of the major environmental organizations like the Sierra Club, Conservation International, and Friends of the Earth now urge their members to shop more responsibly.

There are different philosophical underpinnings that inform the diversity of green consumerism. Essentially, it lies along a continuum of philosophical positions and associated activities, from the most *eco-centric* to the most *technocentric*. *Eco-centric* green consumers advocate more radical lifestyle changes and economic relationships; some might even go "back to the land" to live "off the grid," producing their own energy and food. More *technocentric* green consumers, those with greater faith in green technologies, might advocate moderate shopping-style changes, perhaps purchasing a hybrid car and shopping for organic food. Most green consumers are between these extremes, for example, growing food in their backyard, or—while owning a car—riding a bike when feasible.

IMPACT ON BUSINESS AND CONSUMERS

This mainstreaming of green consumption has greatly influenced business. Companies now talk about measuring success through the triple bottom line—economic viability, environmental soundness, and social responsibility—which is more formally understood as the concept of *corporate social responsibility* (CSR). The ethos of CSR, while at one level led by consumers' concern for companies to "do well by doing good," has also been led by companies working to increase efficiency and boost revenues.

Below the surface, how does green consumption work? The dissemination of information is fundamental to the processes of green consumerism. This involves providing consumers with knowledge about various commodities and companies to assess their claims of environmental sustainability and give "greener" choices. Additionally, activists and journalists provide "muckraking" exposés of the environmental and human exploitation by corporations and commodities. This provides consumers with a sense of what to avoid, but also puts pressure on companies to change their products or supply chains. Examples of food-based "muckraking" include Eric Schlosser's *Fast Food Nation* and Morgan Spurlock's film *Super Size Me*. Exposing Nike's

The use of eco-friendly, nonchemical housecleaning products is one expression of "green consumerism."

labor abuses in footwear manufacturing is one of the most famous activist-led exposés.

Information is also provided to consumers on market shelves. This is a process known as *eco-labeling*: A product, through the use of logos, images, and descriptive language, decries to consumers its environmental-friendliness and/or its ethical properties by giving information about its sustainability. Eco-labeling allows companies to differentiate themselves and draw in new green consumers. Further, eco-labeling often utilizes an audit-type regulatory systems. For example, all U.S. foods labeled as "organic" must be produced to a United States Department of Agriculture (USDA)-regulated set of standards and certified by a USDA-approved certification agency. The Forest Stewardship Council has created a certification system for sustainably sourced wood. Standards and logos make production processes transparent to foster a verifiable trust between the green product, company, and consumer.

"Doing" green consumption involves two main activities: the *boycott* and the *buycott*. Boycotting is the active avoidance of particular products or a particular company to protest their actions or environmental record. The latest incarnation of the boycott, which targets consumerism as a whole, is known as the international "Buy Nothing Day." The buycott involves purchasing from a particular company or a particular commodity to "vote" with one's dollar for that company or product. For example, Seafood Watch (www.seafoodwatch.org), in suggesting "choices for healthy oceans," unequivocally states that, "You have the power…your consumer choices make a difference." The group supplies a list of seafood to buy "to support those fisheries and fish farms that are healthier for ocean wildlife and the environment." Green consumption can involve both the buycott and boycott. Seafood Watch lists which seafoods to avoid—an explicit boycott—while eating organic foods involves a buycott but also the implicit boycott of industrially farmed foods.

Recycling, while strictly different from green consumption in that nothing is "consumed" per se (except in the case of buying recycled products), is one of the most accessible forms of green consumerism. At the consumer level it is quickly expanding beyond bottles and cans to include plastics, green and food wastes, and clothes and appliances.

PROBLEMS AND CRITIQUES

There are many trenchant critiques of green consumerism that legitimately call it into question. The most obvious criticism leveled against green consumerism is that it individualizes the problem and solution of environmental conservation and makes it a function solely of consumer choice. Thus, in dealing with environmental problems, many of which are caused by corporations and governments in the first instance, these are lain at the feet (and wallets and hearts) of conscious middle-class consumers rather than at those that should be held accountable.

Individualization and the intensive marketization of conservation and social justice through green consumerism can be further questioned in these ways: (1) green consumerism cannot explain to consumers the complexities of environmental problems such as global climate change or confront such a multi-causal phenomenon though a change in shopping behavior; (2) green products are often more expensive and less accessible for lower-income consumers instituting a class bias into these markets; (3) in a lost irony, more consumption (of the "right" products!) is posed as the solution to what is clearly a function of overconsumption; (4) many purchases are narrowly based on personal risk, such as avoiding pesticides by eating organic, rather than a wider environmental and social ethic; (5) green consumerism further adds to the aestheticizing of society, trivializing the seriousness and severity of ecological problems; (6) there is a fashionability to green consumption (i.e., saving the whales one day, saving the rain forest the next) that targets "hot" environmental problems and specific species, but ignores more mundane and important parts of the environment; (7) many suggest that shopping for the latest eco-product has become a substitute for more "real" forms of political opposition and social change for greater environmental sustainability; (8) others argue that green consumerism and production merely treat the symptoms of environmental and social exploitation and do not address the root systemic causes of exploitation in capitalism's relentless drive for economic growth and profit; (9) and finally, one of the most well-known critiques of green consumerism is that of *greenwashing*, where large companies hide behind the marketing of one or two eco-friendly products or services, while causing environmental harm in other ways and in other locations.

In these ways, green consumerism might actually prevent the accountability of those truly responsible for environmental destruction and distract from more committed and deeper socioeconomic progress in the production of goods, how we relate to ecologies, and how we relate to each other across social, economic, and geographical divides. And, while the controversy over the effectiveness and authenticity of green consumerism will continue, there is little doubt that, while a beginning of some sort, there is a long and winding way for green consumerism to go for it to put us on the path to environmental sustainability and social justice.

SEE ALSO: Consumers, Ecological; Consumption; Green Production and Industry.

BIBLIOGRAPHY. Maurie Cohen and Joseph Murphy, *Exploring Sustainable Consumption: Environmental Policy and the Social Sciences* (Elsevier Science, 2001); Green Shopping Guide, www.greenconsumerguide.com (cited February 2007); Julie Guthman, "Fast Food/Organic Food: Reflexive Tastes and the Making of 'Yuppie Chow'," *Social and Cultural Geography* (v.4, 2003); Naomi Klein, *No Logo* (Picador, 2000); Thomas Princen, Michael Maniates, and Ken Conca, *Confronting Consumption* (MIT Press, 2002); M. Redclift, *Wasted: Counting the Costs of Global Consumption* (Earthscan, 1997); John Stauber and Sheldon Rampton, *Toxic Sludge Is Good for You: Lies, Damn Lies and the Public Relations Industry* (Common Courage Press, 1995); The Responsible Shopper, www.coopamerica.org (cited March 2007).

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Green Movement

SOCIAL MOVEMENTS ARE described as agents of social change. Green movements are collectives of actors pursuing environmental issues from a variety of political, class-based, and ethical persuasions whose tactics vary from direct action to policy reform. Green movements can be characterized as those that adhere or promote to one or more dimensions of environmentalism, which is seen as an interest group community. Green movements seek to promote social change based on a commitment to sustainability and environmental preservation, but for motivations that range from diverse sets of environmental values from the conservative Wise Use movement to the more radical Earth First!

In social movement theory, green movements are characterized as part of the new social movements. Separate from class-based movements, the specific grievances of new social movements are driven by changing ideas that permeate culture and society. Green movements emergence coincided with the emergence of the women's liberation, anti-Vietnam War, and other leftist counterculture movements. Green movements are unified along the axes of environmental problems, though they constitute a diverse set of political perspectives and ethical orientations.

Early antecedents to green movements organized around concerns about hunting and conservation of natural resources. Soon, urban policy questions around sanitation, clean water, clean air, and public health became the driving concerns of green movements. Some attribute the success of green movements to the spread of values emerging out of the counterculture of the 1960s, particularly the critique of capitalist consumer society.

Others note the importance of the image a fragile earth, from the early space missions and connecting that image to arguments about a finite earth, presented in the report from MIT scientists called the *Limits to Growth*. Much support for green movements emerged with Louis Gibbs' attention to Love Canal, where children were exposed to toxics in the soil below the site of a school that was previously a toxic dump. Soon after, green movements emphasized local issues and extended into households where mothers took up concerns about children's exposure to toxins.

The philosophical orientations of green movements range from the conservation-oriented utilitarians that look to preserve resources for human use to those preservation-oriented perspectives that attribute intrinsic value to ecological systems, biodiversity, and species. Utilitarian perspectives are often characterized as anthropocentric because they ascribe rights only to humans, while the eco-centric and bio-centric perspectives extend the domain of ethical consideration to living species and assemblages of species. The eco-centric and bio-centric perspectives have their origins in the Romanticism of Thoreau and others writing about nature in the 19th century. These views come into conflict with questions about the human use of natural resource management and wilderness preservation. This often leads to contradictory goals across different green movements.

GREEN MOVEMENT GROUPS

Given the diversity of environmental problems, green movements are quite diverse in their foci, although the political power of these groups often varies with their political power of the opponents they encounter. Green movements shape environmental outcomes in various ways, some using the political system, some focusing on the promotion of green consumerism and stewardship, and ecological modernization, while others use more violent tactics like ecotage. There are over 10,000 green movement organizations in the United States, with 44 million members, and income of $2.7 billion and assets of $5.8 billion as of 1995.

Green movement organizations come from a variety of perspectives raising a diverse set of concerns ranging from those that focus on local, "not-in-my-backyard" issues; mainstream Washington-based lobby and policy-oriented NGOs like the Union Concerned Scientists and the World Watch Institute; political parties like the U.S. and German Green Parties; legal-action groups like Friends of the Earth, the Center for Foods Safety, and the Defenders of Wildlife; donor and member-driven groups like the Sierra Club, The Nature Conservancy, GreenPeace, the Wilderness Society, and World Wildlife Fund; and radical "direct-action" groups ranging from Greenpeace to Earth First!

The Earth Liberation Front (ELF) is probably the most controversial group that could be characterized as a green movement, as the Unabomber's lone actions probably do not qualify as a movement. ELF is a radical environmental group that seeks to use destructive tactics to achieve their aims. Listed as a terrorist organization by the Federal Bureau of Investigation, the decentralized group has claimed responsibility for a handful of actions, including arsons committed in new suburban housing developments in Long Island and the widely-publicized destruction of new Hummers at a dealership in Southern California. Those acts of *ecotage* are inspired by the Edward Abbey classic the *Monkey Wrench Gang*, where a group of friends who gained inspiration from the wild, clandestinely sabotaged equipment used to extract natural resources. Sociologist Rik Scarce spent six months in jail for refusing to disclose the details of conversations protected under confidentiality agreements with ELF, demonstrating some of the challenges of studying green movements listed as potential terrorist organizations.

Radical environmentalists are often depicted as being adherents to deep ecology, an environmental ethical or worldview that advocates a duty to preserve nature. Deep ecology was coined by Arne Naess, a Norwegian philosopher and mountaineer who has gone on to write extensively on the moral philosophy of environmentalism. Deep ecologists have been criticized for holding onto pristine myths about nature and for pressing for American-style national parks and wilderness areas in developing third-world countries.

In some cases, disparate groups like Earth First! and the Sierra Club have worked on issues that saw their tactics complement the other. In one case of salvage timber operations in the Warner Mountains in Oregon, a group of Earth First! activists locked down fire road that led to the site of the salvage operations. While the logging operation was being delayed, a lawsuit brought by the Sierra Club was able to sue the Forest Service and temporarily reverse their policy on salvage logging.

POLITICAL AND ETHICAL CLOUT

Green movement popularity has also lent itself to the mainstream programs of political parties. Political parties from all persuasions now seek to claim the environment for themselves. Political parties like the German Green, *Die Grunen,* have gained a populist popularity. The German Greens have leveled a searing critique of industrial society and colonialism and have brought questions about the environment, public health, and military spending into the central planks of their platform. Ralph Nader's appearance as a Green Party candidate in the U.S. Presidential Elections of 2000 is often cited as the reason Gore lost to Bush. Former Vice President Al Gore characterized himself as a green movement leader because of the widespread popularity of environmentalism.

The sustainable agriculture movement is also considered a green movement. It overlaps with the appropriate technology movement that became an advocate of a new economy based on a reflection on the social consequences of technological change. The back-to-the-land movement was based on the influence of books such as Schumaker's *Small Is Beautiful*, Wendell Berry's *Unsettling of America,* Rachel Carson's *Silent Spring*, an attack on DDT serialized in *The New Yorker* in the early 1960s, and Murray Bookchin's *Our Synthetic Environment*, and demonstrated the overlap between environmental and agricultural concerns. Part of the sustainable agriculture movement is linked to the anti-genetic engineering movement that delivers a blistering critique of technological change in agriculture, drawing on the environmental implications of the Green Revolution and top-down third-world agricultural development.

The question about what to eat is perhaps one of the most controversial topics among green movement activists. Animal rights activists and sustainable food system activists often have clashing opinions, but many overlapping agreements. While they differ on the question of local animals in food systems, for example, they are in agreement regarding the cruel punishment and wastefulness in the industrial production of animals.

These groups look at the problems of the global economy and focus inward at remaking communities based on the ideals of small, more local production-consumption linkages in farming systems, for example. Through popular distributions of the Whole Earth Catalogue, environmentalism became more rooted in the consumption counterculture. It fashioned an entire alternative economy by instilling a commitment to collective agriculture, particularly organics. Today the promotion of green consumption is directed at shortening commodity chains through more direct purchasing, such as farmers' markets, to establish connections between producers and consumers of locally grown food as opposed to industrial and fast food.

Green movements have played a significant role discursively as well as materially in transforming the state to a green one. The heyday of the green movement is often depicted as the time period that saw the passing of the Water Pollution Control Act,

Ethical Consumption

Some parts of the green movement promote ethical consumption as a tactic for promoting sustainability and environmentalism. Perhaps the most widely recognizable form of ethical consumerism is vegetarianism, which seeks to motivate consumers on the ethical consequences of eating meat. This remaking of market relationships based on an ethical orientation toward environmentalism is referred to as *Green Consumerism.* Epitomizing green consumerism and the role of green movements is the international coffee situation, where a transition to full-sun coffee has led to declines in migratory birds that overwinter in the tropics where coffee has been traditionally grown in shade coffee systems. Green movement actors promote the consumption of bird-friendly coffee because shade plantations have demonstrated higher levels of biodiversity in birds, trees, and many other species. The promotion of labeling has become a widely used tactic in green movements from organic agriculture to fisheries conservation to timber certifications.

The danger of green consumerism is that reinscribing a commodity fetish based on the environmental characteristics of commodities may perhaps dilute the ideas that it intended to promote, or undermine sustainability in other dimensions. For example, organic agriculture is promoted for environmental benefits, but those benefits are limited to certain dimensions of environmental issues like pesticide use and take no consideration of scale-related issues, never mind the sticky problem of labor in agriculture.

the Clean Air Act, the National Environmental Policy Act, and the Endangered Species Act during the Nixon Administration of the early 1970s. However, the codification of environmental problems through the state served to take the green movement's momentum away from the left and take up environmentalism as a cause for the right. Nixon sought a consensus approach to environmental problems and his creation of a policy apparatus for environmental problems served to take away the political momentum of the left. While the EPA looked to regulate the harms of production practices, the failure to include the Department of Agriculture, Department of Energy, and Department of Transportation into the planning and regulatory sphere, leaving their interventions more at the whims of the market forces and political cronyism. The critique, entitled the Death of Environmentalism, blamed the failure of the environmental movement on a narrowly defined policy wonkism that fails to maintain political coalitions and win-win scenarios that promote jobs and environmental concern.

INSTITUTIONALIZED GREENING

Some have questioned whether or not the institutionalization of mainstream green movement organizations qualifies them as a social movement, which to some is a contradiction: you cannot have a movement that is institutionalized. The institutionalization of green movements has led to an increase in passive members who simply write checks in the name of some environmental organization, many of which have to maintain large overheads to stay afloat. Another concern is that environmental organizations move away from protest tactics and critiques of multinational corporations to a more collaborative approach. Yet it is unclear whether the deradicalization of green movements makes them more or less effective in dealing with environmental problems. There is also a concern that the institutionalization of the green movement has led to the scientization of environmental problems. This has led to a narrow focus on the science of environmental problem that often neglects their social origins.

Green movement concerns merge with those of development in the developing Third World. Successful green movements in developing countries include the Chipko Andolan Movement, who protected trees in Northern India through acts of civil disobedience against transnational logging companies. Often, these campaigns rest their success on bringing concerns about livelihoods together with concerns about the environment. Chico Mendez led a group of rubber tappers in Brazil on a crusade to link their practices to the preservation of biodiversity in the Amazon.

Some have even characterized the social unrest in Chiapas as coming out of political persuasions that include green movements. But not all developing country environmental campaigns have been successful. The Three Gorges Dam project in China is one glaring example of mass relocation and devastating environmental impact that green movements have found difficulty in challenging.

More recently, environmental justice groups have refocused attention to environmental concerns in urban areas and cities. An executive order by President Clinton in the 1990s required U.S. Federal agencies to evaluate the consequences of agency actions on the distribution of environmental burdens. Many urban green movements draw attention to the problem of environmental racism where communities are disproportionately exposed to negative environmental consequences. Green movements in urban centers around the world have been successful in promoting the idea of community gardens in some cities. With the rapid rise of urban populations around the world the promotion of sustainable cities has been cited as a high priority by many green movement actors.

SEE ALSO: Chipko Andolan Movement; Green Chemistry; Deep Ecology; Green Consumerism; Green Production and Industry; Green Revolution; Love Canal.

BIBLIOGRAPHY. John Dryzek, *The Politics of the Earth: Environmental Discourses* (Oxford University Press, 1997); Roger Gottlieb, *Forcing the Spring: the Transformation of the American Environmental Movement* (Island Press, 1993); Ramachandra Guha, "Radical American Environmentalism and Wilderness Preservation: A Third World Critique," *Environmental Ethics* (v. 11, No.1, Spring 1989); M. Mayer, *The German Greens: Paradox Between Movement and Party* (Temple University Press, 1994); Christopher Rootes, "Environmental

Movements," David Snow et al., eds., *The Blackwell Companion to Social Movements* (Blackwell, 2003); Andrew Szasz, *EcoPopulism: Toxic Waste and the Movement for Environmental Justice* (University of Minnesota Press, 1994).

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Green Production and Industry

GREEN PRODUCTION INCREASES the efficiency of standard industrial practices while eliminating or minimizing wastes at their source, rather than after they have been generated. In industrial processes, green production includes conserving raw materials and energy, eliminating toxic raw materials, reducing the quantity and toxicity of emissions and wastes, and minimizing waste and emissions of the aggregate production.

Major changes in current industrial production and consumption systems are required to meet the needs of a growing world population while using environmental resources in a sustainable manner. To achieve a more rational and integrated use of resources, a reorientation of science and technology toward the objectives of sustainable development is necessary and achievable by incorporating green design into all facets of industry.

Green design is a growing industry trend begun in the fields of architecture, construction, and interior design and now moving to all aspects of industry and production. Green design is also referred to as "sustainable design," "eco-design," or "design for the environment." The broad principles are fairly simple: choose energy efficiency wherever possible, work in harmony with surrounding resources, and use materials grown using sustainable methods or recycled rather than new materials from nonrenewable resources.

To determine true sustainability, all production technologies and products should undergo a comprehensive life-cycle analysis (LCA), a means of quantifying energy and raw material use and the waste generated at each stage of a product's life. Ideally, an LCA includes quantification of material and energy needed for raw material extraction; manufacturing of all components; use requirements; generation (if any, as in the case of solar photovoltaic cells); end-of-use (disposal or recycling); and distribution/transportation between each stage. Based on LCA, methods are applied to reduce materials and energy required during a product's life cycle. LCA optimization not only means lower materials and energy requirements for a product but also encourages extending the useful life of a product.

Green design begins in the initial research and design phase. Unfortunately, the assessment of trade offs between the environmental attributes associated with competing processes or products is extremely challenging due to technical, societal, and cultural perspectives associated with environmental quality. In the green design process, designers may look at the source, makeup, and toxicity of raw materials; the energy and resources required to manufacture the product, and how the product can be recycled or reused. Balanced with other considerations such as quality, price, ease of production, and functionality, eco-designed products are environmentally and economically viable alternatives to traditional products.

ENVIRONMENT AND ECONOMY

The green industry movement has challenged the notion that environmental and economic goals are mutually exclusive. Green design and clean production have historically been encouraged and become financially viable where government regulation has been first introduced. Increased efficiency in green production, however, sometimes gives a company an advantage in the market. Green-designed reduction of energy and materials is generally economically feasible, as it often represents cost savings in engineering. Also, many green industrial patterns are beginning to include the "triple bottom line" in their business planning, which captures a spectrum of values including environmental and social concerns in addition to simple economics. The problem of externalities, however, which make waste affordable by shedding environmental costs, can still discourage transition to green production.

Green industry and green production are growing at explosive rates. The Greening of Industry Network

(GIN) has formed to coordinate this growth. The GIN is an international network of professionals focusing on issues of industrial development, environment, and society that is dedicated to building a sustainable future. In every country, some factories already operate at world-class environmental standards, and many profitable enterprises comply with national pollution regulations. The pinnacle of green industry will be reached when all products are designed without depleting natural resources using the current solar income and all waste is converted to food for another industrial system (e.g., industrial ecology) or for the natural systems.

To date, attempts to manage technology have been complex, involving statutes, tort law, technology standards, consumer behavior, and insurance. Most scientific efforts to manage technology have concentrated on banning or setting limits on pollutants. In the United States, the number of federal statutes concerning the environment grew exponentially from the 1960s, leading to a proliferation of regulations, not always appropriate and not always enforced. Generally these laws focus on pollution and health hazards and few efforts address resource depletion or environmental issues in a global context.

These trends may also be changing. A growing number of regulations now support green design. For example, several European countries require manufacturers to take products back from consumers at the end of the product's life, creating an incentive for manufacturers to design products for easy recycling or reuse or those that can be disassembled. Initiatives in the United States include the Extended Product Responsibility concept, which spreads environmental responsibility from designer to manufacturer to distributor to retailer. Future legislation will push for products that have built-in end-of-life options, requiring designers and manufacturers to take responsibility for their products.

A mature green industrial system would purify air, water, and soil rather than pollute them; retain valuable materials for perpetual, productive reuse rather than destroy or waste them; require no regulation; celebrate an abundance of cultural and biological diversity; enhance nature's capacity to thrive; grow health, wealth, and useful resources; and generate value and opportunity for all. Such a green industrial system, modeled on the natural world's abundance can solve rather than just manage the problems industry currently creates, allowing both business and nature to thrive.

SEE ALSO: Externalities; Green Chemistry; Green Consumers; Life-Cycle Analysis; Sustainable Development.

BIBLIOGRAPHY. Richard Devon, "Green Industry: Necessary, Difficult but Possible," *Engineering and Public Policy Newsletter* (American Society for Engineering Education, June 1996); Doris Fuch and Daniel Mazmanian, "The Greening of Industry: Needs in the Field," *Business Strategy and the Environment* (v.7/4, 1998); Greening of Industry Network (homepage), www.greeningofindustry.org (cited June 2006); Peter Groenewegen, Kurt Fischer, Johan Schot, and Edith G. Jenkins, *The Greening of Industry Resource Guide and Bibliography* (Island Press, 1995); Enrique Leff, *Green Production: Toward an Environmental Rationality* (Guilford Press, 1995); William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (North Point Press, 2002); Joshua Pearce and Andrew Lau, "Net Energy Analysis for Sustainable Energy Production from Silicon Based Solar Cells," *Proceedings of American Society of Mechanical Engineers Solar 2002: Sunrise on the Reliable Energy Economy* (ASME, 2002); World Bank, *Greening Industry: New Roles for Communities, Markets, and Governments* (Oxford University Press, 2000).

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Green Revolution

THE GREEN REVOLUTION refers to a major transformation in agricultural practices in the developing world based on a specific technological and institutional package, including high-yielding variety seeds (HYV's), fertilizers, and irrigation. The package parallels industrial agricultural practices that developed in the United States after World War II. Western institutions began promoting the package aggressively in the mid-1960's as an answer to the developing world's accelerating population growth and mounting hunger problem. They also viewed the Green Revolution package as a means to foster capitalist economic development and to solidify their ties to developing countries in the context of the cold war. Although the package continues to spread today, the most transformative period was around 1966–1972.

Initially, the Green Revolution focused on just two crops: wheat and rice. The most important trait that was bred into an HYV was dwarfism. Dwarfs that are well fertilized and irrigated focus their energy on the growth of their seeds and produce strong stems to support the additional grain. The HYV's are only high yielding, however, if they receive the correct amount of fertilizers, irrigation, and weeding. The technology must be supported by four critical institutional resources: an irrigation infrastructure; a financial system to help farmers purchase the seeds, fertilizers, equipment, water, and labor inputs in advance; a transportation and marketing infrastructure to connect farmers with input sellers and grain buyers; and an educational system to teach farmers the management techniques.

In its early stages, the Green Revolution impacted only those parts of the developing world that cultivated wheat or rice, and that could marshal the four critical institutional resources. South and Southeast Asia experienced a significant impact, whereas only small parts of Latin America and the Middle East and very little of Africa adopted this early package. Later, HYV's were developed for additional crops and environmental conditions, increasing its geographic range. Impediments remain significant, however, in regions that have difficulty developing the institutional infrastructure, particularly in Africa.

In adopting countries, assessments of its impact are controversial. Those supportive of the Revolution emphasize how agricultural output has increased rapidly enough to keep up with population growth and keep food prices low, particularly for the urban poor. As well, many farmers increased their income, spurring rural economic development. The high-yielding technology also averted some deforestation, as less agriculture had to expand into forested land than might otherwise have occurred.

Those critical of the Revolution argue that it worsened socioeconomic differences within adopting countries, bringing prosperity to a few and hunger to many. Large farmers proved better able to access institutional resources and were more profitable than small farmers, forcing many small farmers to sell out. Those small farmers, who had previously produced much of their own food, were now dependent on wage labor, which proved to be unreliable and insufficient for many, spurring rural to urban migration. Many of those who managed to keep their land found themselves deep in debt as periodic crop failures left farmers unable to repay the cost of their inputs at the time of harvest. As well, the Green Revolution monocrops increased the need for pesticides, causing environmental contamination and health risks to farmers and consumers.

SEE ALSO: Agriculture; Golden Rice; Green Chemistry; Green Consumerism; Green Movement; No-Till Agriculture; Organic Agriculture.

BIBLIOGRAPHY Robert Huke, "The Green Revolution," *Journal of Geography* (1985: 84, 248–254); Frances Moore Lappé, Joseph Collins, and Peter Rosset, *World Hunger: 12 Myths* (Institute for Food and Development Policy, 1998); David Pimentel, *Green Revolution Agriculture and Chemical Hazards, the Science of the Total Environment* (1996: 188 Suppl. 1, S68–S98); Vandana Shiva, *The Violence of the Green Revolution* (Atlantic Highlands, 1991).

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Greenhouse Effect

THE GREENHOUSE EFFECT is a natural phenomenon of the earth atmosphere. Gases, in particular carbon dioxide, methane, and ozone, are present in the atmosphere in small quantities. They have the capacity to retain energy in a manner analogous to a greenhouse. However, the comparison is not exact because greenhouses and the atmosphere use different trapping mechanisms.

Greenhouses are made of clear translucent material such as glass or plastic that allows sunlight to enter. The ambient temperature outside of the greenhouse can be many degrees colder, but the temperature inside of the greenhouse will be much warmer. This happens because the sun's rays warm the atmosphere of the closed greenhouse, causing its indoor temperature to rise. Because the glass panes of the greenhouse act as insulating material, heat is not easily transferred from inside of the greenhouse to the colder air outside. In the earth's atmosphere, greenhouse gases create a similar warming effect, but it is not exactly the same as the warming that occurs in a greenhouse.

Earth, Venus, and Mars also have atmospheres, and a greenhouse effect as well. In the case of Mars, the effect is insufficient to warm the planet. For Venus, it is too much of a good thing. Because Venus is rich in carbon dioxide, it retains heat, producing an inhabitable surface temperature of around 850 degrees F. In the case of Earth, its atmospheric greenhouse effect has been just right, with an average global temperature of 59 degrees F, until recently.

A NATURAL PROCESS

The greenhouse effect is a complicated natural process that occurs in the earth's atmosphere, which has four major layers. The Troposphere is the thick layer extending from the surface of the earth to about 7 miles (11.3 kilometers). It holds the air life on earth breathes and most of the clouds. The Stratosphere extends from the top of the troposphere to about 30 miles (48 kilometers) above the surface of the earth. It has some high flying clouds, but its upper portion is the location of the ozone layer. The Mesosphere is the third layer of the earth's atmosphere. It extends to about 50 miles (80 kilometers). The final layer is the Thermosphere. The atmosphere is extremely thin, and extends to about 600 miles (965 kilometers) above the surface of the earth. Beyond is empty space.

Solar energy striking the earth is composed of more than just visible light. In the electromagnetic spectrum, the radiation leaving the surface of the sun is composed of short-wave X-rays and gamma rays. Gamma rays are deadly to humans for even a short period of time. However, these forms of radiation are absorbed in the Thermosphere by the time they have penetrated the atmosphere to a depth of about 100 miles (160 kilometers) above the earth's surface.

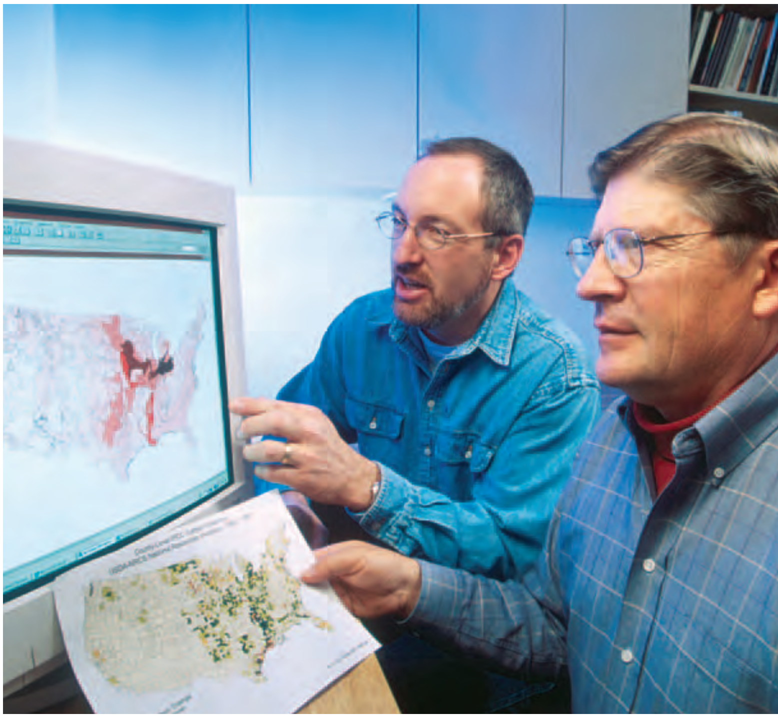
Ultraviolet (UV) waves are next to X-rays and gamma rays in wavelength. These wavelengths extend across the electromagnetic spectrum to violet light in the visible spectrum. UV waves are dangerous to living things. They cause sunburn and can kill plankton in the oceans. They are absorbed in the top of the Mesosphere by ozone. Without the ozone layer there would be an increase in damage to eyes and skin cancers.

The visible light spectrum as seen by human eyes ranges from purple to red in a spectrum of increasing wavelengths. Just beyond the visible red spectrum is infrared radiation. About 60 percent of the sun radiation is infrared, invisible to humans and to most animals. The tongues of snakes have infrared sensors to detect the heat of animals in the dark. Camera film has been designed to detect infrared radiation. It is this form of radiation that heats the earth.

Visible light and infrared radiation penetrate the earth's atmosphere as if they were light shining through a glass pane. Much of the radiation is absorbed by plants or by cultivated areas of the earth's surface or by the oceans. However, some of the radiation is blocked by clouds, and some it returns to space from bright surfaces on the earth like deserts or ice-snow fields.

As radiation warms the earth's surface, some infrared radiation is radiated back into space, but not all. The earth's radiation is heat energy in the form

Scientists look for ways and areas to sequester carbon dioxide, a greenhouse gas, with high-biomass crops.



of long-wave infrared radiation. The heat radiation waves have wavelengths ranging from 4–100 micrometers. The earth's heat radiation is much longer in wavelength than that striking the earth's surface directly as sunshine. The electromagnetic energy from the sun penetrates the atmosphere as if through an open window. However, the longer wavelengths of the earth's radiation act differently. The result is that the atmosphere is transparent to the sun's radiation, but not to the long-wave infrared radiation coming from the earth's surface. The earth's radiation is absorbed in the Troposphere by greenhouse gases. The gases, in effect, act like a blanket warming the earth.

GREENHOUSE EFFECT PROCESS

The greenhouse effect is caused naturally by the small quantities of carbon dioxide (CO_2), carbon monoxide (CO), ozone (O_3), nitrous oxide (N_2O); Chlorofluorocarbons (CFCs); water vapor (H_2O), and particulates of various kinds. In addition, in the atmosphere are some trace gases such as argon that also have a role in the greenhouse effect. Neither oxygen nor nitrogen hold the energy of the sun very well; however, these other gases do hold in the energy of the sun. These two gases constitute nearly 99 percent of Earth's atmosphere. The greenhouse gases compose less than one percent.

Carbon dioxide, water vapor, and trace gases all absorb some to the heat energy of the earth. Carbon dioxide absorbs infrared waves that are 13–100 micrometers. Water vapor absorbs infrared waves that are between 4–7 micrometers. Infrared waves that are between 7–13 micrometers, on the other hand—the "infrared window"—are not usually absorbed. Instead, they pass easily through the atmosphere and into space.

The infrared energy absorbed by the greenhouse gases is given off as radiation that returns to earth. In effect, these gases "trap" heat energy coming from the earth and return it to the earth. Without the atmospheric greenhouse effect, the earth would be a block of ice. Eventually, some of the radiation is radiated out into outer space. Historically, the natural system of the greenhouse effect has been in equilibrium. Without the effect, the surface of the earth might look like the moon, which at about the same distance from the sun as the earth, receives roughly the same amount of radiation. The temperature on the surface of the moon is 212 degrees F (100 C) in the sunshine, but –238 degrees F (–150 C) in the dark, on average.

EARLY OBSERVATIONS

The greenhouse effect was first observed by French scientist Jean-Bapiste-Joseph Fourier. He described the earth atmosphere in 1827 as being like a glass vessel that retained heat. In the 1850s James Tyndall, a British physicist, analyzed the earth's atmosphere in order to identify the greenhouse gas. He was surprise to discover that neither oxygen nor nitrogen hold the sun's energy. Most of the earth's atmosphere is composed of nitrogen and oxygen. This meant that 99 percent of the earth atmosphere was not involved in the greenhouse effect.

In 1938 George Callendar, a British coal engineer, published a study of global weather readings including temperatures. He concluded that the earth's atmosphere was gradually getting warmer. He attributed the atmospheric warming to the burning of fossil fuels since the Industrial Revolution. Distracted by World War II and by a downspike in global temperatures from the 1940s until the 1970s, scientists ignored the issue of global warming, or better put, "global climate change." Those who did consider the subject thought that the oceans would absorb the additional carbon dioxide because the oceans act as a carbon sink as great quantities of vegetation and animals sink to its depths.

During the Geophysical Year (1957–58) measurement of carbon dioxide were made Charles David Keeling of California, who developed a device for measuring in parts per million the amount of carbon dioxide in the atmosphere. He took reading from the top of the Hawaiian volcano far from an industry. His readings have been accumulated into the Keeling Curve, which since then have shown that the amount of carbon dioxide has increased significantly since the Industrial Revolution and that the amount in the earth's atmosphere is rapidly rising.

Carbon dioxide is part of the carbon cycle that is used by plants in photosynthesis. From tests done on ice core samples taken from Antarctica and Greenland that go back to 160,000 years ago it has been determined that carbon dioxide was present in the atmosphere at an average of 270 parts per million (ppm) until the advent of the Industrial Revolution. However, since then, carbon dioxide in the atmosphere has risen to around 380 ppm. The same increase is also happening with methane and other greenhouse gases. Their increases are predicted to cause global warming, which is better described as *global climate change*.

Scientists studying the greenhouse gases have noted that the infrared window is being "dirtied" by the increase in greenhouse gases. Some of these gases are much more absorbent of infrared radiation than is carbon dioxide—in the case of methane, 30 times as absorbent. Added to the increase in gases is global deforestation, and the increased use of nitrous oxide as a fertilizer.

Climate models are forecasting major global climate changes if the increases in greenhouse gases are not stopped. Some of the increases will be from human industrial or agricultural sources. Others such as the melting of the permafrost in the Arctic region will release huge quantities of carbon dioxide and methane from bacterial action on thawed plants.

SEE ALSO: Green Chemistry; Green Movement; Greenhouse Gases; Industrial Revolution.

BIBLIOGRAPHY. Ronald F. Abler, *Global Change and Local Places: Estimating, Understanding and Reducing Greenhouse Gases* (Cambridge University Press, 2003); R.F. Follett. R. Lal, and J.M. Kimble, *Potential of U. S. Grazing Lands to Sequester Carbon and Mitigate the Greenhouse Effect* (CRC Press, 2000); Martin H. Halmann and Meyer Steinberg, *Greenhouse Gas Carbon Dioxide Mitigation: Science and Technology* (CRC Press, 1998); Ann Henderson-Sellers and Russell J. Blong, *The Greenhouse Effect: Living in a Warmer Australia* (UNSW Press, 1989); Chang-Jun Liu, M. Aresta, and Richard G. Mallinson. eds., *Utilization of Greenhouse Gases* (American Chemical Society, 2003); Patrick J. Michaels, ed., *Shattered Consensus: The True State of Global Warming* (Rowman & Littlefield Publishers, 2006); Roland Paepe and R. W. Fairbridge, eds., *Greenhouse Effect, Sea Level and Drought* (Springer-Verlag, 2002); Darlene R. Stille, Robert Davis, and Terrence E. Young, *Greenhouse Effect: Warming the Planet* (Capstone Press, 2006).

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Greenhouse Gases

THE EARTH SURFACE absorbs energy from the sun and radiates it back into the atmosphere. So-called *greenhouse gases* are gases that, when present in the atmosphere, form a layer of insulation that traps the earth's outgoing heat. This causes the earth's overall temperature to become warm, a phenomenon originally known as the *greenhouse effect,* now more frequently called *global warming* or *global climate change*. The latter is a broader term that includes other atmospheric changes besides the greenhouse effect. Principal greenhouse gases include carbon dioxide (CO_2), methane (CH_4), ozone (O_3), chlorofluorocarbons (CFCs), Nitrous oxides (N_2O) and sulfur hexaflouride (SF_6). While greenhouse gases are entering the atmosphere from both natural and human origins (the latter known as anthropogenic), the increase in human origins of such gases is most significant, and is thus driving the overall change in climate.

Atmospheric concentration of greenhouse gases has increased over the last century due to industrial and agricultural activity. The most significant greenhouse gas by volume is carbon dioxide. This is released into the atmosphere through the burning of fossil fuels (oil, natural gas, and coal) in vehicle exhaust, coal fired power plants, and industry. Similarly, methane concentrations have increased as a result of the production and transportation of fossil fuels, rice paddy farming, livestock production, and emissions from municipal solid waste landfills. Nitrous oxide is released from agricultural and industrial activities, and the combustion of both fossil fuels and solid waste.

Each greenhouse gas has a different per-molecule capacity for heat absorption. Methane traps over 21 times more heat per molecule than carbon dioxide, and nitrous oxide absorbs 270 times more heat per molecule than carbon dioxide. CFCs are also more powerful than carbon dioxide, however, emissions of CFCs have decreased significantly since the Montreal Protocol. There is significant public confusion between greenhouse gases that contribute to global climate change and gases that contribute to ozone depletion. This confusion is magnified by the fact that chlorofluorocarbons (CFCs) contribute to both ozone depletion and climate change.

REGULATION OF GREENHOUSE GASES

International coordination to reduce global climate change has been highly politically charged. This is in part because nations from around the world have very different levels of carbon dioxide emissions and will face different degrees of impact from the changing climate. In addition to national governments, oil companies and environmental organizations are involved in negotiations. Issues of contention have included extent of overall emissions by each nation, process for emissions reduction and the degree to which nations meet targets by using "carbon-removal" methods such as planting forests versus reducing actual emissions. International collaborative efforts on climate change began as far back as 1979 with the the first World Climate Conference in Geneva.

In 1992, the United Nations Framework Convention on Climate Change was adopted at the World Conference on Environment and Development in Rio de Janeiro. Signatory nations agreed to reduce and inventory emissions and to mitigate for climate change. Developed countries and countries with economies in transition were required to reduce their greenhouse gas emissions to their 1990 levels by the end of 2000. This commitment was voluntary, however, rather than binding. The convention was ratified by the United States and went into effect in 1994.

Voluntary commitments were not leading to emissions reductions, thus after years of highly charged international negotiations, the Kyoto Protocol went into effect in 2005. Under the Kyoto Protocol, industrialized nations are committed to legally binding reductions in greenhouse emissions between 2008–12. Included are provisions for emissions trading among nations and so called "clean development mechanisms," which encourage industrialized nations to transfer technology that would reduce emissions to developing countries. Conflict over many issues, especially the responsibility of China and India for greenhouse emission reduction, was significant. Furthermore, the Kyoto Protocol went into effect without the ratification of the world's largest emitter of greenhouse gases, the United States. In 2001 George W. Bush rejected the Kyoto Protocol on the basis that it was too costly for the U.S. economy, proposing instead a highly criticized plan that focuses on voluntary reductions in emissions, tax credits for emissions reductions, and increased research and development for new energy technologies. In contrast to the 7 percent reduction that would have been required under the Kyoto Protocol, this plan allows for a 12 percent increase in greenhouse gas emissions by 2012 and has provided no mechanism for ensuring that this target will be met.

SEE ALSO: Global Environmental Change; Global Warming; Kyoto Protocol; Montreal Protocol.

BIBLIOGRAPHY. A. Agarwal, S. Narain, et al., *The Global Commons and Environmental Justice-Climate Change. Environmental Justice* (Transaction Publishers, 2002); Bruce Johansen, *The Global Warming Desk Reference* (Greenwood Press, 2002); L. Pinguelli-Rosa and M. Munashinghe, eds., *Ethics, Equity and International Negotiations on Climate Change* (Edward Elgar, 2002); S. Raynor, E. L. Malone, et al., *Equity Issues and Integrated Assessment. Fair Weather? Equity Concerns in Climate Change* (Earthscan Publications, 1999); D. Victor, *The Regulation of Greenhouse Gases: Does Fairness Matter? Fair Weather? Equity Concerns in Climate Change* (Earthscan Publications, 1999).

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Greenpeace

GREENPEACE IS AN international environmental organization that pioneered environmental direct-action tactics and has gone on to become one of the largest and most important global forces in the name of environmental protection. Greenpeace, which takes its name from its dual concerns of antimilitarism and environmentalism, was founded in Vancouver, British Columbia, in 1971. It was one of several new environmental organizations to grow out of the New Left activism of the 1960s, and it adopted a decidedly more confrontational approach to environmental protection relative to the conservation organizations that preceded it.

Its first action was characteristic of the tactics and style that would come to define the organization. A number of activists, along with invited journalists, sailed an old fishing vessel toward the Aleutian Island of Amchitka north of Alaska with the intent to draw attention to the underground nuclear testing that was being conducted by the United States in that area. Although the contingent was intercepted by U.S. forces and never reached the testing zone, the incident received a great deal of publicity and the activists successfully brought the issue of nuclear testing to the world's attention. International pressure spawned by Greenpeace actions eventually brought an end to nuclear testing in the Aleutians.

Using the Quaker notion of "bearing witness," Greenpeace activists would continue to use nonviolent civil disobedience to draw attention to practices that threatened the environment. Although some were critical of the masculinist organizational culture associated with the focus on daring stunts, the group's actions continued to attract media attention and win public support. For its first decade these actions focused primarily on nuclear issues and the protection of ocean mammals. Greenpeace activists campaigned against seal hunts and the whaling industry, sometimes placing themselves between whaling vessels and their prey.

HIGH-PROFILE TACTICS

Inspired by their high-profile tactics, new Greenpeace chapters were formed throughout the 1970s. But these remained largely autonomous and loosely joined during this period. Although there were internal conflicts about focusing on action versus formalizing the organization, in 1979 the six existing chapters were brought together more formally as Greenpeace International.

During the 1980s, Greenpeace expanded its agenda beyond oceans and nuclear testing to include issues such as energy and toxic waste. It was also during this period that Greenpeace was targeted by the French Secret Service. In 1985, French agents planted a bomb and sunk the Greenpeace vessel, the *Rainbow Warrior,* while it was docked in New Zealand. One crew member was killed. The incident received international attention and support for the organization grew significantly.

Greenpeace has played a central role in advancing a number of environmental causes. Its campaigns against nuclear testing and the ocean dumping of nuclear waste led to international treaties that banned many such practices. The group was also instrumental in achieving a ban on commercial whaling. In addition, Greenpeace played an important role in the protection of Antarctica. In 1983 it was among the first major environmental organizations to call for the protection of the undeveloped continent. In part as a result of their work on this issue, the 1991 Madrid Protocol to the Antarctic Treaty banned resource extraction from the region. Greenpeace also successfully campaigned to ban the production of chlorofluorocarbons (CFCs), gasses that deplete the ozone layer of the earth's atmosphere. Current campaigns include climate change, forests protection, fair trade, toxics use reduction, and the elimination of genetically modified organisms.

Greenpeace continues to work on nuclear issues. They have dramatized the security threats at nuclear plants, utilizing classic civil disobedience tactics that they pioneered in the 1970s. In 2002, Greenpeace activists easily gained access to and occupied the Sizewell nuclear facility in Britain vividly demonstrating before the media and the world that nuclear facilities are not secure.

Today, Greenpeace International is headquartered in Amsterdam, and has offices in over 40 nations. Organizationally, it incorporates elements of different types of environmental movement groups, which usually specialize in either professional lobbying and litigation or grassroots tactics. Greenpeace continues to be run by professional staff with little grassroots participation beyond letter writing. Direct action media events are carried out by a handful of trained activists. But professional staff members also carry out lobbying and litigation as well as international diplomacy. Although the organization is hierarchically structured, chapters retain a good deal of autonomy and are therefore able to respond quickly to local developments.

The organization is funded through foundation grants and individual contributions. Although no formal membership exists, contributors number over 2.8 million and many more participate in Greenpeace letter writing and Internet lobbying campaigns. Greenpeace continues to be a significant voice in international environmental politics.

SEE ALSO: Animal Rights; Antarctica; Chlorofluorocarbons; Ecotage; Genetically Modified Organisms; Nuclear Power; Nuclear Weapons; Whales and Whaling.

BIBLIOGRAPHY. William K. Carroll and R.S. Ratner, "Media Strategies and Political Projects: A Comparative Study of Social Movements," *Canadian Journal of Sociology* (v.24/1, 1999); Peter Dykstra, "Greenpeace," *Environment* (v.28/6, 1986); Robert Gottlieb, *Forcing the Spring* (Island Press, 1993); Greenpeace International (homepage), www.greenpeace.org (cited April 2006).

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Gross National Product (and GDP)

GROSS NATIONAL PRODUCT (GNP) is one of the most comprehensive measures of the overall amount of economic production taking place in a national economy. The first set of national accounts, prepared under Simon Kuznets, Nobel Prize Laureate in Economics, was presented to the United States in 1937. Kuznets helped the U.S. Department of Commerce to standardize the measurement of GNP.

Since World War II, GNP has been regarded as the most important indicator of the status of an economy. GNP is the sum of the different kinds of earnings permanent residents receive in a given country, plus any income earned by residents from investments abroad such as profits, interests, and royalties. While Gross Domestic Product (GDP) measures economic activity within a country's borders, the GNP measures the total income of a country's population. It adds rents, interest, and profits and dividends flowing into the country to GDP, while deducting rents, interests, and profits and dividends paid out to foreigners. At present, GDP is preferred to GNP because policy makers are usually interested in the level of economic activity within a country's borders. In most cases, GDP and GNP are approximately equivalent, although for some countries with a large foreign presence, such as Ireland, GNP is the preferred measure.

GNP in economics is a quantitative measure to assess a country's total economic activity. The GNP equals the GDP plus income earned by domestic residents through foreign investments, minus the income earned by foreign investors in the domestic market. GNP at current market prices is equal to gross national product at factor cost plus taxes on expenditure less subsidies. It represents the total expenditure on the output of goods and services of the national economy valued at the prices at which the expenditures are incurred. The expenditure is made up of personal expenditure on consumers' goods and services, net expenditure by central and local government on current goods and services, gross domestic physical capital formation (comprising fixed capital and stocks), and net expenditure by the rest of the world on goods and services originating in a given country, plus net factor income from the rest of the world. Economic and political life revolves around the GNP.

LIMITATIONS OF GNP

The GNP system has three main limitations. First, if there is no transaction, it doesn't affect the overall economy (GNP excludes nonmarket activities). All nonmarket activities are based on production and consumption that occur outside the market economy. Volunteer work and child care are two contributors to the economy that are not included in the GNP. Second, if there is no money involved, GNP is not concerned. Nonfinancial transactions receive no credit within the GNP system because the GNP is a measure of the movement of money through a national economy. For example, grandparents are the second largest group of child care providers, but their contribution receives no recognition within the GNP calculation, because they do not receive payment for their effort. Third, there are no value judgments on the market transactions. The GNP is simply a measure of financial transactions; it makes no value judgment on whether the transactions were socially useful. Crime and car accidents increase the GNP because of increased work for police, ambulances, and prisons. A reduction in crime reduces the GNP. The GNP contains no information about justice or social capital. Other limitations are that greater access to knowledge, better nutrition and health services, security against crime and physical violence, political and cultural freedoms, and so on are not fully captivated in the GNP.

As a specific measure of economic performance relative to the environment, the GNP is an especially poor indicator. Growth in GNP cannot in any way measure the concomitant impact that increased economic activity may have on the environment. Ironically, disasters such as bushfires, earthquakes, volcanoes, floods, and snowstorms boost the GNP, by driving expenditures for recovery and management. The GNP measures environmental damage only if people pay to clean it up. High levels of waste (or "throughput") in the economy, where consumers dispose of still-useful goods (washing machines, cars, etc.) to purchase new models also boosts the GNP, while actually representing poor ecological efficiencies. In many societies, the GNP is increasing while the condition of the environment is deteriorating.

While the GNP concept has many limitations, at the time of its creation, it was a major breakthrough in the development of system of national accounting. It has since enabled economic comparisons to be made between countries, and allowed governments and individuals to think more globally in an efficient way. Efforts to develop more robust "green" indicators for national income accounting are ongoing, however. By folding in measures of efficiency, deforestation, human development, or carbon production, alternative economic indicators in the future may better capture the trade offs between economic growth and environmental protection. Until then, GNP must be used with caution as an indicator of progress.

SEE ALSO: Capitalism; Economics; Environmental Accounting; Moral Economy; Research Methods.

BIBLIOGRAPHY. V. Anderson, *Alternative Economic Indicators* (Routledge, 1991); R.W. England and J.M. Harris, "Alternatives to Gross National Product: A Critical Survey" in Frank Ackerman et al., eds., *Human Well-Being and Economic Goals* (Island Press, 1997); Christian Leipert, "A Critical Appraisal of Gross National Product: The Measurement of Net National Welfare and Environmental Accounting," *Journal of Economic Issues* (v.21, 1987).

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Groundwater

GROUNDWATER IS UNDERGROUND water found in the pore spaces and cracks of soil, sand, and rock. The source of all groundwater is precipitation, either through direct percolation into the earth's surface, or through replenishment from local surface water including lakes, ponds, wetlands or rivers. Sometimes groundwater also flows into surface water through a process called baseflow. The process of groundwater replenishment is termed *recharge*.

Groundwater is stored in and moves at varying speeds through aquifers. An aquifer is a water-bearing geologic formation that can store and yield usable amounts of water, and consist of permeable layers of soil, sand, gravel or fractured rock such as granite or limestone. They are classified according to type, areal extent, thickness, yield, and direction of groundwater movement. There are two types of aquifers: consolidated rock and unconsolidated rock. Consolidated rock aquifers are composed of limestone, sandstone or other rock. Some, such as granite, are almost impervious and yield very little water, while others, such as limestone, are very porous and can yield vast amounts of water. Unconsolidated rock aquifers are composed of granular materials such as sand and gravel and typically yield larger amounts of water.

Aquifers are also confined or unconfined. Unconfined aquifers are typically located near the land surface, are composed of permeable materials such as sand or gravel, and recharge quickly, making them susceptible to contamination. The area of the aquifer that is filled with water is termed the *saturation (*or *saturated) zone*; the top of the saturation zone in an unconfined aquifer is termed the *water table* or *phreatic surface*, where water pressure equals atmospheric pressure. The area between the saturation zone and the land surface is the *vadose zone*.

Confined or artesian aquifers are typically located at greater depths and below impermeable layers such as rock or clay. They are typified by little or no recharge. For this reason, they often contain what is termed fossil or geologic water, and are thus susceptible to mining. Groundwater mining occurs either when groundwater extraction exceeds recharge (as in unconfined aquifers) or when groundwater will not be recharged naturally as in most confined aquifers. Artificial recharge is also possible either through the direct injection of water into the subsurface as in California or through directed rainwater recharge as is increasingly common in northern India.

Contrary to popular myth, groundwater does not flow in rivers or channels beneath the earth's surface. The one exception is with Karst topography. Karst (an area of Slovenia) topography is where the solution of limestone, dolomite, gypsum, or marble, creates very erodable areas on the land surface or underground. It is possible for water to flow through the underground caverns created through this process. Karst is found in the U.S. states of Florida, Texas, and Kentucky, and in China, Slovenia, and Turkey.

Groundwater flows through aquifers toward lower elevations through the force of gravity. In confined aquifers, however, groundwater can flow up gradients, causing artesian conditions, where groundwater flows to the surface due to pressure created through the confined character of the aquifer. This occurs along the foothills of the Rocky Mountains in the United States, but is also common in other areas.

The source of all groundwater is either precipitation or through replenishment from local surface water.

The largest aquifer in the United States is the Ogallala Aquifer (also called the High Plains Aquifer). It is an unconfined aquifer located in the states of South Dakota, Wyoming, Nebraska, Kansas, Colorado, Oklahoma, Texas, and New Mexico. The thickness of this aquifer ranges from 1 (0.3 meters) to 1300 feet (396 meters) and covers an area of 175,000 square miles (453,250 square kilometers). The Ogallala is used mostly for irrigation, especially in the Southern High Plains, but also supplies water to many cities. It irrigates 20 percent of total irrigated area in the United States, or 11,000 square miles (28,490 square kilometers), with a yearly discharge of 12 billion cubic meters of water. It has been heavily mined in Texas, with smaller declines occurring in other states. The future viability of the Ogallala is threatened due to overdraft.

In many parts of the world, including parts of the United States, Europe, Australia, Southwest Asia (i.e., the Middle East), Mexico, China, and India, groundwater is overexploited, with extraction surpassing recharge. This is of serious concern as groundwater is highly relied upon throughout the world. For example, it provides 51 percent of all drinking water in the United States, and in India supplies 70 percent of irrigation water and 80 percent of its domestic water. The largest user of groundwater in the world is irrigation. The advantages of groundwater over surface water for drinking and irrigation purposes are many: it is reliable in dry seasons and during droughts; it is cheaper to develop, since when unpolluted it requires less treatment than surface water and can be tapped by individuals, decentralizing costs to individuals; and it can be tapped when and where needed, such as at the household level, reducing expansion (of capacity) and conveyance costs.

There are several concerns, however, with this massive reliance on groundwater. The first is overexploitation. Second, groundwater is very susceptible to contamination. Contamination is both human-induced (anthropogenic) and due to naturally occurring minerals. Anthropogenic causes of groundwater contamination include gasoline, oil, road salts, storage tanks, septic systems, hazardous waste sites, landfills, and industrial chemicals. One gallon of gasoline (3.8 liters) can contaminate one million gallons (3.8 million liters) of groundwater, making it unsuitable for drinking purposes. Furthermore, it is estimated that over 10 million underground storage tanks and over 20,000 abandoned hazardous waste sites exist in the United States. Naturally occurring sources of contamination include arsenic and fluoride. Arsenic contamination is a major source of groundwater contamination in the Ganges Plain of Bangladesh and northern India. As groundwater is withdrawn, naturally occurring mineral concentrations can increase, making groundwater unfit for human consumption or for irrigation. Third, saltwater intrusion may occur in coastal areas as groundwater withdrawal alters normal groundwater flow, inducing seawater to flow into nonsaline aquifers. Fourth, excessive groundwater withdrawal can cause the land surface to subside as it has in Mexico City, and in New Orleans, Louisiana, and Las Vegas, Nevada. Fifth, in many areas excessive groundwater withdrawal is substantially reducing baseflow to wetland and riparian areas, adversely impacting riverine and riparian species of flora and fauna. This has sparked fierce debate in the Platte River and the Ogallala Aquifer system in Nebraska, and also in the Edward's Aquifer and San Antonio River system in Texas. And finally, these issues all lead to the matter of groundwater governance.

Grounded in Ancient History

Groundwater use and exploitation has an ancient social history. Egyptians, Chinese, and Persians constructed wells as early as 2000 B.C.E. During this period, the Chinese dug wells as deep as 3,000 feet deep with drill bits constructed of bamboo. Qanats, which are human-built systems that tap underground mountain water sources and then transport this water underground often several kilometers, date back 2,500 years. They probably originated in Iran but then spread to Afghanistan, Africa, Europe (Spain), China, and South America. In India, within the Hindu caste system, entire castes called the Beldar are historically devoted to digging wells. Similarly, various forms of water dowsers (or diviners) abound in multiple societies. Also in India, informal institutions have evolved for the sharing and management of groundwater and wells.

GOVERNANCE OF GROUNDWATER

The greatest challenge for the 21st century facing groundwater is one of governance. When the first laws were created for water use, surface and groundwater were thought to be distinct. Historically, therefore, laws governing the use of surface and groundwater have treated these two separately, even though they are connected. This, in part, has led to a confusing set of legal institutions governing groundwater. Further complicating water law is the lack of legal standing for nonhuman uses, such as in-stream flow needs of fish and other flora and fauna.

Multiple formal and informal institutional arrangements have evolved for the management of groundwater. In the United States, groundwater regulation is the domain of individual states. Regulatory and rights structures vary by state, with much of groundwater management resting with local institutions as in Nebraska and Texas. There are four categories of groundwater rights in the United States. States east of the 100th meridian follow the Doctrine of Riparian Rights, while those west of the 100th follow the Colorado Doctrine (strict Prior Appropriation) as practiced in New Mexico; the California Doctrine (Correlative Rights Principle—a combination of riparian rights and prior appropriation) as practiced in California and Nebraska; or Absolute Ownership, as practiced in Texas.

The Colorado Doctrine of strict prior appropriation allows a landowner to use water based on historical precedent: "first in time, first in right." The amount of water provided with a water right is based on the amount of water historically diverted and put to beneficial use: "use it or lose it."

The California Doctrine applies the concept of "reasonable and beneficial use." The appropriative right/use must be deemed economically beneficial; otherwise, a riparian user has the right to co-opt its use. For example, a rancher using water to irrigate alfalfa could lose their right to water if an industry could produce more capital with it. This differs from strict prior appropriation in that it distinguishes by use, where as strict prior appropriation does not.

Groundwater rights in Texas are based on absolute ownership and the "right of capture." Under absolute ownership, the "landowner owns everything on his or her property from the land surface, up to the heavens, and down to the center of the Earth." In theory, there are no limitations on pumping for the current or future based on current or past use, and it is legal to sell groundwater. In Texas, local institutions have formed for the management of groundwater. The High Plains Water Conservation District Number 1 (HPUWCD) is one such local organization. Comparisons of the New Mexico state centered model with the Texas self-organized model of groundwater management indicate that state-managed groundwater usage is not superior to self-organized local management of the HPUWCD.

The most recent iteration of the debate surrounding the governance of groundwater boils down to essentially whether it is a public or a private good. Historically, water has been thought of as a public good, held in the public trust, for the use of all people for consumption, sanitation, aesthetic values, and environmental protection. Viewed as a private good, water can be developed, used, traded, and sold for economic productivity and financial gain. It is this latter view that is gaining currency around the world.

Under this second view, proponents follow the logic of Garret Harding that groundwater is an open access resource and is subject to the "Tragedy of the Commons." They argue that private property rights over groundwater should be established yielding transferable or tradable rights that under the laws of supply and demand will inevitably move water toward the highest value uses, while preventing the problem of open access. But to think of groundwater or any resource as open access is to ignore that they are actually common pool resources and are subject to localized rules of use and institutions, which govern their use, distribution, and protection. Furthermore, it is problematic because uses such as irrigation will always have lower value added than industrial production, shifting water away from important primary commodity production. This would have drastic effects in developing countries such as India, where peasant producers rely on small plots of land and groundwater irrigation, the rights to which would probably be transferred to a higher economic use. Similarly, in a market-based system there is little incentive to protect stream flows or others' property through reduced groundwater pumping. Groundwater is both a private and public resource. The solution is not, therefore, in either extreme but somewhere in the middle, taking into account local context and the local historical development of groundwater management expertise and institutions.

SEE ALSO: Prior Appropriation; Public Trust Doctrine; Riparian Areas; Riparian Rights; Tragedy of the Commons.

BIBLIOGRAPHY. The American Groundwater Trust, "The American Groundwater Trust," www.agwt.org (cited May 2006); E. Brooks and J. Emel, *The Llano Estacado of the U.S Southern High Plains: Environmental Transformation and the Prospect for Sustainability* (United Nations University Press, 2000); Thomas Cech, *Principles of Water Resources: History, Development, Management, and Policy* (John Wiley & Sons, 2005); The Groundwater Foundation, "The Groundwater Foundation: Educating and Motivating People to Care for and About Groundwater," www.groundwater.org (cited May 2006); M. Rosegrant, X. Cai, et al., *Global Water Outlook to 2025: Averting an Impending Crisis.* (United Nations, 2002); United States Geological Survey, "Groundwater Information," water.usgs.gov (cited May 2006); World Bank "India: Bracing for a Turbulent Water Future," www.worldbank.org (cited May 2006).

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Guam

THE ISLAND OF Guam, located in the Western Pacific Ocean, forms the southern tip of the Mariana Archipelago. Guam is an unincorporated U.S. territory. While just larger than 200 square miles (518 square kilometers), it is the biggest and most economically developed island in Micronesia. With a year-round population around 160,000 and more than a million tourists annually, Guam is also the most populous island in the region.

Ferdinand Magellan landed on Guam in 1521 and Spain claimed the island in 1565. The native

Chamorro population, known for seafaring, hunting, and weaving, frequently rebelled against Spanish rule. There was considerable bloodshed as the Spaniards assumed power, followed by loss of life from diseases such as smallpox and influenza. Nevertheless, Chamorro culture remains strong. In the 2000 census, more than one-third of the total population of Guam claimed Chamorro ethnicity. Chamorro joins English as an official language on the island.

Spain ceded the island to the United States in 1899. Japan briefly invaded Guam in 1941, but by 1944 the United States regained control. July 21 is celebrated as Liberation Day, but as much as 80 percent of the structures on the island were destroyed in combat. Japan's wartime crimes were largely left uncompensated. A World War II Loyalty Recognition Act was introduced into the U.S. House of Representatives in 2005, but passage remains uncertain.

The island population voted in 1982 to become a U.S. Commonwealth, like the Northern Mariana Islands, but its status has not changed. Guam remains militarily and politically important for the U.S. position in the Pacific. Residents do not pay taxes to the United States, but around $1 billion is transferred to Guam from the U.S. government annually. Guam's currency is the U.S. dollar. Most food and industrial goods are imported. The island's economy is largely dependent on Japanese tourism and U.S. military bases. Guam's motto is "where America's day begins," due to the Chamorro Standard Time Zone.

The creation of Apra Harbor after World War II required significant ecological change. It is the only deep lagoon in the Marianas. The breakwater was built on top of reefs, and banks were formed to enclose the channel. The inner harbor requires frequent dredging. Artificial shorelines were also created. Guam's transportation infrastructure, such as the harbor, continues to be important to the United States, which plans to expand the island's military facilities.

Environmental policies on Guam have historically not been well monitored. A broad spectrum of environmental contaminates have been identified on former U.S. defense sites and active instillations. A currently unresolved issue is compensation for exposure to nuclear testing. Guam is downwind from the Marshall Islands, a testing site. The island's harbor was also used for the decontamination of boats used in the atomic tests. The U.S. Environmental Protection Agency (EPA) has recovery plans for some threatened species, such as a local fruit bat and the Mariana crow. The island is often used as an example of bioinvasion. The brown tree snake was introduced on military ships and decimated native fauna. The snake is an apt climber and a generalist predator. Scientists believe that some island prey did not instinctually flee because they evolved largely without predators.

SEE ALSO: Coral Reefs; Endangered Species; First Nations; Indigenous Peoples; Invasive Species; Nuclear Weapons; Radioactivity.

BIBLIOGRAPHY. James Brooke, "Decades after Abuses by the Japanese, Guam Hopes the U.S. Will Make Amends," *New York Times* (August 14, 2005); Thomas H. Fritts and Gordon H. Rodda "The Role of Introduced Species in the Degradation of Island Ecosystems: A Case History of Guam," *Annual Review of Ecology and Systematics* (v.29, 1998); Robert F. Rogers, *Destiny's Landfall: A History of Guam* (University of Hawaii Press, 1995); U.S. General Accounting Office, *Environmental Cleanup: Better Communication Needed for Dealing with Formerly Used Defense Sites in Guam* (April 2002).

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Guatemala

WITH AN AREA of 42,085 miles (109,000 square kilometers), Guatemala is largest country in Central America. It is bordered by Mexico, Belize, Honduras, and El Salvador, as well as the Pacific Ocean and the Caribbean Sea. The climate and topography range from the hot and humid tropical lowlands of the northern Petén region and the narrow southern coast to the cooler mountainous regions of the west. With the largest tropical rain forest in Central America, Guatemala also has a diversity of flora and fauna increasingly being threatened by deforestation and pollution.

Guatemala lies in the heart of classic Mayan civilization, which flourished from about 800 B.C.E. to 900 C.E., with the rise and eventual collapse of great cities like Tikal. Following the Spanish conquest in 1524, the colonial government ceded vast tracts of land for agricultural production with forced indigenous labor. After Guatemala gained independence in 1821, a series of governments expanded to new cash crops like coffee and bananas, creating wealth for a rising elite class. Nevertheless, the coercive agricultural export model heightened economic inequality and repression was utilized to quell growing social unrest. An increasingly volatile political climate after 1954 led to 36 years of civil war, which ended with the signing of a peace accord in 1996.

Today, 40 percent of Guatemala's 12 million people live in urban areas, including the capital, Guatemala City. The official census shows that 60 percent of the population is of mestizo (mixed) descent with the other 40 percent comprising indigenous, largely Mayan groups. Other estimates assert the indigenous population is much larger. Fifty percent of the active adult population is involved in agricultural production including sugarcane, corn, bananas, coffee, and livestock.

Dropping prices for coffee, the country's largest export crop, have led to intensification of production and efforts to grow for organic and fair trade markets. Corn, in particular, has strong economic, social, and cultural importance for subsistence use. Guatemala City is the industrial center, manufacturing textiles, furniture, and chemicals. Petroleum and mining are also important although the biggest industry has quickly become tourism.

Redemocratization has signaled a number of changes. It opened avenues for social mobilization around a broad set of socioeconomic and environmental issues, and political stability led to renewed efforts in the promotion of economic growth through major infrastructure projects like Plan Puebla Panama. Although created under the guise of sustainable development, individual projects have stirred controversy. These include a series of hydroelectric dams proposed for the Usumacinta River, on the northwestern border of Guatemala with Mexico, which could displace 50,000 people as well as flood Mayan archaeological sites and the most biologically diverse areas of the country. The euphoria of the peace accords a decade earlier has subsided with the realization of the difficult tasks ahead. Rain forests in the Petén are being destroyed at some of the highest rates in the world for ranching and petroleum exploration. The Central American Free Trade Agreement (CAFTA) was signed in March 2005, amidst intense street protest over a host of environmental and socioeconomic concerns, among these the future of subsistence agricultural production. Social mobilization continues to mount despite violence against political activism reaching an alarming rate.

SEE ALSO: Bananas; Coffee; Deforestation; Floods and Flood Control; Hydropower; Indigenous Peoples; Rain Forests; Subsistence; Tourism; Trade, Fair; Trade, Free.

BIBLIOGRAPHY. Arturo Arias, in Carol Smith, ed., *Guatemalan Indians and the State: 1540–1988* (Latin American Studies Association, 1990); CIA, *The World Factbook,* "Guatemala," www.odci.gov/cia/publications/factbook/docs/history.html (cited April 2006); James Dunkerley, *Power in the Isthmus: A Political History of Modern Central America* (Verso, 1988); Susanne Jonas, *Of Centaurs and Doves: Guatemala's Peace Process* (Oxford University Press, 2000).

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Guha, Ramachandra (1958–)

RAMACHANDRA GUHA IS a social historian of environmental change. Trained as a sociologist, he has also been called an anthropologist, ecologist, journalist, and historian. Born in Dehradun, India, in 1958, Guha studied at St. Stephen's College, Delhi, and took his doctorate at the Indian Institute of Management, Calcutta. Between 1985–95 he held academic positions in India, Europe, and North America. Since 1995 he has been a full-time writer based in Bangalore, India.

Ramachandra Guha's first book, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya* (1989), is a social history of the Himalayan forests, from the 19th century to the Chipko movement in the 1970s and 80s. This seminal study explores the intersection of ecology, social structure, and peasant politics. Guha shows how the Chipko movement, in which Himalayan villagers protected their traditional forests from industrial loggers by hugging the trees, is part of a century of protests by villagers. For Guha, this contemporary environmental crisis in the Himalayas is not a new phenomenon, but a new expression of old peasant resistance against the ruling elite.

In *Varieties of Environmentalism: Essays North and South* (1997), Guha and Juan Martinez-Alier examine environmental philosophies around the world. The authors maintain that it is a mistake to see environmental movements only through the lens of the United States, where environmentalism is a middle-class concern for nature protection and is seen as a consequence of affluence rather than poverty. By looking at the "environmentalism of the poor," they show that environmental struggles in southern countries are about control over the land, forest, and water resources needed for subsistence livelihoods.

This book challenges the long-held twin beliefs that the United States is the home of the pioneers of environmental thought—such as Henry Thoreau, John Muir, and Aldo Leopold—and that the protectionist paradigm of wilderness conservation is the only valid global model. In sum, this book presents a very different view of environmental concerns and priorities in the Southern Hemisphere.

One of Guha's most influential essays, *Radical American Environmentalism and Wilderness Preservation* (1989) has been reprinted in more than a dozen anthologies on society and the environment. Here he decries what he calls the "imperialist manifesto" associated with northern conservation agendas as they are forced on southern countries. Guha feels this preoccupation with wilderness preservation compounds the neglect by the American environmental movement of more pressing environmental problems in the third world.

Guha's work contributes to two critical issues in environmental studies: how do we theorize the intersection of society and nature? And how can marginalized voices (ironically often the voices of the people most dependent on nature for survival) be brought into mainstream thinking on environmentalism? He worries that creative voices in the developing world are being pushed out of the current dialogue. By amplifying these marginalized voices, Guha challenges the assumption that the northern ideology of environmentalism is the best way to achieve sustainable resource use at a global scale.

Guha cautions contemporary environmentalists against extremist positions that demonize industry, government, and markets. Instead, to balance conservation with development, they need to work toward the ideals of economic efficiency, social equity, and ecological stability. Guha's idea of balancing ecology with social justice is best summed up in a poem by Cheradanaraju, used as the epigraph to *Ecology and Equity*, which Guha coauthored with Madhav Gadgil:

I will not stop cutting down trees
Though there is life in them
I will not stop plucking out leaves,
Though they will make nature beautiful
I will not stop hacking off branches,
Though they are the arms of a tree
Because—
I need a hut.

SEE ALSO: Chipko Andolan Movement; Environmentalism; Equity; Ideology; Justice; Subsistence.

BIBLIOGRAPHY. Madhav Gadgil and Ramachandra Guha, *Ecology and Equity* (Routledge Press, 1995); Madhav Gadgil and Ramachandra Guha, *This Fissured Land: An Ecological History of India* (Oxford University Press, 1992); Ramachandra Guha, "The Authoritarian Biologist and the Arrogance of Anti-Humanism: Wildlife Conservation in the Third World," *Ecologist* (v.27/1, 1997); Ramachandra Guha, *Nature's Spokesman—M. Krishnan and Indian Wildlife* (Oxford University Press, 2002); Ramachandra Guha, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya* (University of California Press, 1989); Ramachandra Guha, "Radical American Environmentalism and Wilderness Preservation," *Environmental Ethics* (v.11/1, 1989); Ramachandra Guha and Juan Martinez-Alier, *Varieties of Environmentalism: Essays North and South* (Earthscan Publications, 1997).

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Guinea

SINCE WINNING INDEPENDENCE from France in 1958, the Republic of Guinea has been ruled by only two presidents. The first of these, Sekou Toure, served until his death in 1984. General Lansana Conte succeeded to the presidency after Toure's death led to a military coup. He was returned to office in 1993 in Guinea's first democratic election. Guinea's population of 9,690,000 has expanded partially in response to the influx of 141,000 refugees from the politically tumultuous Ivory Coast, Liberia, and Sierra Leone. In response to situations in these countries, a panic over food shortages led to riots in local markets in Guinea. Despite natural resources that include half of the world's bauxite reserves, iron ore, diamonds, gold, uranium, hydropower, fish, and salt, Guinea is essentially an underdeveloped nation.

Less than 35 percent of Guineans live in urban areas. Eighty percent of the population is engaged in the agricultural sector, mostly at the subsistence level. The mining industry is essential to the Guinean economy, providing 70 percent of export revenues. In 2003, most World Bank and International Monetary Funds were suspended. With a per capita income of $2,200, Guinea is ranked 175 of 232 nations in world incomes. Forty percent of Guineans live in poverty, and over a fourth of the population is undernourished. Income disparity results in the most affluent 10 percent of the population holding almost a third of the nation's wealth. The United Nations Development Program (UNDP) Human Development Reports rank Guinea 156 of 232 countries on overall quality of life issues.

Major social indicators reveal the vulnerability of the Guinean population. Life expectancy is low at 49.5 years. Infant mortality, on the other hand, is high at 90 deaths per 1,000 live births. The population is at risk from an HIV/AIDS prevalence rate of 3.2 percent that has killed 9,000 people since 2003. Only six percent of rural resident and 13 percent of all residents have access to improved sanitation. A little over half the population has sustained access to safe drinking water, but less than 40 percent of rural residents do so. Guineans experience a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever. Other threats come from schistosomiasis, a water contact disease, meningococcal meningitis, a respiratory disease, and Lassa fever—a disease caused by contact with infected aerosolized dust or soil. In some locations, high risks for contracting malaria and yellow fever also exist. With a fertility rate of 5.9 children per woman and a literacy rate of only 21.9 percent, life is particularly difficult for females.

Bordering on the North Atlantic Ocean, Guinea has a coastline of 320 kilometers. The sources of the Niger River and its tributary the Milo are located within the Guinean highlands. Guinea shares land borders with the Ivory Coast, Guinea–Bissau, Liberia, Mali, Senegal, and Sierra Leone. The terrain of Guinea is mostly flat coastal plain with a hilly to mountainous interior. Elevations range from sea level to 1,752 meters at Mont Nimba. The climate is hot and humid, with a monsoonal-type rainy season from June to November that is accompanied by southwesterly winds. From December to May, the dry season ushers in hot, dry, northeasterly harmattan winds that reduce visibility.

ENVIRONMENTAL DEGREDATIONS

Over several centuries, Guineans engaged in slash-and-burn agriculture that led to an annual deforestation rate of 1.14 by the mid-1990s. During the 1980s, approximately 89,000 acres were lost to such tactics, turning forests into woodland, grass, and bush and endangering plant and wild life. Irresponsible mining practices also led to major environmental damage, including pollution, soil erosion, and desertification. Guinea has a significant shortage of potable water and pollution caused by agricultural runoff and improper waste disposal further threatens water resources and leads to major health problems. Overfishing has threatened the food supply and damaged vulnerable marine ecosystems.

In 2006, scientists ranked Guinea 113 of 132 countries on environmental performance, in line with the relevant geographic group but below the relevant income group. The overall score was reduced because of the poor grade on environmental health. Over 28 percent of the land area of Guinea is forested, and the government brought over 100,000 hectares of forests under national protection in the early years of the 21st century, including the nature reserve on Mont Nimba. Of 190 endemic mammal species, 12 are endangered, as are 10 of 109 endemic bird species.

The National Directorate of the Environment is responsible for implementing and enforcing the environmental laws and regulations of Guinea. With an overall plan of achieving environmental sustainability, targeted goals include reducing poverty, improving health and education, increasing protected areas, and enhancing access to safe drinking water and improved sanitation. The National Directorate of Water and Forests is also involved in providing environmental assessment and in promoting sustainable forest management.

Through the government-sponsored Declaration of Policy on Land Tenure Security in Rural Areas and the activities of Non-Government Organizations and international groups, villagers have been trained in ways to practice sustainable development. Guinea participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Wetlands, and Whaling.

SEE ALSO: Guinea–Bissau; Ivory Coast; Sierra Leone.

BIBLIOGRAPHY. CIA, "Guinea," *World Factbook* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC–CLIO, 2003); ISAID, "Guinea: Global Climate Change" www.usaid.gov (cited April 2006); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); UNDP, "Human Development Report: Guinea," www.hdr.undp.org (cited April 2006); World Bank, "Guinea," www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Guinea–Bissau

THE REPUBLIC OF Guinea–Bissau has experienced several decades of political unrest since obtaining independence from Portugal in 1974. From 1980–99, the brutal regime of Joao Bernardo "Nino" Vieira was marked by repeated attempted coups and massive political unrest. Removed from office in 1999, Vieira returned to power in 2005 through the electoral process. With a per capita income of only $800 and hampered by a devastated infrastructure, Guinea–Bissau is the 13th poorest country in the world. Over half the population lives in abject poverty. There is massive income disparity, with the poorest 10 percent of the population sharing only 0.5 percent of the wealth. At the other end of the spectrum, 42.4 percent of resources are held by the richest 10 percent. The United Nations Development Programme's Human Development Reports rank Guinea–Bissau 172 of 232 countries on overall quality of life issues.

Around 82 percent of the work force in engaged in subsistence agriculture. Rice is the major crop and is the staple of most Guinean diets. Guinea–Bissau is the sixth largest producer of cashews in the world. While 34 percent of the population lives in urban areas, industrial activities are limited to processing agricultural products and manufacturing beer and soft drinks. The largely unexploited natural resources include petroleum, fish, timber, phosphates, bauxite, clay, granite, and limestone. Survival is largely dependent on budgetary support from the World Bank and the International Monetary Fund, which provided over 80 percent of the 2004 budget.

Bordering the North Atlantic Ocean, Guinea–Bissau has a 350 kilometer coastline and 8,120 square kilometers of inland water resources. Guinea–Bissau shares land borders with only two countries, Guinea and Senegal. Except for the savanna in the eastern section of the country, the terrain is covered by a low coastal plain that turns to swamps in the west. Elevations range from sea level to 300 meters at an unnamed location near the northern border with Guinea. The tropical climate of Guinea–Bissau is hot and humid with a monsoonal-type rainy season from June to December that is marked by southwesterly winds. The dry season from December to May produces the harmattan, a dry and dusty northeasterly wind that reduces visibility and creates major environmental damage.

DISEASE AND DEGREDATION

Environmental health is a major issue in Guinea–Bissau among the population of 1,442,000, partly because of the 10 percent adult prevalence rate of HIV/AIDS, which threatens Guineans who are already beset by poverty and disease. By 2001, some 1,200 Guineas had died from HIV/AIDS, and another 17,000 were living with the disease. The people of Guinea–Bissau have a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever as well as the respiratory disease meningococcal meningitis and the water contact disease schistosomiasis. In some areas, there is also a high risk of contracting vectorborne diseases such as malaria and yellow fever.

High disease rates in Guinea–Bissau have resulted in low life expectancy (46.87 years) and growth rates (2.07 percent) and high infant mortality (105.21 deaths per 1,000 live births) and death rates (16.53 deaths per 1,000 population). Guinean women birth an average of 7.1 children each. Trying to teach the population basic facts about environmental precautions that could prevent many diseases is made more difficult by low literacy rates of 27.4 percent for females and 58.1 for males and a combined school enrollment of only 37 percent.

Destroying some 40,000 hectares of land each year, brush fires are a common threat in Guinea–Bissau and are a major cause of soil degradation and deforestation. Overgrazing has further damaged land area, just as overfishing threatens the food supply and marine life. Guinea–Bissau has one of the richest coastal ecosystems in West Africa, and it has not reached the level of degradation common among more industrialized neighbors. The World Bank has partnered with the government to institute the Coastal Biodiversity Management Program designed to promote sustainable management while promoting coastal biodiversity. The success of the project is tied to the participation of local communities.

In 2006, scientists at Yale University ranked Guinea–Bissau 120 of 132 countries on environmental performance, in line with the comparable income group but below the comparable geographic group. The lowest score was predictably in the category of environmental health, but Guinea–Bissau was also ranked below average in the field of biodiversity and habitat. Almost 78 percent of the land area is forested, but deforestation is occurring at a rate of 0.9 percent annually. Of 108 endemic mammal species, three are endangered. Bird species fare better as none of the 235 endemic species are threatened. Responsible management of the national park network that includes the Joao Vieira and Poilao National Park, the Orange National Park, the Cascheu Mangrove National Park, the Cufada Lagoon National Park, and the Cantanhez game reserve are essential to protecting the biodiversity of Guinea–Bissau.

ENVIRONMENTAL PROTECTIONS

In 1979, the government created the Ministry of Natural Resources with the responsibility for enforcing all environmental laws and regulations. It was not until 1993, however, that Guinea–Bissau developed a comprehensive National Environment Action Plan and established the advisory National Commission on Environment. The following year, the government created the position of Secretary of State for Tourism, Environment, and Traditional Arts, which was upgraded to the Ministry of Tourism, Environment, and Traditional Arts the following year and given greater environmental policy responsibilities. Under the Basic Law on the Environment, a number of laws and programs have been initiated to ensure that Guinea–Bissau remains committed to sustainable development and conservation of resources. The government also signed the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Law of the Sea, and Wetlands.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Guinea; Rice.

BIBLIOGRAPHY. Central Intelligence Agency, "Guinea–Bissau," *World Factbook* www.cia.gov/cia (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective*

(Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC–CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Guinea–Bissau," www.hdr.undp.org (cited April 2006); World Bank, "Guinea–Bissau," www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Gulf Stream

THE GULF STREAM is the ocean current that is active throughout the Atlantic Ocean and has kept northwestern Europe warmer than other lands of comparable latitude and has encouraged the development of civilization there. Changing global climatic conditions threaten the stable continuation of the Gulf Stream with far-reaching implications for human settlement. The water of the oceans continually circulates in response to tidal and geological processes. One major system, which gives rise to the Gulf Stream, is produced by the westward movement of water caused by the trade winds that drive water at up to four miles per hour through Florida in the United States and then northwards past the Bahamas.

This flow of water forms a kind of barrier or border between bodies of water of different temperatures or origins. It isolates the Sargasso Sea, for example, from colder regions that surround it and can cause water temperatures to vary by up to 100 degrees C over a comparatively small area. The water travels north toward the Gulf of Hatteras, and then east past Greenland, and ultimately to the continent of Europe. The force of the water has been much diminished by this time, and part of the way across the Atlantic it divides into two parts: one of which flows toward northwest Europe, and the other toward the Iberian Peninsula where it constitutes the Canary Current.

The Gulf Stream is one important example of the phenomenon of water movements throughout the world known as the Ocean Conveyor. The Gulf Stream causes waters of different temperatures to mix together and this results in turbulence in the water that increases the amount of salt and minerals present. Consequently, the amount of fish in the area is increased and this has made areas serviced by the Gulf Stream among the most commercially valuable fishing grounds in the world.

in the North Atlantic, the Gulf Stream's northern edge transitions from warm (deep blue) to cooler water.

Research has shown that during a previous ice age, more cold water was forced into the Gulf Stream as it passed between Greenland and Scotland and this caused a rapid decrease in temperatures, perhaps as much as five degrees C over just a few decades.

As global warming melts the Greenland ice sheet, a similar impact is expected. Increased fresh water (from melted ice) and precipitation associated with global warming will reduce the density of the water and this will force the Gulf Stream to lower levels at which its heat will further dissipate. It is possible that the Gulf Stream will then be interrupted or come to an end altogether. This would reduce the temperatures in northwestern Europe and provide more severe winters, which is likely to produce an increase in demand or energy for heating. However, current predictions suggest that the cooling effect will be more than compensated for by increases in atmospheric temperatures globally. Previous examples of abrupt climate change have resulted in the vulnerability of food crops and fresh water, and the destruction of civilizations.

SEE ALSO: Climate, Marine West Coast; Currents, Ocean; Global Warming; Oceanography; Oceans.

BIBLIOGRAPHY. Ocean and Climate Change Institute of the Woods Hole Oceanographic Institute, www.whoi.edu (cited July 2006); R. Seager et al., "Is the Gulf Stream Responsible for Europe's Mild Winters?" *Quarterly Journal of the Royal Meteorological Society* (v.128/586, 2002); Alan P. Trujillo and Harold V. Thurman, *Essentials of Oceanography* (Prentice Hall, 2004).

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Guyana

INITIALLY SETTLED BY the Netherlands, Guyana was turned over to the British in 1815. After slavery was abolished, indentured servants were brought from India to supply labor for the large sugar plantations of the colonial period. As a result of this complex labor history, one-half of the 765,200 population of Guyana is East Indian, while another 36 percent are of African descent. These ethnic differences have often fed political dissension. Boundary disputes with Venezuela and Suriname have also led to political tensions and to a lack of regional cooperation. In 1992, Guyana held its first free election since independence was granted in 1966.

The Guyanese economy suffers from the lack of skilled labor and the low level of infrastructure. The length of borders and low levels of policing mean that illicit narcotic transshipment is suspected. Much new industrial activity has been centered on logging the valuable hardwood trees in the interior, and mining for new deposits of minerals. Health and safety standards are generally low, and a number of injuries and deaths have resulted, notably at Omai in 1995. Conflict with the indigenous peoples occupying the land desired for exploitation by mining and logging organizers has also resulted in violence. Unchecked logging has resulted in a number of potential environmental problems, not least of which is flooding. Removal of trees means that tropical rainstorms deliver large amounts of water that are no longer held up by the roots and foliage surrounding the missing trees. Flooding, often on a wide scale, results. Efforts to clear land for ranches have also inspired similar problems. It was estimated in 2000 that 486 square kilometers of Guyana's land was being deforested annually, which represented about 0.28 percent of the total land.

With unemployment approaching 10 percent and significant underemployment, as well as low income levels—per capita GDP is approximately $4,600, but there is considerable inequity of distribution—Guyana needs to develop new industries and investment projects to help its people to attain better social and economic opportunities in the future. The Guyanese government must balance the opening of the economy necessary to achieve this with protection of the environment.

SEE ALSO: Brazil; Sugar; Suriname.

BIBLIOGRAPHY. Marcus Colchester, *Guyana: Fragile Frontier: Loggers, Miners, and Forest Peoples* (Ian Randle Publisher, 1997); Jang B. Singh, "Business Activity and the Environment: The Case of Guyana Sugar Corporation and Thallium Sulphate," *Journal of Business Ethics* (v.7/5, 1988); World Bank, www.worldbank.org (cited July 2006).

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Habitat

HABITAT IS THE environment in which natural or human species live. In all cases, a habitat is an area where an individual or population exists or can exist. The Joshua Tree, for example, can only be found in its natural habitat, which is the Mohave Desert. Water lilies can only be found in aqueous conditions, while cacti can only be found in desert conditions. Certain types of fish reside only in the ocean's abyss while longhorn sheep live on mountains.

A habitat can consist of a single individual living alone on an island, such as the fictional character Robinson Crusoe, as well as the individual members of a species in an area. Habitats can cover wide or small areas.

A microhabitat can be viewed as the immediate surroundings in which a plant or animal lives. A goldfish in a fishbowl dwells in a microhabitat. If it lived in an artificial pond, its habitat would be the area in the pond where it can swim. The microhabitat for a plant in a home aquarium is the immediate place where the planted is located.

Scientists usually use the term *habitat* in a general sense to mean the ecology of an area where the species exists. The habitat shared by many species is usually termed a *biotope*. A *biome* includes all of the flora and fauna living in the habitat of a certain geographic area.

The destruction of habitat is a grave danger to many species. It may well be the leading cause of species extinction. This is especially the case for species that are dependent on unique ecological niches. For example, the ivory-billed woodpecker resided only in fully matured forests. However, the destruction of most of its habitat probably caused its extinction, unless reported sightings of ivory-billed woodpeckers around 2004 turn out to be true.

Ecological niches are descriptions of the role that a species plays in an environment. The way that a species gets its food, that is, "earns its living," can be of significance to other species. Some species such as panda occupy a narrow niche as do koala bears, which live entirely on eucalyptus leaves. Pigs, in contrast, are generalists and feed on almost anything.

Habitats can be destroyed by natural or human causes. Volcanoes can cover wide areas burying all living things under a layer of ash and lava. If a unique species has developed a special niche in the area of a dormant volcano that returns to life, it can be destroyed by geological developments.

Climatic changes have also changed the habitats of many species in the geologic ages of the earth's biography. The Sahara Desert was a grassy savannah with teeming wildlife 5,000–10,000 years ago. Numerous species that it supported lost their habitats because of the climatic changes that overtook the Sahara.

Habitats for some species can be greatly expanded as well as destroyed by natural or human activity. Geologic or meteorological forces can cause massive changes in the ecology of wide areas in a relatively short time. However, geological and climatic forces can also cause enormous changes in the habitat conditions. The great Sahara desert was verdant until a few thousand years ago. Climatic changes have made it into a desert without any apparent human intervention.

Human intervention has changed some of the Caribbean islands from wet to arid because of the destruction of the original vegetation. The destruction led to the loss of habitat for many species. Human activity can impact species. The snail darter is a small fish that needs clean gravel in moving water as a major part of its habitat. It was threatened with extinction by the building of the Tellico Dam on the Tennessee River.

The destruction of habitat is a grave threat to species like the North American mountain lion.

The building of dams can destroy some species, but it can also increase the habitat for others. There has been a marked increase of some insects and parasites behind the Aswan Dam in Egypt because their habitat has been increased. The same phenomenon happens when farming occurs or is abandoned. Heavily forested areas are more favorable habitats for some species, while broken country is more agreeable to others. The decrease in farming in the eastern United States has led to declines in the upland dove populations because the corn or other seeds favored as food are no longer available. However, the broken country of suburbs and the absence of hunting have led to an explosion in the deer population because the habitat is more favorable than previously.

Human intervention that creates—however unintended—a species invasion can have an impact on species. For example, the American grey squirrel was imported into England in the 1800s as a biological diversity addition. However, by the year 2000, it had virtually replaced the native English red squirrel. Its ecological niche is such that it feeds on acorns from oak trees in winter. However, because these oak trees are absent in some areas, the red squirrel has been able to survive. The difference is in how the two species "make their living." The red squirrel species may well become extinct because its habitat has been over run by a more prolific and aggressive similar species.

Habitat destruction is the gravest threat to numerous species at the beginning of the 21st century. The destruction of forest, wetlands, and other places that were home to unique species has led to their extinction. This was evidenced by the extinction of the passenger pigeon shortly after 1900.

Since the late 1800s, a growing number of efforts have developed to protect habitats influenced by the conservation and environmental movements. Programs to promote both government preserves and private land preserves have gained significant political support. Legislation such as the Endangered Species Act and other similar programs has allowed conservation groups to save numerous species. They have also found support in a ruling by the United States Supreme Court that has said that the destruction of critical habitats is as deadly as directly killing the plants or animals in a biome.

Current laws and programs allow habitat conservation plans to be adopted. In addition, species breeding programs have promoted the return of endangered species to habitats they were exterminated from previously. These programs allow for species recovery. The animals and plants that were eliminated earlier can be bred in captivity and later returned to their original habitat.

SEE ALSO: Biome; Endangered Species Act (1973); Sahara Desert.

BIBIOGRAPHY. Kenneth Druse and Margaret Roach, *The Natural Habitat Garden,* (Timber Press Incorporated, 2004); Chris Duerksen and Cara Snyder*, Nature-Friendly Communities: Habitat Protection and Land Use Planning* (Island Press, 2005); Mark Gerard Hengesbaugh, *Creatures of Habitat: The Changing Nature of Wildlife and Wild Places in Utah and the Intermountain West* (Utah State University Press, 2001); Loren M. Smith, Roger L. Pederson, and Richard M. Kaminski, eds., *Habitat Management for Migrating and Wintering Waterfowl in North America* (Texas Tech University Press, 1989); Andrew Warren, *Habitat Conservation: Managing the Physical Environment* (John Wiley & Sons, 2001).

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Habitat Protection

HABITAT PROTECTION REFERS to a range of human-initiated approaches, strategies, and interventions to avoid the potentially detrimental consequences of anthropogenic activities—such as harvesting, gathering, hunting, logging, mining, agriculture, and residential or commercial development—to habitats (the abiotic and biotic components) necessary for the survival of species deemed significant. In many cases, early protection efforts targeted the habitats of species with particular utilitarian value, such as charismatic wildlife or game animals; and unusual and rare species endangered or threatened with extinction. Historically, these efforts have been overwhelmingly focused on terrestrial species, neglecting freshwater and marine environments, and were undertaken by agencies of the nation–state, or in some parts of the world, by colonial administrators. For example, the U.S. Endangered Species Act largely has incorporated a species-specific management approach. In most cases, these efforts have focused on creating a range of management territories.

Increasingly, the scope of habitat protection efforts is broadening, both in terms of the ecosystem components included in efforts and the total area needed for adequate protection. First, this shift is the result of alternative ways of thinking about nature. Recognizing the importance of new concepts, such as biodiversity, there has been a shift away from the narrower focus on plants and wildlife valued for their utilitarian purposes to a broader focus on protecting ecological integrity and ecosystem health. As a result, efforts that consider multiple species at the same time—and their requisite habitats—are, in part, responsible for the fact that larger areas are under consideration for protection. This includes increasing attention to freshwater and marine ecosystems and the habitats that support complex webs of species interaction.

Second, new scientific insights into the ways that ecosystems change through time and the ecological processes that create and maintain particular habitats point to the importance of devising strategies that allow key ecological processes (e.g., flooding, fire, among others) to operate relatively unimpeded by humans. This has led to additional approaches that emphasize spaces that are more clearly reflective of physiographic or natural boundaries, such as watersheds, landscapes (heterogeneous areas of land composed of interacting ecosystem clusters), and entire ecoregions (large areas of land or water whose ecosystems contain regionally distinctive biodiversity).

Nature preserves, reserves, parks, and protected areas are the most commonly used management strategies to protect habitat. These territorial units rely largely on the creation of a central core area where human intrusions are kept to a minimum. According to principles of conservation biology and landscape ecology, this core area should be surrounded by a buffer zone that is designed to reduce the potential impacts of neighboring anthropogenic activities. Ideally, core areas will be connected functionally to other important spaces through the use of habitat corridors to facilitate the movement of species. In both cases, human settlements are located outside of these two zones, with local anthropogenic needs met by the areas within the buffer zone. Taken together, this management provides a mechanism for creating an integrated network of preserved areas that protect species habitats at the landscape and ecoregion scale.

In recent years, there has been a convergence by nongovernmental organizations (NGOs), such as World Wildlife Fund, the Nature Conservancy, Conservation International, and the Sierra Club, among others, on this idea of ecoregion-based conservation as a guiding framework for intervention. Thus, habitat protection is also undertaken by agencies at multiple levels of government within nation-states, and increasingly by NGOs, such as conservation organizations and private land trusts. For example, some state and local governments in the United States conduct habitat planning exercises to design protected area systems within their jurisdictions. These agencies, together with the help of NGOs, are actively purchasing lands outright or using conservation easements to ensure that important habitats will not be developed.

The sociopolitical impacts of habitat protection on human communities have been varied. In some instances, there has been a history of forced removal of local peoples (including indigenous communities and early settlers) by government agencies and colonial administrators to create national parks or wildlife areas in some developed countries and former colonies. Today, efforts to apply the core-buffer model in new places—or the "guns-and-fences" model as it is derisively labeled by some critics—is sometimes seen as a form of neocolonialism or ecological imperialism. In other places, emphasis on habitat protection has been viewed as a threat to private property rights and has spawned political opposition.

SEE ALSO: Biodiversity; Buffer Areas; Conservation Biology; Ecological Imperialism; Ecosystems; Endangered Species Act; Environmental Organizations; Extinction of Species; Fortress Conservation; Habitat; Indigenous Peoples; Land Trusts; Landscape Ecology; Nongovernmental Organizations.

BIBLIOGRAPHY. Timothy Beatley, *Habitat Conservation Planning* (University of Texas Press, 1994); Martha Groom, Gary Meffe, and Ronald Carroll, *Principles of Conservation Biology* (Sinauer Associates, 2005); Craig Groves, *Drafting a Conservation Blueprint* (Island Press, 2003); Gary Meffe, Larry Nielsen, Richard Knight, and Dennis Schenborn, *Ecosystem Management: Adaptive, Community-Based Conservation* (Island Press, 2002); Paul Robbins, *Political Ecology: A Critical Introduction* (Blackwell, 2004).

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Hadley Cell

THE HADLEY CELL refers to a somewhat idealized vertical circulation of air in the Earth's atmosphere and comprises the principal component of the general circulation pattern of the Earth's atmosphere. The Hadley Cells are comprised of a trough of low pressure girdling the globe in an equatorial and tropical band (the intertropical convergence zone, or ITCZ) and its associated rising air and a ridge of high pressure (the subtropical highs) where the air subsides back to the surface. A Hadley Cell thus circulates roughly from between 0 degrees latitude and 30 degrees latitude, north and south, although the actual latitudes will shift over the course of the year as the subsolar point passes between the Tropics of Cancer and Capricorn over the course of the year. There are thus two Hadley Cells; both sharing the ITCZ as the zone of lifting, but separating into two separate circulations as the air settles into both the northern and southern hemisphere subtropical highs.

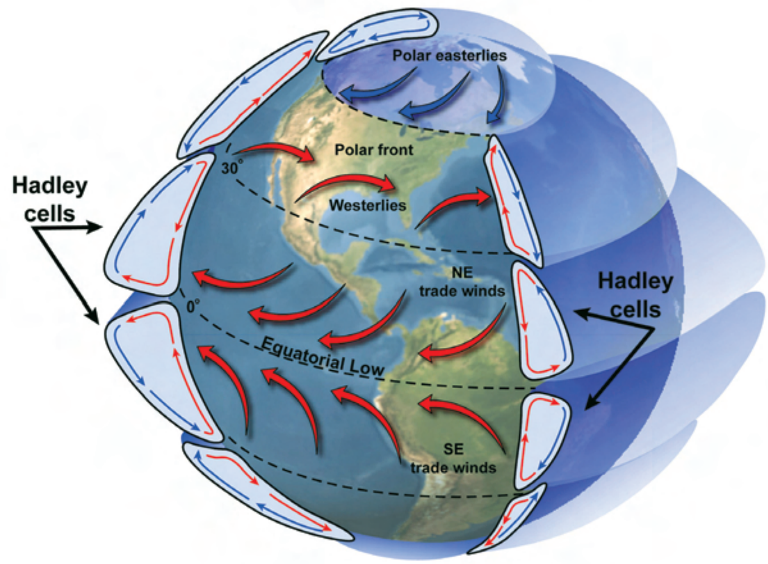
Solar energy drives the system, with the most intense heating of the Earth's surface occurring at the latitude receiving the vertical rays of the sun (the subsolar point). The heating of the surface causes the air above to warm and rise (convectional lifting), creating low pressure. The low pressure draws in surface winds from the higher latitudes (the northeasterly trade winds from north of the ITCZ, and the southeasterly trade winds from the south of the ITCZ). The northeast and southeast trade winds converge on the trough of low pressure, and the collision of these air masses forces the air upwards (convergent lifting), which further decreases pressure. At the surface, the air in the vicinity of the low pressure trough is warm and humid; as the air rises, it cools and the atmospheric moisture condenses into precipitation.

The rising air eventually reaches the tropopause (occurring at roughly 18 kilometers in altitude over the tropics, but descending in altitude to roughly 12 kilometers in the midlatitudes), which is the upper boundary of the lowest region of the atmosphere (the troposphere) and the stratosphere, the region of the atmosphere containing the ozone layer. The ozone is heated by the sun, and above the tropopause, air temperature begins to increase with altitude. The rising air from the ITCZ, having cooled while rising from he surface, encounters warmer atmospheric air (the stratosphere) upon reaching the tropopause; this temperature inversion prevents further lifting of the air.

The circulating air then spreads out along the tropopause, both latitudinally and longitudinally. The longitudinally spreading air becomes accelerated and contributes to the subtropical jet stream. The air spreading toward the higher latitudes along the tropopause are termed *antitrade winds*; the air now is cool and dry (having the moisture removed through condensation and precipitation), and settles back to the surface, forming the subtropical high pressure systems. As the air subsides, it warms such that the air reaching the surface is warm and dry.

The subsiding air spreads out along the Earth's surface, with the winds spreading toward the equator from the subtropical highs feeding back into the ITCZ as the easterly trade winds, and the winds spreading poleward from the subtropical highs being termed the *westerlies* and contributing to midlatitude circulation and the formation of extra-tropical cyclones. Technically, the Hadley Cell circulation strictly refers to the air rising over the ITCZ, circulating poleward as the antitrade winds, subsiding to the Earth's surface as the subtropical highs, and circulating back into the ITCZ as the easterly trade winds. Although the westerlies are functionally tied to the subtropical highs, they are not technically considered to be part of the Hadley Cell circulation system.

The Hadley Cell circulation influences many of the Earth's climate systems and biomes through its



The Hadley cells are composed of rising air in the heart of the tropics and sinking air in the subtropics.

effects on precipitation patterns. High levels of annual precipitation are associated with the ITCZ; the subtropical highs have a variable effect on precipitation, although it is generally associated with drier conditions. Where the ITCZ is present throughout the year, annual rainfall (152–254 centimeters) with no dry season, and defines the tropical wet climate and corresponds to the tropical rainforest biome, composed of broadleaf evergreen trees. With increasing latitude, the influence of the subtropical high tends to confer winter dry seasons of increasing length. Tropical monsoon climates (254–508 centimeters precipitation with 1–3 months of winter dry season) give way to tropical savanna climates (90–180 centimeters annual precipitation and 1–6 months winter dry season), and tropical rain forest gives way to tropical deciduous forest, which grades into the mixed trees, shrubs, and grasslands of the tropical savanna biome.

Poleward of these tropical climates, the subtropical high pressure system exerts the greater influence on climates, but the effect on precipitation is variable. Where the dry, warm air subsides over continental interiors, the climates are quite arid. Where the air subsides over the oceans, the warm air has a high capacity for moisture, evaporation increases and the air can become quite humid. Whether this translates into precipitation over the land is then a function of surface winds. Around high pressure systems, winds follow an anticyclonic circulation, which translates into a clockwise rotation in the Northern Hemisphere and an anticlockwise rotation in the south. On the equatorward margins of the subtropical highs, winds follow an easterly path (giving rise to the northeasterly and southeasterly trade winds). Thus, on the western coasts of continents, dry, warm air subsides over land and blows eastward as an offshore flow of wind, and maintains extremely arid conditions.

As one travels poleward from the tropics on the west coast to the center of continents, the tropical savannas give way to the subtropical steppe climates and subtropical desert, and the savannas give way to grasslands and ultimately low-latitude hot desert biomes. Along east coasts, however, the easterly flow of winds around the equatorward margins of the subtropical highs create an onshore flow of winds, and the moisture the subsiding air picks up over the oceans becomes expressed as precipitation overland. Regions thus affected exhibit humid subtropical climates, which support midlatitude deciduous forests. Although not technically part of the Hadley Cell circulation, the westerlies flowing poleward from the subtropical highs affect Mediterranean, marine west coast, midlatitude cold desert, and steppe and humid continental-hot summer climates and their associated vegetation. The Hadley Cell circulation thus governs the precipitation pattern of most of the Earth's climate systems.

For human societies, the Hadley Cells thus play an important roll in providing food security by supporting agriculture through precipitation. The majority of the world's developing countries are located in the tropics, are heavily dependent on agriculture, and thus dependent on the rainfall imparted by the ITCZ. In the arid zones affected by Hadley Cells, lack of precipitation in conjunction with growing demand for agricultural production and improved irrigation technology results in a growing dependence on groundwater, with groundwater mining (extracting groundwater at rates quicker than it can be replenished), aquifer collapse, and sea water intrusion being common problems in these regions, such as on the High Plains of the United States and in the Middle East. Severe seasonally flooding often accompanies the arrival of the monsoons in South Asia. Also, tropical cyclones form within the Hadley Cell system.

Additionally, variation in strength of the pressure gradient between the subtropical high and ITCZ across the South Pacific creates the El Niño-Southern Oscillation (ENSO) phenomenon. An increased frequency and intensity of tropical cyclones in the South Pacific, as well as locally severe droughts and flooding accompany these ENSO events.

SEE ALSO: Atmosphere; Atmospheric Science; Biome; Climate; Climate, Tropical; Inter-Tropical Convergence Zone (ITCZ); Solar Energy.

BIBLIOGRAPHY: Edward Aguado and James E. Burt, *Understanding Weather and Climate* (Prentice Hall, 1999); Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); H.J. de Blij and Peter O. Muller, *Geography: Realms, Regions and Concepts* (John Wiley & Sons, Inc., 2000); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Tom L. McKnight and Darrel Hess, *Physical Geography* (Pearson Prentice Hall, 2005)

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Haiti

THE SOCIO-ECOLOGICAL CONDITIONS in present day Haiti are deeply conditioned by its past. During the colonial period, France developed Haiti into one of the most productive and profitable Caribbean islands. The emphasis on forestry and sugar exports led to the importation of slaves on a huge scale, massive environmental degradation, and eventually to a slave revolt. In 1804, Haiti declared independence, making it the only successful slave revolution in history. The legacy of underdevelopment, slavery, and the commodity economy has been persistent, however. Violence has continued to plague Haiti, which is the poorest country in the Western Hemisphere with a per capita income of only $1,600. The abject poverty rate of 80 percent and the fertility rate of 5.8 children per female are in large part responsible for the major health and environmental threats to Haiti's population of 8,121,622. Furthermore, environmental and health information are difficult to disseminate because of low educational and literacy rates (52.9 percent).

Two-thirds of the population has no formal employment. The country has a low life expectancy (52.92 years), high infant mortality (73.45 deaths per 1,000 live births) and death rates (12.34 per 1,000 population), and a low population growth rate (2.26 percent). HIV/AIDS (5.6 percent) is a growing threat to the Haitian people. Two-thirds of the populations have no access to improved sanitation, and almost 30 percent lack access to safe drinking water; the lack of potable water creates a major health hazard in Haiti. Despite the extreme poverty, irregularities have led to the suspension of millions of dollars in international aid. The UNDP Human Development Reports rank Haiti 153rd of 232 countries on general quality-of-life issues.

Haiti covers one-third of the island of Hispaniola; the remaining two-thirds is occupied by the Dominican Republic. Bordered by the North Atlantic and the Caribbean Sea, Haiti has a coastline of 1,771 miles (2,851 kilometers). The climate is tropical except for the semiarid area where mountains block the trade winds. The terrain is generally rough and mountainous. Because Haiti is in the center of the hurricane belt, the country is vulnerable to severe storms from June to October. Periodic droughts and occasional flooding and earthquakes pose additional threats to the environment and lives. In 2004, southern Haiti experienced massive flood damage, and the northwest was hit by Tropical Storm Jeanne. Thousands of lives are lost whenever such disasters occur. Many deaths and much environmental degradation are caused by landslides that result from the absence of trees to serve as natural barriers to eroding soil.

Deforestation is rampant at 98 percent. Despite efforts to prevent further damage, locals continue to clear forests for agriculture use. The battle for survival also leads Haitians to cut down trees for fuel. Nearly a third of Haiti is arable, and two-thirds of the people are involved in subsistence agriculture. Only the 38 percent of Haitians who live in urban areas

Citadelle La Ferrière

The "Citadel" in Haiti is the largest fortress in the Caribbean and was constructed between 1804 and 1817 with some 20,000 men working on the project. It overlooks Cap Hatien, in the north of Haiti and is one of the marvels of engineering the early modern period, although it was used as a castle, its original purpose.

The construction of the Citadel followed the Haitian Revolution in 1803, when Black slaves rebelled successfully against their French masters and on January 1, 1804, Jean-Jacques Dessalines proclaimed independence for Haiti, the first black republic in the world, and also the second independent country in the Americas. When Napoleon Bonaparte crowned himself emperor later that year, Dessalines did the same creating himself Jacques I, Emperor of Haiti.

Dessalines was worried that the French might launch a counterattack and try to retake Haiti, and for this reason started work on the building of the Citadel. To do this, large numbers of people were forced to help in the building of the castle, which could easily be defended against a French assault. Built at the top of a mountain, it has walls up to 43 feet thick, and has cisterns, reservoirs, and water storage facilities for thousands of gallons of water which would be used to sustain a garrison of up to 10,000 for a year. There were also 365 cannons, some being as heavy as 10 tons, and supplies of cannonballs.

Unfortunately, although Dessalines led a major slave revolt, and was partially influenced by some of the tenets of the French Revolution, he ruled as an autocrat regularly threatening laborers with dreadful punishments or even death if they did not comply with his demands. Dessalines himself died was killed in 1806 and replaced by other tyrants who continued the building of the Citadel.

As things turned out, Napoleon and the French were too concerned with events in Europe, and never launched an expedition against Haiti—they even sold Louisiana to the United States in 1803. The Citadel remains a major tourist attraction for visitors to Haiti.

have access to electricity. Haiti's natural resources include bauxite, copper, calcium carbonate, gold, marble, and hydropower, but the country lacks the infrastructure to adequately exploit these resources.

As a result of mass deforestation, desertification and soil erosion are widespread. It has been estimated that Haiti loses 36 million tons of soil annually. In 2006, a study by Yale University ranked Haiti 114th of 132 countries in environment performance. The country was substantially lower than both the relevant geographic and income groups. The lowest scores were received in the areas of biodiversity and habitat, environmental health, and air quality. Only .4 percent of the land area is protected. One-fifth of the 20 endemic mammal species are endangered, as are 14 of the 62 endemic bird species. Haiti's air supply is polluted by emissions of carbon dioxide from solid and liquid fuels, gaseous fuels and gas flaring, and cement manufacturing.

In 1994, the National Assembly created the Ministry of the Environment, which has been charged with implementing environmental policies and strategies that include forest management, conservation, national parks, buffer zones, mineral and energy resources, and water management. However, the lack of a comprehensive environmental policy and specific legislation has made it difficult to carry out much-needed change and reparations.

Haiti also has a National Commission for the Environment in which the prime minister ostensibly works with relevant agencies to implement the National Environmental Action Plan. Unfortunately, the plan has never been fully implemented due to a lack of funding and structure. Much of the work on Haiti's extensive environmental problems is funded by international groups and nongovernmental organizations (NGOs). For instance, international agencies such as the Inter-American Development Bank, the World Bank, and the UNDP have provided Haiti with funding to launch forest preservation programs and to establish a national flood warning system.

In line with endemic environmental issues, Haiti participates in the following international agreements: Biodiversity, Climate Change, Desertification, Law of the Sea, Marine Dumping, Marine Life Conservation, and Ozone Layer Protection. The government has signed but not ratified the Hazardous Wastes agreement.

SEE ALSO: Deforestation; Drinking Water; Extinction of Species; Fertility Rate; Hurricanes; Infant Mortality Rate; Life Expectancy; Pollution, Air; Poverty; Soil Erosion.

BIBLIOGRAPHY. CIA, "Haiti," *The World Factbook,* www.cia.gov (cited April 2006); CLAWRENET, "Haiti Country Report," www.fao.org (cited April 2006); Franklin W. Knight and Teresita Martinez-Vergne, eds., *Contemporary Caribbean Cultures and Societies in a Global Context* (University of North Carolina Press, 2005); Mark Kurlansky, *A Continent of Islands: Search for the Caribbean Destiny* (Addison-Wesley, 1992); One World, "Haiti Guide," www.uk.oneworld.net (cited April 2006); UNDP, "Human Development Reports: Haiti," www.hdr.undp.org (cited April 2006); World Bank, "Haiti," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Hamilton, Alice (1869–1970)

ALICE HAMILTON (1869–1970) shaped the field of industrial medicine in the United States beginning in the Progressive Era through research on the urban environment. She advanced knowledge of the health effects of chemicals, particularly lead, and successfully campaigned for protections such as workers' compensation and basic environmental standards. Hamilton staunchly supported labor movements, especially in their crusades for health and safety. Decades before the birth of modern environmentalism, she criticized industrial practices that harm human health.

Hamilton was born in 1869 and grew up in Fort Wayne, IN, in a close-knit and well-to-do family. She earned her medical degree—when women doctors were rare—from the University of Michigan. Upon joining the faculty at Northwestern University in 1897, she moved into Jane Addams's Hull House in Chicago. Settlement houses like Hull House served as community centers in poor, urban neighborhoods, where live-in activists from privileged families offered education, political organizing, and self-help opportunities. At Hull House, Hamilton provided health education and studied neighborhood illnesses including typhoid and tuberculosis.

Her investigations into tuberculosis, which she believed was exacerbated by factory conditions, led Hamilton to her career studying the "dangerous trades." Though the field of industrial medicine was at the time respected and active in Europe, industrial disease received little attention among American physicians. To take an interest in working conditions was to risk being deemed a Socialist or merely sentimental.

Both doctors and industrialists denied the importance of workplace illnesses such as phosphorus and lead poisoning. When they acknowledged disease, they often blamed workers themselves for neglecting proper hygiene or engaging in bad habits at home. Company doctors often seemed to favor their employers over their patients. Workers, furthermore, tended to hide their illnesses in order to avoid losing their jobs. Hamilton succeeded in reversing many of these circumstances, often cooperating closely with labor unions and activists, and sometimes industry leaders.

Hamilton conducted the first U.S. studies on lead in the workplace for the Illinois Commission on Occupational Diseases and the U.S. Bureau of Labor Statistics. Often shocked by the conditions she found, Hamilton confronted employers to urge immediate changes to the factory environment. While some employers were eager to comply, some resisted her work, and company doctors accused her of exaggeration and slander. The American Association of Labor Legislation used her findings to craft a bill, adopted by several states, setting basic standards for lead in the workplace. In later years Hamilton urged that industries substitute a less-toxic substance for lead, particularly in the 1920s, when gasoline companies began adding tetraethyl lead to their product.

In 1919 Hamilton became the first woman faculty member at Harvard Medical School. Harvard's creation of a program in industrial medicine was a sign of the growing recognition of the field. Hamilton continued her studies for the Bureau of Labor Statistics, examining trades that exposed workers to industrial solvents, mercury, granite dust, radium, and other dangerous substances. Increasingly granted access to the shop floor, Hamilton was able to work with employers and unions to devise remedies and alternatives to the hazards she found. She also systematized the practices of company doctors to ensure future surveillance of the health effects of industrial processes. Hamilton maintained a special concern about women's exposure to environmental hazards; she considered women more vulnerable and exploitable. This belief led her to take a controversial stance against the Equal Rights Amendment because she thought it would expose more working-class women to exploitation and gender-specific health effects.

Hamilton died at the age of 101 in 1970, the same year that Congress created the Occupational Safety and Health Administration, an agency that brought many of her ideals to fruition.

SEE ALSO: Addams, Jane; Sewer Socialism; Health; Lead; Mercury; Radioactivity; Urbanization; Workplace Hazards.

BIBLIOGRAPHY. Robert Gottlieb, *Forcing the Spring: The Transformation of the American Environmental Movement* (Island Press, 1993); Alice Hamilton, *Exploring the Dangerous Trades* (Little, Brown, 1943); Barbara Sicherman, *Alice Hamilton: A Life in Letters* (Harvard University Press, 1984); Wilma Ruth Slaight, *Alice Hamilton: First Lady of Industrial Medicine* (Case Western Reserve University, 1974).

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Haraway, Donna (1944–)

DONNA JEANNE HARAWAY is one of the leading contemporary theorists on environment and society. A professor in the History of Human Consciousness Program at the University of California at Santa Cruz, her research contributes to a vigorous discussion of how scientists' research of the natural environment construct modernist subjectivities and how natural processes are constructed as objects of research. Over her career, Haraway has published six titles that analyzed the international political economy of research into the natural environment, and the image of the world as a "scheming trickster." In a recent interview, Haraway compared her work with Bruno Latour, Evelyn Keller, and Alison Wiley.

Born in Denver in 1944, Haraway completed her doctorate in biology at Yale University, after which she held teaching posts at Johns Hopkins and the University of Hawaii; she joined the Santa Cruz faculty in 1980. Among her most influential works are the dissertation *Crystals, Fabrics, and Fields: Metaphors of Organicism in Twentieth-Century Developmental Biology* (1976); *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (1989); and *Simians, Cyborgs, and Women: The Reinvention of Nature* (1991).

In a recent interview with Thyrza Nichols Goodeve, Haraway explained that she had written *Primate Visions* and *Simians, Cyborgs, and Women* simultaneously, with significant sections completed while she was in residence at the Institute for Advanced Studies in Princeton in 1987. Haraway said about *Primate Visions*'s leading idea, "So many issues in culture, history, politics come to be narrated as biological and evolutionary stories. And the reverse—in other words, the way biological and evolutionary stories are thickly layered with the tools of political economy." In a series of chapters that are as empirically based as they are theoretically-sophisticated, Haraway traces primate researchers from the industrial northern nations; because their study of monkeys and apes is located in the formerly colonized parts of the world, primatology becomes deeply enmeshed in sexual, racial, and national myths. In that same interview, Haraway confesses that, even as it has proved influential on how the field poses research questions, a number of primatologists have resisted her assertions.

Simians, Cyborgs, and Women brought together previously published works as a "cautionary tale." To bring these to closure, Haraway introduces a new metaphor for the natural environment as the object of study, describing nature as a "witty agent and actor," a "coding trickster with whom we must converse." Haraway agrees that the trickster "is also there to caution us against anthropomorphism. It's hard because even a word like *conversation* conjures up speech as we know it. But the trickster figure is about the world that is also nonhuman, about all that which is not us, with whom we are enmeshed, making articulations all the time."

SEE ALSO: Feminist Politial Ecology; Political Economy; Primatology.

BIBLIOGRAPHY. Thyrza Nichols Goodeve, *How Like a Leaf: Donna J. Haraway, An Interview with Thyrza Nichols Goodeve* (Routledge, 2000); Donna Haraway, *Companion Species Manifesto: Dogs, People, and Significant Otherness* (Prickly Paradigm Press 2003); Donna Haraway, *Crystals, Fabrics, and Fields: Metaphors of Organicism in Twentieth-Century Developmental Biology* (Yale, 1976); Donna Haraway, *The Haraway Reader* (New York: Routledge, 2004); Donna Haraway, *Modest_Witness@Second_Millennium.FemaleMan©Meets OncoMouse™: Feminism and Technoscience* (Routledge,1997); Donna Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (Routledge, 1989); Donna Haraway, *Simians, Cyborg, and Women: The Reinvention of Nature* (Routledge, 1991).

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New York Public Library

Hardin, Garrett (1915–2003)

GARRETT JAMES HARDIN, born in 1915, was an ecologist from Dallas, Texas. Hardin graduated from the University of Chicago in 1936 with a BSc in Zoology, and in 1941 was awarded a Ph.D. in microbiology from Stanford University. He held the position of Professor Emeritus at the University of California, Santa Barbara, from 1933 until he retired in 1978.

Hardin wrote prolifically about environmental issues. In books such as *Nature and Man's Fate* (1959) and *Exploring New Ethics for Survival* (1977), he argued that unless human population growth is curbed, disease, starvation, and social disorder will result. He is best known for his landmark article, "The Tragedy of the Commons," which was published in *Science* in 1968.

In this essay, he used the example of an imaginary field in England where cattle herders have free and open access (the commons). He shows how each herder receives a benefit from adding one animal to graze the lands, while the cost of degradation to the field is shared by all. He thus argues that each herder has the incentive to put as many cattle on the land as possible. Hardin shows that while this may seem to be the most economically rational choice, exercising that choice ultimately leads to irreversible degradation, hence the tragedy of the commons. As he notes, "it is no use asking independent herdsmen in a commons to act responsibly, for they dare not. The considerate herdsman who refrains from overloading the commons suffers more than a selfish one who says his needs are greater."

Hardin uses this analogy to discuss the challenges of managing human populations and their impact on environmental systems, concluding that "freedom is the recognition of necessity," and that through the recognition of resources as commons in the first place, identifies the need for effective management.

PROVOKING CONCEPTS

His ideas have provoked a separate school of thought, especially from those who do not agree with Hardin's assumption that humans will always behave selfishly, or that privatization of resources will reduce negative human impacts on the environment. For example, E. Ostrom and F. Berkes have argued that community-based management offers a model where control of and maintenance of the "commons" can be achieved through community sanctioned and agreed to mechanisms and penalties.

While Hardin's Tragedy of the Commons has since been extensively applied within environmental and resource management programs and embedded within literature worldwide, Hardin himself focused on using his theories to advocate for the moral, ethical, social, and political dimensions of the population debate.

During the 1970s, Hardin developed his ideas on population with an analogy, describing societies as a lifeboat. Metaphorically, he argued, each rich nation amounts to a lifeboat full of comparatively rich people. The poor of the world are in other, much more crowded, lifeboats. He argues that the key challenge facing the world is how to reconcile the "ethics" of the lifeboat, namely, what should the passengers on the rich life boat do? His book, *Living Within Limits: Ecology, Economics and Population Taboos*, which develops these theories, received the Phi Beta Kappa Science Award in 1993.

In 2001, he argued that we need to teach "literacy, numeracy and ecolacy" in order to survive as a species. Hardin's last book, *The Ostrich Factor: Our Population Myopia*, published in 1999, argued for coercive constraints on "unqualified reproductive rights" as a means to address overpopulation.During his life he was active in community campaigning to progress his views, such as the 1960s campaign to legalize abortion, and was President of the Environmental Fund in 1980–81. Hardin died in 2003.

SEE ALSO: Common Property Theory; Tragedy of the Commons

BIBLIOGRAPHY. F. Berkes, "Commons Theory for Marine Resource Management in a Complex World," in N. Kishigami and J. Savelle, eds., *Indigenous Use and Management of Marine Resources* (National Museum of Ethnology, 2005); G. Hardin, "The Tragedy of the Commons," *Science* (v.162, 1968); G. Hardin, *Exploring New Ethics for Survival: The Voyage of the Spaceship Beagle* (Viking Press, 1972); G. Hardin, *The Immigration Dilemma: Avoiding the Tragedy of the Commons* (Federation for Immigration Reform, 1995); G. Hardin, *Creative Altruism: An Ecologist Questions Motives* (The Social Contract Press, 1999); G. Hardin, *The Ostrich Factor: Our Population Myopia* (Oxford University Press, 1999); G. Hardin, *Living Within Limits: Ecology, Economics, and Population Taboos* (Oxford University Press, 2000); G. Hardin and J. Baden, *Managing the Commons* (Ecobooks, 1977); E. Ostrom, *Governing the Commons. The Evolution of Institutions for Collective Action* (Cambridge University Press, 1990); E. Ostrom, J. Burger, C. Field, B. Norgaard, and D. Policansky, "Revisiting the Commons: Local Lessons, Global Challenges," *Science* (v.228, 1999).

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Hazards

HAZARDS ARE PROCESSES with a specific dimension to potentially have a negative impact on individuals, communities, or society. The nature of the hazard refers to the origin, being natural, manmade or social.

An urban and industrial society is based on technology. Technology should be understood as a system of interrelated components of design, building, management, and disposal components. A failure may happen at any stage, so the use of technology implies dealing with a hazard. Living in an industrial society means living at risk. A human failure is a malfunction of a component, not an isolated condition. More attention is paid to new and high technologies in developed countries, while low-technology accidents in developing countries are rarely reported. The transfer of technology to these countries to avoid labor or environmental controls relocates and increases risk for the destination's lax control.

PARAMETERS OF HAZARDS

The effects of technological accidents are complex: environmental or health-related in its nature; durable and extended to unborn generations, cumulative or temporary; and global, regional, or local in extent. In an event, the following are involved: a material: chemical, inflammable, or radioactive; a process: structural failure, fire, explosion, or a release; a sector: chemical, transportation, energy production, mining or agriculture, or simply a lifestyle.

Natural hazards and disasters are classified into a range of major categories: atmospheric (hurricanes, wind storms, tornadoes, heatwaves, droughts); hydrological (floods, snow avalanches); geological and geomorphological (earthquakes, volcanic eruptions, tsunamis, landslides, erosion); and biological (human epidemics, pests, wildfires).

The dimensions of a hazard are the magnitude of energy released, the complexity or potential level of hazard combination, the spatial dimensions as a real extent and diffusion, and the temporal dimensions as rate of onset, duration, frequency, and recurrence. Dimension is also a key element for public awareness, since media and governments usually draw their attention to rapid-onset, dramatic, and extreme events. Less attention is paid to slow-acting or biological processes like epidemics, famine, drought, or soil erosion, which have time-extended effects, concealed victims and environmental degradation over large areas.

Risk is a measure of the probable impact and the subsequent economic and noneconomic losses. An impact is an eventual interaction between a hazard and a vulnerable set of persons, goods, functions or resources. If an extreme event hits an unpopulated area, the effect on the society is null, while a slight change on a populated area—like snow in winter—may have a negative or positive impact.

The disaster is a disruption of the economic, social, institutional, and environmental functioning produced by an extensive loss as a result of a hazardous event. The criteria differentiating it from lower-energy accidents is the magnitude of the loss; the number of casualties, deaths and injured, and economic loss. This implies an administrative responsibility or financial liability, and the determination of whether the loss will be covered by individuals, insurance companies, administrations, or nongovernmental organizations (NGOs). Common criteria applied to droughts are looser, requiring a large number of people affected, even some reports exclude drought victims from ordinary natural disaster counts.

The differentiation between disaster and catastrophe is a matter of dimension. A country or a community recovers from a disaster with resources of their own, with some aid; but the magnitude of a catastrophe reaches a point that their own resources are not enough to cope with response and recovery. Losses are enormous and critical, for there is a general destruction of buildings and infrastructures, emergency facilities are not operational, administration is dismantled, and everyday life is interrupted. This was the case with hurricane Mitch in 1998 in Honduras.

Perception is an intervening factor in the definition of disaster. There is a band of tolerance within hazard dimensions, where some damages are not judged considerable. The relationship between earth processes and risk tolerance changes with time. Diminished resources—like drinking water availability—is always intolerant, causing increasing stress; however, an increasing tolerance diminishes stress.

The Celtiksuyu Boarding School lay in ruins after the May 2003 earthquake (Richter scale 6.4) hit Bingol, Turkey.

EFFECTS OF DISASTERS

The effects of a disaster are as complex as the causes. Primary effects on people are loss of life, injuries or impairment, together with damage or destruction of resources, property, heritage, and disruption of production, commerce, transport, lifelines, and services. Secondary hazards, such as urban fires or aftershocks following the destruction caused by an earthquake, are effects facilitated by vulnerability and insufficient preparedness. Social functions are interrupted, and the results are starvation, illness, unemployment, social violence, displacement and migration, unemployment, and inflation. Losses increase vulnerabilities to famine, diseases, debt, or homelessness. Side effects include displacement and a decline in fertility, although there is a contradictory effect—of returning to former homes—when memory vanishes.

The effects of a disaster in developing and developed countries are significantly different. While more commodities are at risk in developed countries, more people are at risk in developing countries. The Kobe earthquake in 1995 caused an estimated damage of $150 billion, the most costly disaster in the 20th century. In the developing world, the two most deadly events were the Bangladesh cyclone in 1970 with 300,000 fatalities, and the Tangshan earthquake in 1976 with 250,000 victims. Again, in Third World countries, the Indian Ocean tsunami in 2004 caused an estimated number of 275,000 deaths.

The impact of natural disasters is increasing, for there is a higher population growth rate in developing countries, particularly in urban areas. Population and affluence demand more land and drive up its value, putting more pressure on vulnerable and marginal areas. The process of economic and industrial relocation, in addition to financial mobility—inherent to the globalization process—has lead to an interconnectedness and interdependence of national and regional markets in distant geographical areas. A production or transportation crisis caused by a disaster has effects in distant areas, illustrated by market distortion. Technological development actually creates a vulnerability, as social functions are increasingly reliant on its quality, accuracy, and uninterrupted operation.

VULNERABILITY TO HAZARDS

Vulnerability is the human capacity of coping withthe impact of a disaster, and materializes as a disadvantageous response, defective resilience, and powerlessness. It is complex for its physical, social, economic, institutional, and environmental nature, and is variable depending on the dimensions, energy, and complexity of the hazard. Physical vulnerability is based on the quality, resistance, and design of construction. Social and economic vulnerability depends on social class, age, sex, ethnicity or minority. Casualties in earthquakes principally happen at community buildings and homes to women, children, and the elderly—although it is also dependent of other factors like the time of the day.

Poor people are more vulnerable, for they lack resources to contend with every phase of the risk process. Largely, they dwell in hazard-prone areas. They do not get ample information for they do not easily reach media, are not integrated in the risk preparedness system, and their low education levels conditions their perception of the environmental threats and the access to training. Evacuation is a challenge due to the reduced mobility of the young, the elderly, the impaired, and those with lack of personal transportation. Rural settlements and urban squatters are not priority areas for rescue and assistance, as well as for rehabilitation and reconstruction in the phase of recovery, even though shantytowns become overpopulated and built with unsuitable materials. The lack of risk and emergency management strategies in less developed countries is structural and reflects political and financial priorities when resources are limited.

External aid helps to stabilize the post-event situation and acts as a relief by providing temporary shelter, health, sanitary, and sanitation services. Sources of assistance are small-scale community aid in smaller events, and external and internal governments, international agencies and nongovernment organizations (NGOs). This support, however, discourages spatial relocation and local government responsibility for development, creating dependency. External aid is highly reliant on the interest of media in rapid-onset events to channel public and government attention, which declines in the post-event phases of rehabilitation and reconstruction. Critical recovery processes become very dependent on voluntary and external resources to organize aid donations after the event.

RESILIANCE TO HAZARDS

Resilience is a measure of the ability to return close to the previous state after an impact. The more resilient a population, the more efficient their previous adaptation to environmental change. Availability of assets, land, income, capital, skills, technology, insurance coverage, and access to information discriminate this capacity. But resilience is not only a post-disaster component; these factors also intervene in preparedness. Developed areas respond to disaster at various administrative levels, because they own resources; resilience is not only at the individual or household level. In less-developed regions, the capacity for coping with the impact of a disaster is almost exclusively at the household level.

The most frequent natural hazards—earthquakes, tsunamis, volcanoes, tropical storms, or desertification processes—have a clear zonal location component, shaping hazard regions. They are an additional factor restraining development in developing countries because the human and economic costs of response and recovery delay the effects of investments. Urban areas, with their high technology density and exposure, shape further regions of risk.

SEE ALSO: Disease; World Health Organization.

BIBLIOGRAPHY. David Alexander, *Confronting Catastrophe: New Perspectives on Natural Disasters* (Oxford University Press, 2000); Edward Bryant, *Natural Hazards* (Cambridge University Press, 2004); Susan L. Cutter, *Living With Risk: The Geography of Technological Hazards* (Edward Arnold, 1993); Kenneth Hewitt, *Regions of Risk. A Geographical Introduction to Disasters* (Addison Wesley, 1997); Mark Pelling, *The Vulnerability of Cities: Natural Disaster and Social Resilience* (Earthscan, 2003); Keith Smith, *Environmental Hazards: Assessing Risk and Reducing Disaster* (Routledge, 2004); Ben Wisner et al. *At Risk: Natural Hazards, People's Vulnerability, and Disasters* (Routledge, 2004); Donald J. Zeigler, James H. Johnson, and Stanley D. Brunn, *Technological Hazards* (Association of American Geographers, 1983).

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Health

MANY ACADEMICS AND health professionals look to the World Health Organization's (WHO) constitution for a definition of health. Here, health is recognized broadly as not merely the absence of disease or distress, but more positively as a state of physical, mental, and social well-being. It is also generally accepted that, although good health can be a collective goal and good for society on an individual level, different people have different needs for health, different ideas as to what exactly good health is and different thresholds for poor health (such as physical pain or mental distress).

The public have displayed a growing interest in health and body matters, particularly in weathier, Western societies. The media and the Internet have played a significant role in creating a consumerist health culture and sustaining demand through providing a wealth of information on diseases, products, treatments, and health maintenance. This has been mirrored by the increased interest shown in health by the private sector, which has begun to market a vast array of health-related products ranging from food supplements to fitness machines.

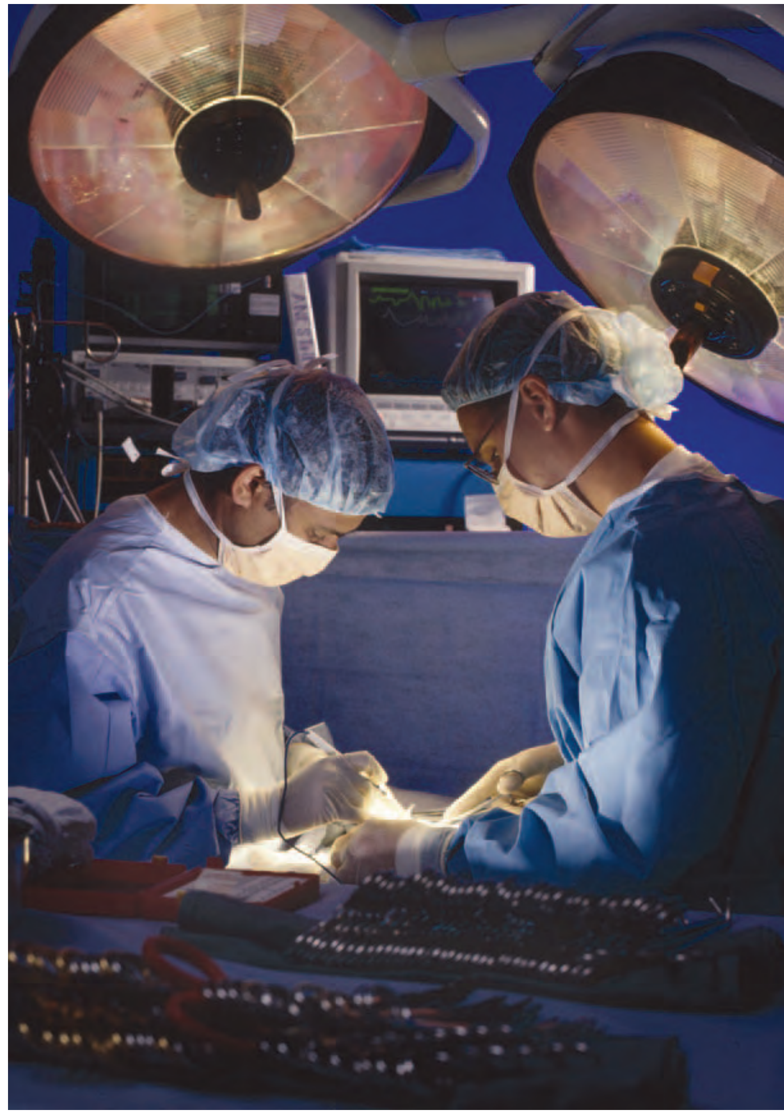
The fitness boom of recent years has involved higher percentages of people regularly partaking in activities to improve their health. Complementary and alternative medicine, often connected with nature and natural lifestyles, have become more mainstream. The "pull factors" include its holistic and personalized nature, the greater time spent in consultations, the spiritual dimension, and the wider identification with an alternative ideology or culture.

At the same time, a growing number of people are involved in health-harming activities such as drug use and high-fat and high-calorie diets. It has been necessary to target policy and public heath efforts against a wide range of unhealthy activities.

An array of complex measurement tools have been developed to define and measure health. Health economists have developed the QALY (Quality Adjusted Life Year) as a combined measurement of quality and quantity of life. Meanwhile, the SF-36 is a well known and widely used measure of health status. Hundreds of research studies investigate the many human activities that effect health. Concepts such as well-being and wellness, and subjects such as public health, sports, and fitness are increasingly scrutinized. Similarly, health systems and services now incorporate disease prevention and public health alongside their traditional clinical disciplines. A complex and interrelated array of health disciplines now coexist and focus on women, children, familes, nutrition, communities, and behavior.

ENGAGING WITH THE ENVIRONMENT

All of these engage with the environment in their own unique ways. For example, academic geographers have begun to explore the dynamics between health and environment. In 1992, Wil Gesler noted the positive psychological responses that people obtain from places, and how they affect physical, mental, spiritual, social, cultural, and emotional components of healing.



The public have displayed a growing interest in health and body matters, particularly in wealthier, Western societies.

An important debate over recent years has focused on the relationships between public health and the urban environment. Research has amply demonstrated the existence of geographical differences in mortality, morbidity, and health-related behaviors, but results vary on if health and health-related behavior in specific places is more greatly influenced by the characteristics of social composition—gender, marital status, employment status, income, and debt—or by the services and facilities available to them, such as the presence of primary care, particular retail outlets, and affordable and healthy foodstuffs. However, it is argued that, in contrast, the affluence and social and cultural norms of particular groups might affect their use of services and facilities within specific locales. This "collective" dimension to area-based explanations for health emphasizes the sharing of traditions, values, and interests—ethnic, religious, political, historical, cultural, and/or labor-based—within places. Such collective dimensions facilitate group actions and support that potentially impact health.

ENVIRONMENTAL HEALTH

The substantial field of academic research known as environmental health considers the impact of local environmental conditions on population health and health-related behaviors, and primarily focuses on environmental impacts on physical health. These range from relatively minor aliments and complaints to persistent, long-term conditions of varying severity (such as asthma and eczema), to others that are often terminal (such as Leukemia and lung disease). Meanwhile, a lesser number of studies focus on environmental impacts on mental health.

A great deal of research on the scales of environments focuses on health impacts on communities within broad regions—for example, states or provinces in North America—while some is focused on health in smaller locales, typically towns and urban neighborhoods. Often taking an epidemiological approach, research studies have identified the negative impact of toxic hazards on health. Air pollution has been a substantive issue for investigation. In particular, researchers have studies the impacts of area sources of pollution (such as radon and ozone); linear sources that are often mobile (such as traffic pollution); point sources (such as industrial pollutants); and a range of factors adding to local air quality.

A smaller volume of research has considered the spatial impacts of waterborne disease (such as cholera, schistosomiasis, and gastroenteritis) and chemical contamination (such as aluminum and arsenic) on health. During the past decade, environmental health concerns and research has expanded to include an attention to the public's health beliefs, localized environmental risk perception, community reaction and local health policy. In addition, researchers interested in public health have also extended their gaze and considered micro-scale individual polluting behaviors such as smoking. These studies engage with concepts such as social and moral responsibility and the roles of individuals and governments, and articulate the everyday conflicts that can occur within and over community spaces.

SEE ALSO: Disease; Social Capital; World Health Organization.

BIBLIOGRAPHY. J. Eyles, "Environmental Health Research: Setting an Agenda by Spinning Our Wheels or Climbing the Mountain?" *Health and Place* (v.3, 1997); A.C. Gatrell, *Geographies of Health: An Introduction* (Blackwell, 2002); W. Gesler, "Therapeutic Landscapes: Medical Issues in the Light of the New Cultural Geography," *Social Science and Medicine* (v.34, 1992); W. Gesler, *Healing Places* (Rowman and Littlefield, 2003); W. Gesler and R. Kearns, *Culture/Place/Health* (Routledge, 20002); M. Shaw, R. Mitchell, and D. Dorling, *Health, Place and Society* (Prentice Hall, 2002); S.E.L. Wakefield and B. Poland, "Family, Friend or Foe? Critical Reflections on the Relevance and Role of Social Capital in Health Promotion and Community Development," *Social Science and Medicine* (v.60, 2005).

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Heat (Balance and Capacity)

HEAT IS A transfer of energy. Heat is not contained in a body, therefore, but is instead a condition of energy moving from one body to another. The amount of heat to change the temperature of a specific substance one degree Celsius is its specific heat capacity. Heat balance occurs when the amount of heat coming into an object equals the amount of heat leaving it.

All matter is made up of atoms. The greater the energy level in the atoms and molecules of objects, the greater their movement. Objects that have rapidly moving molecules are hot, and those with slow molecules are cold. Temperature is a measurement used to indicate the internal energy level of an object.

Temperature indicates the energy transfer that will occur when a hot body comes in contact with a cold body. For example, two identical pieces of iron cut from the same bar are placed into either boiling water or a freezer for an hour, then placed on top of one another on an insulated board. The hot iron would have a higher internal energy level than would the iron from the freezer. The heat energy would flow from the hot iron to the cold iron. This transfer of heat would continue until both bars were the same temperature.

To measure the heat flow into an object, the specific heat capacity of a subject is used to measure how much energy it will take to make it hotter or colder. Scientists and engineers define the term *specific heat capacity* as the amount of energy (or heat) that it takes to raise the temperature of one gram of water one degree Celsius. Denser materials take more heat to raise their temperature one degree than do less dense materials.

Heat capacity as the capacity of a body to store heat is measured in units of joules per Kelvin. The *extensive quantity* of a body expresses the size of a body, such as an above-ground swimming pool versus a cup of water. Specific heat capacity is found by measuring the capacity of a material by its mass. The mass-specific heat capacity is an *intensive quantity*, which means that it is a measure that is not dependant upon the mass or type of material of an object.

Heat is transferred from one body to another in one of three ways. *Conduction* is the transfer of energy (heat) from molecules bumping into one another. If one end of a silver rod is put into a flame, the other end of the bar will soon warm, because the molecules conduct energy from one end of the bar to the other by bumping into each other.

Convection is the transfer of energy in liquids or gases. Because the molecules are too far apart to be effective conductors of energy, the energy is moved by currents in the fluid gas or liquid. A space heater warms surrounding air, causing it to rise as cooler air is drawn to the heater.

Radiation is the third way that heat is transferred. If the body is a metal, such as a cherry-hot iron or a glowing fire, it sends out infrared waves of energy.

Heat balance occurs when the energy output of a system equals the energy input in a specific place or specific system, creating an equilibrium. In natural systems of the earth, heat balance is very important. The sun's rays warm the earth and oceans. This produces warm water, evaporation of water into vapor to become clouds, and heated air from the warmed earth. The effect is temperatures that cause rising air and water vapor. The rising air creates a low pressure area into which cooler air, which is heavier, moves. Globally, this is a massive form of heat flux seeking a heat equilibrium or balance that is never finally achieved. If it were, the atmosphere would stagnate from a lack of circulation.

Heat as balance and capacity are also important factors in life. For example, sleeping bags are designed to trap and hold air around the body. If the insulation in the sleeping bag is effective, heat is not transferred from the body to the surrounding colder atmosphere. A heat balance is achieved, and the sleeper is warm all night despite the cold.

SEE ALSO: Energy; Solar Energy; Thermodynamics.

BIBLIOGRAPHY. American Institute of Chemical Engineers, ed., *Ideal Gas Law, Enthalpy, Heat Capacity, Heats of Solution and Mixing* (American Institute of Chemical Engineers, 1984); Yunus A. Cengel, *Introduction to Thermodynamics and Heat Transfer* (McGraw-Hill, 1996); Hans U. Fuchs. *The Dynamics of Heat* (Springer-Verlag, 1996); Donald W. Rogers, *Einstein's Other Theory: The Planck-Bose-Einstein Theory of Heat Capacity* (Princeton University Press, 2005).

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Heat Island Effect

HEAT ISLANDS OCCUR when urban areas experience higher levels of thermal heating than adjacent exurban and rural areas. Cities that maintain a higher average temperature than their surroundings can be viewed as islands of heat surrounded by cooler, nonurban landscapes. Around the world, many cities maintain air temperatures up to 10 degrees F (5.6 degrees C) warmer than surrounding areas. Scientists, urban planners, and historians are beginning to recognize that urban heat islands are not simply inconsequential environmental phenomena. Rather, the effects of urban heat islands are now being linked to processes of urban economic development and to levels of individual and community vulnerability.

Urban areas contain distinct physical properties that contribute to higher surface temperatures. The conversion of formerly vegetated landscapes to nonvegetated surfaces "forces" urban temperatures upwards by changing the thermal properties of urban environments in four significant ways.

First, vegetation absorbs solar energy out of the atmosphere in order to complete the process of evapotranspiration. Removing vegetation therefore eliminates an important cooling mechanism. Second, materials commonly used in the construction of asphalt roads and parking lots decrease the overall reflectivity, or albedo, of cities while simultaneously increasing heat-absorbing capacity. Third, the conversion of urban areas to nonimpervious surfaces facilitates the expedient removal of rainwater from the urban system. Because the evaporative capacity of water takes heat out of the urban environment, its rapid removal minimizes this important cooling process. Fourth, the replacement of low-lying trees and buildings with large structures that block natural wind patterns can diminish the role of wind as a natural cooling mechanism.

Urban heat islands can have negative health and environmental consequences. Increased average urban temperatures, especially during hot spells, create health hazards for many vulnerable urban residents. The 1995 midsummer Chicago heat wave resulting in approximately 525 fatalities. Researchers noted that while many urban residents experienced only minor inconveniences when daytime temperatures hovered near 100 degrees for over 5 days, others, such as the elderly and homeless, fell victim to the unrelenting heat.

Urban heat islands also increase photochemical reactions that lead to the production of harmful, ground-level ozone pollution. In Los Angeles, health risks from high smog levels increase when temperatures rise over 95 degrees F. Moreover, as temperatures increase, demand for air conditioning by urban residents goes up, which in turn leads to increased coal-fired energy production and more pollution. Higher urban temperatures can also disrupt local weather patterns. The city of Atlanta continues to experience heavier rainfall, increased thunderstorms, and locally generated winds as the city expands and the heat island effect becomes more pronounced.

A consortium of U.S. organizations, including the National Aeronautics and Space Administration and the National Ocean and Atmospheric Administration, use thermal sensory data to detect "hotspots" and evaluate existing surface characteristics in U.S. cities. The U.S. Environmental Protection Agency suggests a number of "smart growth" approaches for cities, including reducing large parking lots and other impervious surfaces, maintaining preexisting vegetation, promoting tree planting programs, and establishing educational outreach efforts for urban residents. Many municipalities have initiated programs to mitigate the production and/or effects of heat islands. These include promoting green roofs, aggressively incentivizing carpools, building with lighter surfaces, and strategically designing urban corridors that maximize wind channeling.

SEE ALSO: Air Conditioning; Carpooling; Environmental Protection Agency; National Ocean and Atmospheric Administration; Pollution, Air; Urbanization.

BIBLIOGRAPHY. EPA, "Heat Island," www.epa.gov/heatisland/index.html (cited October 2005); T.R. Oke, *Boundary Layer Climates,* 2nd ed. (Routledge, 1987); B. Stone and M.O. Rodgers, "Urban Form and Thermal Efficiency: How the Design of Cities Influences the Urban Heat Island Effect," *Journal of the American Planning Association* (v.67/2, 2001).

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Heat Wave

A HEAT WAVE is a prolonged period of unusually warm and humid weather, lasting for a period of days to weeks; a minimum of three consecutive hot days is a common rule of thumb. Similarly, the temperature threshold that indicates a heat wave depends on what is normal for the region. In assessing the impact of a heat wave, the most useful measure is the *apparent temperature*, which is an index that combines air temperature and humidity to assess the total stress that individuals will experience.

Heat waves create uncomfortable conditions, and are often associated with increases in human mortality. The hot, humid conditions characteristic of heat waves raise the body temperature while simultaneously limiting evaporative cooling, producing discomfort and increased stress on the body. Heat wave deaths are higher among elderly populations, and are often attributed to cardiovascular and respiratory problems, exacerbated by the heat stress. Increases in death rates during heat waves are more common in northern cities, where air conditioning is less common and the population is not acclimated to high temperature and humidity. In southern cities, where high temperatures are typical during summer, unusually warm events tend to have less of an impact. In addition, there are socioeconomic patterns in heat-related deaths, as air conditioning and effective medical care are often less available to the poor. Overall, heat-related deaths tend to be more frequent than any other form of weather-related mortality, although the direct cause of death is often attributed to an underlying medical problem that increase a person's vulnerability to heat stress.

In addition to mortality, heat waves result in vast increases in energy consumption. Failures of the energy infrastructure due to increased load can contribute to discomfort and mortality. Economic impacts can include a decrease in shopping and worker efficiency. Agriculture is also affected: livestock mortality rises during heat waves, and the production of milk and eggs is reduced.

Heat waves tend to be a larger problem in urban areas than rural areas. Due to the urban heat island effect, cities can be several degrees warmer than the surrounding countryside. More significantly, cities do not cool off as much during the night due to the slow release of heat stored in concrete and other surfaces, as well as waste heat produced by transportation and industry. Unusually warm nights can be particularly important during heat waves. Nighttime normally provides an opportunity for the body to relax and recover. When nights are unusually warm as well, this recovery is limited and mortality can be increased. During a heat wave, the majority of excessive deaths tend to occur in the early days of the event, as the more vulnerable members of the population succumb. As the heat wave continues, the death rate tends to drop, due to the gradual acclimatization of the populace.

HEAT WAVES IN HISTORY

In recent years, several significant heat waves have produced excessive mortality in the United States and Europe. In July 1995, a period of high temperature and humidity was responsible for over 1,000 deaths in the U.S. Midwest, including over 500 in Chicago, which was ill-prepared for the severity of the event. Many of these deaths were attributable to extremely high nighttime temperatures, and disproportionately occurred among the elderly and poor residents in urban areas. Four years later, a similar heat wave affected nearly the same area with far fewer deaths. The reduced death toll in 1999 can be at least partly attributed to the improved responses of state and city governments, including better public notification, the opening of cooling centers for residents without air conditioning, and careful attention to electrical infrastructure.

In the summer of 2003, a record heat wave struck much of Europe and resulted in over 35,000 deaths, many of them elderly. This effect was exaggerated due to the demographic structure of many European countries, which have relatively high proportions of elderly people. As in Chicago, national and regional governments were not prepared for such extreme heat in a region that does not typically experience hot summers. Because heat waves are unusual, air conditioning is uncommon and people are not well-acclimated to high temperatures. In addition, the heat wave struck in August, a month when many people, including physicians and other health workers, traditionally vacation.

Of significant concern is the question of whether global warming will result in increased frequencies of heat waves and the associated mortality. Over the past century, the global average temperature has risen by approximately 0.6 degrees C (1.1 degrees F), and continued warming is anticipated. As much of this warming is expected to occur at higher latitudes, it is reasonable to expect that heat waves should become more common in northern cities. However, heat-related mortality has in fact decreased in the United States since the 1960s, despite the fact that stressful weather conditions have become more common. There are many possible explanations for this trend, including improvements in health care, the wider availability of air conditioning, better governmental responses to extreme weather, and a general acclimatization to heat in the population. Still, heat remains the largest weather-related killer and will continue to be a serious concern.

SEE ALSO: Global Warming; Weather; Heat Island Effect.

BIBLIOGRAPHY: Shaoni Bhattacharya, "European Heatwave Caused 35,000 Deaths," www.newscientist.com/article (October 2003); Frank C. Curriero, Karlyn S. Heiner, Jonathan M. Samet, Scott L. Zeger, Lisa Strug, and Jonathan A. Patz, "Temperature and Mortality in 11 Cities of the Eastern United States" (*American Journal of Epidemiology*, 155(1):80-87, 2002); Robert E. Davis, Paul C. Knappenberger, Patrick J. Michaels, and Wendy M. Novicoff, "Changing Heat-Related Mortality in the United States" (*Environmental Health Perspectives*, 111(14):1712-1718, 2003); Thomas R. Karl and Richard W. Knight, "The 1995 Chicago Heat Wave: How Likely is a Recurrence?" (*Bulletin of the American Meteorological Society*, 78(6):1107-1119, 1997); Frederick K. Lutgens and Edward J. Tarbuck, *The Atmosphere,* 8th ed. (Prentice-Hall, 2001); Michael A. Palecki, Stanley A. Changnon, and Kenneth E. Kunkel, "The Nature and Impacts of the July 1999 Heat Wave in the Midwestern United States: Learning from the Lessons of 1995" (*Bulletin of the American Meteorological Society*, 82(7):1353-1367, 2001).

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Heavy Metals

HEAVY METAL IS a term frequently used by environmentalists to describe a group of metallic elements that frequently have toxic effects. The heavy metals include elements such as mercury, lead, and cadmium. However, as a definition of a class of toxic compounds, the term *heavy metals* is somewhat problematic. The term implies the toxic material is in metallic form, whereas many heavy metals in the environment may actually be present as a compound, for example methylmercury.

Another problem with the term is that several elements that are sometimes encompassed in the category include the potentially toxic substances arsenic (a semimetal) and selenium (a nonmetal). The definition of "heavy" is also problematic. Various definitions consider metals with densities of anything from 3.5 to 7 g/cm^3 or above as heavy. However, some metallic elements that are actually "light" may also be of environmental concern, such as aluminum (density 2.7 g/cm^2) and beryllium (density 1.85 g/cm^2). Also, using density as a categorization is problematic as such a physical property can vary according to condition or state of an element.

Sometimes atomic weight is used as a defining characteristic of heavy metals; for example, an atomic mass of 63.5 or greater. This again would exclude several elements that are of environmental concern as heavy metal contaminants, such as chromium, nickel, and cobalt (approximate atomic masses 52, 58.7, 59, respectively) and would exclude metals with low atomic masses that form toxic compounds, such as beryllium (approximate atomic mass 9).

Sometimes the term *trace element* is preferred by many scientists to categorize inorganic contaminants; however, the term *trace* suggests that quantities of the element occur in the environment in very low amounts, or that even a "trace" of an element might be toxic. The term also may cause confusion with the language of nutrition, in the context of elements that may be required in "trace" amounts in the diet because they have essential functions within the body of organisms.

Many toxic heavy metals are not necessarily toxic in their pure, metallic forms, and the toxicity of the substance varies according to the state or valency of the element. For example, hexavalent chromium (VI) compounds (i.e., Cr^{6+}) can be extremely toxic and carcinogenic, whereas chromium (III) compounds are generally not a health concern.

Whereas some heavy metals have no known role in the nutritional needs of organisms, such as mercury, and even low levels may be of toxicological concern, several heavy metals are actually required in the diet and are trace essential nutrients, including cobalt, a component of vitamin B_{12}; iron, which is a component of hemoglobin, the pigment that carries oxygen in the blood; and zinc, a component of many enzymes that facilitates metabolic reactions in the body. However, high intakes of these elements may be toxic. High concentrations of heavy metals are problematic, but high concentrations of almost any substance in the environment, even relatively benign substances, can also be toxic.

Heavy metals are naturally occurring, and can be released into the atmosphere as the result of forest fires or volcanic emissions; as a gas, particle, or bound to the surface of dust; or they may be released from rocks by erosion and carried by water, in solution, as particles, or bound to the surface of a suspended substance, into rivers or the ocean. Anthropogenic activities also produce heavy metals, such as burning of fossil fuels in power plants or automobiles, as a by-product of mining, the dumping of heavy metal containing waste, or discharges by industry or sewage systems.

Heavy metals may also be transferred via organisms, and are not broken down by biological processes. Although plants and animals can regulate their metal content to a certain point, metals that cannot be excreted bioaccumulate—build up in an organism over its lifetime—especially long-lived species, concentrating in protein-rich tissues such as liver and muscle. Moreover, predators can absorb heavy metals contained within the tissues of their prey species, gaining even higher inputs of contaminants on up the food chain, until animals at the highest trophic level obtain the highest concentrations of heavy metals, a process known as *biomagnification*.

As humans are a long-lived, top predator, they are at risk from bioaccumulation and magnification of heavy metals. In humans, problems of heavy metal pollution were first brought to world attention with so-called Minamata disease in the 1950s. This primarily neurological condition was caused by consumption of mercury. However, many other so-called heavy metals have effects on the human nervous, immune, and reproductive/hormonal sysyems; for example, lead is of particular concern.

SEE ALSO: Carcinogens; Lead; Mercury; Minimata, Mining; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. J.H. Duffus, "Heavy Metals—a Meaningless Term?" *IUPAC, Pure and Applied Chemistry* (v.74, 2002); Morton Lippmann, *Environmental Toxicants: Human Exposures and Their Health Effects* (John Wiley & Sons, 1997); Bibudhendra Sarkar, Heavy Metals in the Environment (CRC Press, 2002); Jun Ui, *Industrial Pollution in Japan* (United Nations).

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Hedgerows

HEDGEROWS ARE LONG, thin, organized rows of plants, mostly woody shrubs, which are used to divide areas of land. Hedgerows have been used especially in Europe for many centuries, and some are up to 700 years old. They have become important homes to many species of wildlife and are recognized, at least by some, as valuable working artifacts.

Woody plants used for hedgerows include holly, oleander, privet, and hawthorn. The number of woody plants found in a 30-yard stretch of hedgerow is roughly equivalent to its age in centuries. The exact composition of the hedgerows varies according to specific local conditions, as does their method of construction. They also represent effective barriers to most forms of wind erosion.

Where land ownership is divided into small lots, hedgerows may represent problems for subsequent land planning, such as road planning. Hedgerows have been used as evidence of boundaries for land ownership and so can be taken as legal proof. Careful examination of hedgerows in many parts of Britain reveals that many are constructed on the basis of multiples of 22 yards (approximately 20 meters), which is a traditional measurement known as a *chain*.

Many farmers have in recent years found that hedgerows occupy too much of a proportion of their land and also hinder their ability to use tractors or other large machinery. Dividing land into small parcels may also appear to be inefficient in terms of economies of scale. However, due to to the importance of hedgerows as objects, they are protected in Britain by the 1997 Hedgerow Regulations, which aim to maintain in their current form those hedgerows that are not wholly contained within a domestic garden. These regulations are made more complex by the provisions for distinguishing between trimming and pruning hedgerows for maintenance versus reducing them in scope. Even so, economic pressure on hedgerows means that they are still disappearing gradually, so conservationists have been conducting research to determine other benefits that can be added to the cost-benefit analysis of their preservation. These include the fact that hedgerows shelter some beetles and insects that assist in pest control; that they are comparatively difficult to vandalize or to damage; their ability to support rabbits, pheasants and other creatures that may be hunted; and their provision of shade for livestock.

SEE ALSO: Agriculture; Conservation; Preservation; United Kingdom.

BIBLIOGRAPHY. Peter Ashley, *Pastoral Peculiars: Curiosities in the Countryside* (English Heritage, 2005); Gerry Barnes and Tom Williamson, *Hedgerow History: Ecology, History, and Landscape Character* (Windgather Press, 2006); Alan Brooks and Elizabeth Agate, *Hedging* (BTCV), www.handbooks.btcv.org.uk (cited December 2006).

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Herbicides

HERBICIDES ARE CHEMICALS or biological agents used as pesticides to kill a weed, which is any plant growing where it is not wanted, usually those abundant enough to take over flowerbeds, gardens, or reduce yield in agricultural fields. Reasons for using herbicides include improving the aesthetic appeal of a landscape or ornamental garden, increasing crop yields, or to kill intoxicants or narcotic plants grown as illegal substances. Herbicides have also been used to expose enemy combatants in jungle areas.

Until the time of World War II, weeds were controlled mechanically. This included plowing, weeding by hand, or using a hoe. Cultural controls are methods used to cultivate the land so it is less hospitable to weed development. Altering the pH of the soil, its salinity, and its fertility are other ways to hamper weed development.

Some plants are natural herbicides. Sassafras trees (*Sassafras albidum)* act as herbicides with allelopathic toxins produced in their roots. Allelopathy occurs when one plant interferes chemically with the development of another. Other allelopathic plants include black walnuts, sagebrush, and sunflowers.

Most herbicides are synthetic chemicals manufactured for specific purposes. There are a number of ways to classify herbicides, such as by the kind of vegetation they control, the activity, use, chemical family name, or mode of action. Contact and systemic herbicides are "activity" herbicides. Contact herbicides kill plant tissue on contact. They are fast-acting and are generally most effective on annuals. Systemic herbicides work by being taken into the plant, which it then poisons. These herbicides are usually applied by spraying on the leaves or by applying it to the soil.

Preemergent herbicides are applied to the soil before the crop emerges to prevent weeds from germinating. Postemergent herbicides are applied after the crop has emerged. Some herbicides inhibit the biology, enzymes, or proteins of a plant, interfering with the mechanism of action of a weed. The ACCase (Acetyl coenzyme A carboxylase) inhibitors are used to kill grasses by interfering with the lipid synthesis in their cell membranes. Acetohydroxyacid synthase (AHAS) acetolactate synthase (ALS), inhibitors interfere with enzymes or with amino acid production in plants, causing them to slowly starve to death. Other inhibitors interfere with the production of amino acids in plants. Glyphosate, sold commercially as Roundup, is an enolpyruvuylshikimate 3-phosphate synthase enzyme (EPSPS) inhibitor. The first organic herbicide was synthetic auxin, which mimics plant growth hormones to interfere with plant development. Photosystem II inhibitors interfere with electron flow in photosynthesis.

Herbicides are used in enormous quantities in landscaping, landscape turf management, and in agriculture. They are also used along highways in maintenance programs to control vegetation, which are called total vegetation control (TVC) programs. Herbicides are also used extensively in the management of wildlife areas, in forestry, and in pasture management systems. They are also used to eliminate or reduce the growth of weeds in lakes. Most widely used herbicides are mixed with water and sprayed with various equipment, such as a container with a pumping sprayer for small garden spray units. Herbicides may also be sprayed in industrial volume. Railroad and powerline right of ways are often cleansed of weeds in this manner. Airplanes or helicopters can also be used to aerially spray a large volume over wide areas. Chemigation is the method for spraying herbicides through irrigation equipment.

Many of the large number of herbicides in use pose potential health effects on humans, some of them serious. Damaging effects can range from rashes to cancer to immediate death. If applicators are not used properly, gardeners or field workers can inhale aerial sprays. Traces of herbicides can also remain on foods and be consumed. Triazine herbicides have been listed as a human carcinogen, linked especially with breast cancer. Low levels of exposure are believed to disrupt endocrine production. The Environmental Protection Agency has issued a warning concerning the danger of high levels of exposure. Atrazine is an herbicide that has been linked to heart attacks, strokes, eye damage, and birth defects.

Aerial herbicide applications are used to control invasive melaleuca trees on large, remote areas of the Everglades.

Agent Orange was used extensively in the Vietnam War by the United States as a defoliant. Between 1962–71, about 20 million gallons of herbicides were sprayed on the jungles in order to expose enemy troop movements on the Ho Chi Mien Trail and other areas. In the process, American troops were exposed in sufficient doses to cause a number of illnesses.

Herbicides have also caused serious ecological damage. Surface runoff of herbicides has contributed to the pollution of lakes, streams, and rivers used as sources of potable water. Fish kills and other downstream negative health impacts have occurred because herbicides leached or were washed into watersheds. Negative effects from herbicides can also come from soil contamination. Many herbicides deteriorate once sprayed onto an area, but others remain for a sufficiently long period of time that they pose a long-term health danger.

SEE ALSO: Agent Orange; Pesticides; Weeds.

BIBLIOGRAPHY. R. De Padro and J. Jorrin, eds., *Weed and Crop Resistance to Herbicides* (Springer-Verlag, 1997); A.D. Dodge, ed., *Herbicides and Plant Management* (Cambridge University Press, 1990); M.T. Meyer and E.M. Thurman, eds., *Herbicide Metabolites in Surface Water and Groundwater* (Oxford University Press, 1996); National Academies Press Staff, *Veterans and Agent Orange: Committee to Review the Health Effects in Vietnam Veterans of Exposure to Herbicides* (National Academies Press, 2003); S.B. Powles and D.L. Shaner, *Herbicide Resistant Weed Management in World Grain Crops* (CRC Press, 2001); R.M. Roe, R.J. Kuhr, and J.D. Burton, eds., *Herbicide Activity: Toxicology, Biochemistry and Molecular Biology* (IOS Press, Inc., 1997).

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Herders

HERDERS ARE PEOPLE whose lives revolve around the tending of animals and who, consequently, tend to have a seminomadic or nomadic lifestyle. They range from shepherds and cowherds who are found in a wide variety of agricultural settings to the reindeer herders of the north to the nomadic steppe tribes of Mongolia and Central Asia. Despite the name, nomadic tends to mean rotation around a set number of locations on a seasonal or yearly basis. Herders tend to have close knowledge of their environments and are aware of exactly where and when their livestock need to transfer to another location. This is based primarily on the exhaustion of existing food stocks in current locations and understanding the length of time needed for them to be replenished. The mobility of nomadic herders means they are capable of responding to environmental change or the prevalence of disease by rapid migration, which means they are less likely to suffer from the mass starvation that can affect more sedentary people, but which also can lead to conflict with peoples into whose territory they are required to move. It has been argued that such environmental change explains the rise of empires such as that of Genghis Khan's Mongols. In any case, herders and nonherders tend to have competing visions for land use, which can only with difficulty be made compatible and cooperative.

As the demands for greater agricultural production and industrialization of the world increase, combined with desertification processes, the space for herders decreases, especially in the case of those living fully nomadic lives. Since they tend to be poorer than sedentary societies, it is likely that they will be settled in some form of reservation in the same way that the Aborigines of Australia and the indigenous peoples of North America have been settled and are likely to suffer from similar social problems. The poverty of herders is both contributed to by, and results from, the low level of infrastructure and education among their societies, although there are exceptions to this. Efforts by the United Nations Food and Agriculture Organization (FAO), among others, to assist herders have often focused on raising their capacity to deal with state-level actors and to negotiate different living patterns with respect both to the environment and to their neighbors. This is necessary because of possible mistrust by government and also by those neighbors whose lifestyle may differ from the herders and who may feel threatened by or antagonistic toward them for historical reasons.

Because herders occupy lands that may be remote from central governments and have low technical capacity themselves, it is difficult to evaluate their numbers accurately.

SEE ALSO: Livestock; Native Americans; Pastoralism; United Nations.

BIBLIOGRAPHY. Gerry Conaty and Lloyd Binder, *The Reindeer Herders of the Mackenzie Delta* (Firefly Books, 2004); G. Dahl and A. Hjort, *Having Herds: Pastoral Herd Growth and Household Economy* (Liber Tryck, 1976); Brian Fagan, *The Long Summer: How Climate Changed Civilization* (Granta Books, 2004); D. L. Johnson, *The Nature of Nomadism: A Comparative Study of Pastoral Migrations in Southwestern Asia and Northern Africa* (University of Chicago, 1969); United Nations Food and Agriculture Organization (FAO), "Strengthening Capability of Risk Management of the Animal Husbandry Sector and Promoting Sustainable Development in the Grazing Area of Qinghai Province," (FAO, 2005), www.fao.org (cited December 2006).

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Hetch Hetchy Dam

LOCATED IN CALIFORNIA'S Yosemite National Park, the eight-mile-long Hetch Hetchy Reservoir supplies the city of San Francisco, 150 miles to the south, with much of its drinking water and electric power. Formed by the construction of the 410-foot O'Shaughnessy Dam on the Tuolamne River where if flows through the steep walls of the Hetch Hetchy Valley, the reservoir represented one of the most massive construction feats of the early 20th century, promising an ample supply of fresh water and power to a city badly in need of both. To advocates of wilderness protection, however, the dam represented a dangerous incursion of the forces of progress into the nation's wildlands. The heated political debate raged for more than a decade, and provided early environmental advocates with their first national rallying point.

Plans for a reservoir in the Hetch Hetchy Valley had been on drawing boards of San Francisco's city planners since the late 1880s, but because the Valley was located within the boundaries of Yosemite National Park (created in 1890), the federal government rejected early requests, claiming the sanctity of the national park lands took precedence over the city's desire for water. Such claims were made much more difficult to support however, when on April 18, 1906 San Francisco was extensively damaged by a massive earthquake. Far more damaging were the many fires that swept the city in the days that followed, and in the ensuing months, Mayor James D. Phelan and other city planners successfully brought pressure to bear on the federal government. In May 1908, Interior Secretary James R. Garfield approved the city's plans for the damming of the Hetch Hetchy Valley.

FURIOUS OPPOSITION

Opposition to the dam project rose almost immediately. Led by Sierra Club founder John Muir and *Century* magazine publisher Robert Underwood Johnson, opponents of the proposed dam called upon the government to hold a firm line against the invasion of national park lands for purposes of progress and profit. Muir and his allies quickly took to referring to Mayor Phelan and other dam supporters "Satan and Company" and "the money changers," openly suggesting that their motives were driven by greed rather than a desire for a stable city water supply. Drowning the beautiful and pristine valley beneath several hundred feet of water in order to provide water and electricity for a distant city was, for Muir, tantamount to the destruction of a holy temple.

Proponents of the dam, including President Theodore Roosevelt's powerful Chief Forester Gifford Pinchot, saw the issue differently. They argued that few people had ever set foot in the remote Hetch Hetchy Valley—or ever would. Damming the valley to create a dependable source of water and power for citizens represented the greatest good for the greatest number of people, and because of this, issues such as aesthetic beauty or the sanctity of the National Parks should be secondary. Further, since San Francisco's current water and electric demands were met by the powerful Pacific Gas and Electric Company, Progressive Era politicians like Roosevelt and Pinchot saw municipal hydroelectric projects like the Hetch Hetchy Reservoir as an important step toward democratizing control of public utilities.

Debate over the dam proposal inspired a heated national dialogue over the proper role of America's wilderness areas. Muir and other wilderness advocates were able to establish Hetch Hetchy as a powerful symbol of the fate of America's remaining wildlands, and the American public seemed for the first time receptive to the notion of protecting these lands. "The conscience of the whole country has been aroused from sleep," Muir wrote. Members of Congress were barraged by letters and telegrams from all parts of the country, as an obscure mountain valley became the centerpiece of a national political debate.

Despite powerful opposition, on December 6, 1913 Congress passed the bill authorizing the damming of the Tuolamne River at Hetch Hetchy. Muir and others who had fought to preserve the valley suffered a crushing short-term defeat, but the Hetch Hetchy controversy had galvanized opposition to further incursion in the nation's wildlands, reversing a centuries-old mindset that unquestioningly valued technological progress over wilderness preservation. Perhaps more importantly, the controversy had given rise to the first stirrings of a national environmental movement.

BIBLIOGRAPHY. Kendrick A. Clements, "Politics and the Park: San Francisco's Fight for Hetch Hetchy" *Pacific Historical Review* (May 1979); Roderick Nash, *Wilderness and the American Mind* (Yale University Press, 2001); Robert W. Righter, *The Battle Over Hetch Hetchy: America's Most Controversial Dam and the Birth of Modern Environmentalism* (Oxford University Press, 2005); John W. Simpson, *Dam!: Water, Power, Politics, and Preservation in Hetch Hetchy and Yosemite National Park* (Pantheon, 2005).

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Highways

HIGHWAYS ARE MAJOR roads used by the public that connect cities, historic or natural sites, or rural locations. There have been trails or rough roads throughout the world for thousands of years. The Roman Empire built highways that in a few cases are still in use. Other empires built similar road systems to aid communications and the movement of troops. In the 20th century, highways were built to facilitate the movement of people, goods, and military forces. The invention and development of gasoline engines that powered trucks, cars, buses and other vehicles led the United States to build highways.

The United States has the most extensive highway system in the world, some of which are county or state roads. Others are part of the numbered highway system. Even-numbered highways start in the east coast and grow in number toward the west coast, such as old Highway 66 (Route 66) one of the first such highways. U.S. Highway 1 runs from Maine to Florida. U.S. highways that run north and south, such as U.S. Highway 11 or 41, are odd numbered. U.S. Highway 101 runs along the California coast from Mexico to Canada.

Other highways in the United States are interstate highways, which are limited-access roads that are fenced to keep animals from crossing and being killed. Every year, millions of animals are killed on the roads in the United States. In Pennsylvania, the number of deer killed by traffic on the highways has in some years exceeded the number of deer killed by hunters in hunting season. The interstate highway system has been built with road grades that allow for high-speed travel. They have multiple lanes of traffic that are separated by a median to reduce the possibility of deadly head-on collisions. However, thousands of people are killed in highway traffic accidents every year around the world.

Highways in the United States are usually funded by gasoline taxes or tolls. Consumers pay two taxes when purchasing gasoline. The federal tax is uniform throughout the whole country and is applied to the Federal Highway Trust Fund, which supports road building in the states and public transportation. State gasoline taxes vary from state to state, and is distributed in the states in a variety of ways. The highway system has been a great boon to travelers, opening regions that can be seen by tourists. However, highways are also an ecological challenge. Every highway covers vast acreage with paving, which is lost to the environment. Highways also use great quantities of materials for paving—crushed gravel, cement, asphalt, fill dirt, metal, and plastics for rails and markings, as well as glass for lighting.

The design of highways is similar in that most have a dividing median and at least two lanes of traffic flowing in opposite directions. However, some have multiple lanes, and use various access controls such as entrance and exit ramps. Some of the world's most magnificent bridges are part of a highway system. In mountainous areas, tunnels permit easy movements where historically travel over high mountains passes was treacherous.

ROAD TO DEVELOPMENT

Highway development is increasing across the world, with China seeing the most rapid expansion. Some highways cross international boundaries. The Alcan Highway (Alaska-Canadian) runs from the United States through Canada to Alaska. It was built during World War II to provide a viable land route to provide protection to Alaska. Many American highways have been built for defense reasons. The law authorizing the interstate system in the United States is officially the Dwight D. Eisenhower National System of Interstate and Defense Highways, modeled after the German Autobahn. Highways have been beautified in many ways. On some, vast beds of flowers have been planted. However, the great increase in highway building has opened many primitive or rural areas to development, in some cases for vacation homes, hunting, or fishing. The opening of a new highway usually attracts businesses to service the needs of travelers, which then causes growth in areas that were previously undeveloped.

In addition to the direct impacts of highways on the environment, roads have far-reaching impacts on wildlife and their habitat. Passing vehicles create noise and chemical pollution that reach far beyond the pavement. By altering the physical environment, roads and highways modify animal behavior. To avoid them, many species shift home ranges, change movement patterns and even reproductive and feeding behaviors. Perhaps the most pervasive, yet insidious impact of roads is providing access to natural areas and encouraging further development. As our cities and towns sprawl across the landscape, more and more wildlife habitat is forever lost to strip malls and parking lots.

SEE ALSO: Development; Runoff; Transportation; Urban Sprawl.

BIBLIOGRAPHY. Owen D. Gutfreund, *Twentieth-Century Sprawl: Highways and the Reshaping of the American Landscape* (Oxford University Press, 2005); Dan McNichol, *The Roads that Built America: The Incredible Story of the U.S. Interstate System* (Sterling, 2005); Coleman A. O'Flaherty, *Highways* (Elsevier Science & Technology Books, 2002); R.P.P. Roess, W.R. McShane, and E.S. Prassas, *Traffic Engineering* (Prentice Hall, 2004).

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Himalayas

THE HIMALAYAN MOUNTAIN range separates the Indian subcontinent from the Tibetan plateau. The name comes from Sanskrit *himalaya*, which means "the abode of snow." The Himalayas stretch across five countries: Pakistan, India, Nepal, Bhutan, and China. It is the highest mountain range in the world and includes all 14 of the peaks above 8,000 meters ASL (the highest peak being Mount Everest at 8,848 meters ASL) and over 110 different peaks higher than 7,300 meters ASL. The Himalaya is one of the youngest mountain ranges in the world, resulting from the continental collision along the convergent boundary between the Indo-Australian Plate and the Eurasian Plate. The collision started in the Upper Cretaceous period about 70 million years ago, when the Indo-Australian plate was moving about 15 centimeters/year. The plate is still moving northward at about 6.7 centimeters/year, which results in the Himalaya rising by about 5 centimeters a year.

The Himalayan range is composed of three nearly parallel ranges, arranged by elevation and geological age. In the south, the youngest of the three is called the Outer Himalayas (also known as Siwalik Range), has an elevation of about 900–1,400 meters ASL, and is about 48 kilometers wide in the west and gradually narrows toward the east, until it nearly disappears in Bhutan and eastern India. Running parallel to this is the Lesser Himalayas (also called the Lower or Middle Himalayas). With an elevation of 2,000–4,500 meters ASL, and a width of about 80 kilometers, it is made up of a mosaic of forest-covered ranges and fertile valleys. The northernmost range, and oldest of the three, is called the Great (or Higher) Himalayas. It is about 24 kilometers wide, and with an elevation of more than 6,000 meters ASL, it is perpetually covered in snow or ice. It is here that the highest peaks are found. Between the Great and Lesser Himalayas there are numerous fertile valleys.

The Himalaya range has an effect on the climate of the Indian subcontinent and the Tibetan plateau. It stops dry cold arctic winds from blowing south into the Indian subcontinent, which causes the subcontinent to be warmer than other regions of that latitude. It also prevents the monsoon winds to travel northwards, limiting rainfall north of the mountain range, and causing heavy rainfall in the Terai region. Within the Himalayas, the climatic conditions vary according to location and elevation. In the southern foothills, average summer temperatures are about 30 degrees C and average winter temperatures about 18 degrees C.

In the Middle Himalayan valleys, average summer temperatures are about 25 degrees C and winters are cooler. In the higher parts of the Middle Himalayas, average summer temperatures are 15–18 degrees C and winters are below freezing. In the Greater Himalayas, at elevations above 4,880 meters, the climate is below freezing and the area is permanently covered with snow and ice. The eastern part of the Himalayas receives heavy rainfall, while the western part is rather dry.

The Himalaya region has hundreds of lakes, the largest of which is the Pangong t'so, which is spread across the border between India and Tibet, at an altitude of 4,600 meters and is 8 kilometers wide and nearly 134 kilometers long. The large number of glaciers in the Greater Himalayas includes the Siachen Glacier, the largest in the world outside the polar region. These areas are the source of several large perennial rivers, most of which combine into two larger river systems, the Indus Basin, and the Ganga-Brahmaputra-Meghna. The Yangtze, the Huang He (Yellow River), the Mekong, and the Salween rivers originate from parts of the Tibetan plateau, which is geologically distinct from the Himalaya mountain range, and therefore are not considered Himalayan Rivers. In recent years, glaciers in the region have retreated because of global warming. If this pattern continues, it will mean disaster for the millions of people who rely on the water from the glaciers during the dry season.

The Himalayas have been a natural barrier for people for millennia. The difficulty in traveling between the Indian subcontinent and China has prevented frequent contact, and has contributed to the significant differences in language and customs between these two regions. The Himalayas have also obstructed the development of trade routes, and limited the trade between the Indian subcontinent and its neighbors north of the Himalayas. The height and difficulty in traveling across the Himalayas range also prevented military expeditions. For example, Genghis Khan could not expand his empire south of the Himalayas.

Close to 40 million people inhabit the Himalayas, most of which are subsistence farmers with very low incomes. Agricultural land is concentrated in the Tarai plain and in the valleys of the Lesser Himalayas. Patches of agricultural land have also been carved out in the forested areas. However, cold winters and a short growing season limit the cultivation to one crop per year, most commonly potatoes, barley, or corn—except in the Tarai plain, where rice is grown in well-watered valleys. Economic changes and population growth are causing various environmental problems, such as deforestation in the foothills of the Lesser Himalayas, and overgrazing on the high pastures.

There are dozens of different ethnic groups in the Himalayas. Generally, however, the Outer Himalayas and the Lesser Himalayan valleys from eastern Kashmir to Nepal are inhabited by Hindus of Indian heritage. The Great Himalayas from Ladakh to northeast India are predominantly inhabited by Tibetan Buddhists. In the middle regions in central Nepal, at elevations between about 1,800–2,500 meters ASL, the Indian and Tibetan cultures have intermingled, resulting in different religious traditions with combinations of Indian and Tibetan traits.

SEE ALSO: China; India; Mountains.

BIBLIOGRAPHY. K.M. Bauer, *High Frontiers: Dolpo and the Changing World of Himalayan Pastoralists* (Columbia University Press, 2003); R. Guha, *The Unquiet Woods* (University of California Press, 2000); E.L. McHugh, *Honor in the Himalayas: Coming to Know Another Culture* (University of Pennsylvania Press, 2001); A. Rao, *Autonomy: Life Cycle, Gender, and Status among Himalayan Pastoralists* (Berghahn, 1999); D. Zurick and P.P. Karan, *Himalaya: Life on the Edge of the World* (Johns Hopkins University Press, 1999).

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Hiroshima

IN THE CLOSING days of World War II, President Harry Truman made the decision to approve the release of atomic bombs over two Japanese cities to force Japan to surrender after Germany surrendered on May 7, 1945. In addition to the 115,000 deaths that occurred at Hiroshima and Nagasaki, there have been major long-term environmental consequences that continue to be assessed. Cities with large civilian populations were specifically chosen for the attacks to increase the impact of the action so that Japan would be left with no choice but to end the war that caused the deaths of some 62 million people. The decision was effective; within a week, Japan surrendered unconditionally. Nevertheless, the use of atomic weapons has remained one of the most controversial actions in American history. Critics argue that the war would have ended shortly without the use of atomic bombs. Others insist that the blame for the bombing lies not with Truman but with Emperor Hirohito, who delayed surrender, hoping that the Soviet Union would come to Japan's aid.

Truman insisted that his decision was based on a desire to save American lives, and there is strong evidence that the Japanese had pledged to take out another 1 million Americans if Japan were invaded.

In addition to millions of casualties, Japan committed horrific atrocities on prisoners of war, civilians, and internees that included starvation, beatings, torture, rape, and burns. Because the Japanese destroyed most records in the days before the surrender, accurate tallies of atrocities and fatalities are not available, but it is estimated that some 130,000 Chinese were killed by the Japanese.

President Truman and his advisors had chosen the Japanese cities of Hiroshima, Nagasaki, and Kokura as possible targets for the bombs, depending on the weather. On the morning of August 6, 1945, the *Enola Gay* dropped a 10,000-pound uranium-fueled bomb, designated "Little Boy," on Hiroshima, a city of 250,000 people. Immediately, there was a flash of brilliant purple light. The resulting fireball covered a radius of 230 miles (370 kilometers) and raised the temperature immediately below it to 3,000 to 4,000 degrees C. Dust covered the city, where 90 percent of buildings were destroyed. Within minutes, half the population was dead or dying. Initially, deaths occurred as a result of the explosion, fires, and falling debris. Because there was no precedent for dealing with radiation, nothing was done to prevent others from entering Hiroshima in the days following the attack. For up to two weeks, radiation levels remained lethal and were present in the air and soil for an unspecified period.

After the attack, the Japanese and American governments began collecting data on *hibakusha* ("explosion-affected persons"). Because the data was classified, it was not until seven years later when the Americans pulled out of Japan that the full consequences of the bombs became known to the general population. Scientists identified what came to be called "atom bomb disease" because people were dying with no clear reason for their illnesses. Most of these victims died within four months of the attack.

By 1948, the Atomic Bomb Casualty Commission (ABCC) had been designated as the major American research arm of the Hiroshima followup, and scientists began conducting genetic testing on 70,000 children who had survived the attack. Tests revealed higher than normal incidences of conditions that included "radiation cataracts," certain cancers, blood disorders, and birth defects. Incidences of leukemia were particularly persistent, revealing that those who had been within two-thirds of a mile (one kilometer) of the blast were 150 times more likely to develop the disease than were those in the general population. In 1975, the United States and Japan formed the Radiation Effects Research Foundation

Wilfred Burchett

Wilfred Burchett (1911–80) was an Australian journalist and the son of a Methodist law preacher. In 1936 he moved to London and worked at a travel agency, being briefly involved in helping with tours of the Soviet Union. He subsequently moved into journalism and reported on the uprising against the Vichy French on the South Pacific island of New Caledonia. When the Japanese invaded Burma in December 1941, he then reported on Burma, writing several books on his experiences there.

In 1945 Burchett went to Japan, and traveled by train to Hiroshima, arriving on September 2, the day after the formal surrender of Japan on the U.S.S. *Missouri*. Burchett was the first Westerner to arrive in Hiroshima after the bombing and was horrified by what he saw. He sent his report by Morse code to the *Daily Express* newspaper in London. Entitled "The Atomic Plague," it was the first report to mention the effect of nuclear fallout and radiation sickness. It is also thought that Burchett might have contracted some radiation himself during his reporting.

Burchett continued to be a journalist for the rest of his life, managing to get access to the trials of Eastern European Communist leaders during the last years of Stalin. He also reported from the Communist side in the Koreas and in Vietnam. Burchett was accused of working with the communists, which was accentuated by his articles about the Soviet advances in science and economic reconstruction.

Always a controversial figure in his native Australia, Burchett fought a long battle with the Australian government about their refusal to issue him another passport after he lost his original. The author of many books, Burchett died in Sofia, Bulgaria.

to replace the ABCC and charged it with continuing the study of long-term effects of radiation on *hibakusha* and their descendants.

SEE ALSO: Carcinogens; Mutation; Nuclear Weapons; Radioactivity; Uranium.

BIBLIOGRAPHY. Hannah Brown, "Hiroshima: How Much Have We Learned?" *The Lancet* (v.6/August); Shuntaro Hida, "The Day Hiroshima Disappeared," in Kai Bird and Lawrence Lifschultz, eds., *Hiroshima's Shadow* (Pamphleteers Press, 1998); Michael J. Hogan, *Hiroshima in History and Memory* (Cambridge University Press, 1996); Rachel Linner, *City of Silence: Listening to Hiroshima* (Orbis Books, 1995); Robert P. Newman, Enola Gay *and the Court of History* (Peter Lang, 2004); Diana Preston, *Before the Fallout: From Marie Curie to Hiroshima* (Walker, 2005).

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Historical Materialism

HISTORICAL MATERIALISM IS a methodological and explanatory framework for understanding social, political, and environmental conditions and change, based in the thought of Karl Marx. It suggests that the various forms of human institutions and social organization are dependent upon the "production of material life" in communities, and is described most famously in the preface to his *Contribution to the Critique of Political Economy* of 1859. There, Marx calls the ensemble of the material "productive forces" and their corresponding relations of production, as they exist at any one place and point in time, a "mode of production," and offers as examples "Asiatic, ancient, feudal, and modern bourgeois [capitalist]." Historical materialism is thus an explicitly materialist theory of history, for each of the social formations that make up the diversity of human history, "the social, political and intellectual life process in general" will be conditioned or derived from the "mode of production of material life."

The approaches to these relations we know today as political ecology, environmental sociology, and political economy of the environment would be unthinkable without historical materialism. The fundamental object of analysis in the environment–society relation is change: How does human life affect its environment (nature), and how does the environment affect human life? The way in which the mutual shaping of environment and society is critically approached today was largely rejected, even unthinkable, in the intellectual climate from which Marx emerged.

EARLY BEGINNINGS

Marx developed his theory of history as a critique of the idealism dominant in Germany when he began his career. Idealism asserts that human consciousness is independent of the world in which it exists. Within environmental constraints, human life is seen to be a product of human ideas, not of the material ways in which that life is lived. However, historical materialism shares G.F.W. Hegel's idea of historical "development." Hegel argued that society developed through the progressive overcoming of contradictions in human consciousness. Marx agreed with that assumption, but felt that "It is not the consciousness of men that determines their being, but, on the contrary, their social being that determines their consciousness." For Marx, what people are even capable of comprehending is a product of their material–historical life. An approach like political ecology, which attends to the myriad ways in which the environment is both a site of politics and highly politicized, is unimaginable without this central tenet.

Although Marx did not use the term *historical materialism* himself, there are several key ideas upon which historical materialism depends. The most contentious of these is the so-called *base-superstructure model*. Marx claimed that the "sum total of these relations of production constitutes the economic structure of society, the real basis, on which rises a legal and political superstructure and to which correspond definite forms of social consciousness." Also at issue is the process of social change. Marx argues that "at a certain stage of their development, the material productive forces of society come in conflict with the existing relations of production." This dynamic has massive repercussions for individual and collective life, since during "the change of the economic foundation the entire immense superstructure is more or less rapidly transformed." Further, Marx states the "epoch of social revolution" is driven by the "conflict between the social productive forces and the relations of production," which transforms "the legal, political, religious, aesthetic or philosophic—in short, ideological forms in which men become conscious of this conflict and fight it out."

This is the only place in Marx's huge corpus that he uses the terms *basis* and *superstructure*, but the idea has over time become the most widely known formulation of historical materialism, and is the main support for the many who claim Marx was an economic or technological "determinist." Many scholars of historical materialism reject these simplistic accusations. Marx makes it clear that the economic structure or base is not technology, but the social relations of the production of human life. For Marx, human life is produced at many sites like the home, the school, and what he called "nature."

Historical materialism has been crucial in informing a wide range of work on social and environmental change: Fernand Braudel is concerned with the slow, massive changes in human and biophysical landscapes; Piers Blaikie or Michael Watts with the vicious spiral of exploitation, environmental decay and social immiseration; and O'Connor with the inevitable crises precipitated by capitalism's destruction of nature. But in each instance, the conceptual framework is an environmentally sensitive historical materialism.

Marx sometimes described these dynamics as a struggle to subdue or control nature, and sometimes historical materialists do present human history in this manner. More often, however, what is at stake in historical materialism is the way in which it presents analytical categories for rigorous, engaged, socioenvironmental research. In other words, base–superstructure or environment–society can seem an overly simplistic relational model. But if we think of it as the name of a problem, as Fredric Jameson suggests, then we open up enormously productive avenues for thinking about how and why societies and their environments interact the ways they do.

SEE ALSO: Communism; Marx, Karl; Political Ecology; Political Economy.

BIBLIOGRAPHY. Piers Blaikie, *The Political Economy of Soil Erosion in Developing Countries* (Longman, 1986); Fernand Braudel, *Civilization and Capitalism, 15th–18th Centuries*, 3 vols. (University of California, 1992); Fredric Jameson, *Late Marxism* (Verso, 1990); Jake Kosek, *Understories: The Political Life of Forests in Northern New Mexico* (Duke, 2006); Karl Marx, *A Contribution to the Critique of Political Economy* (International Publishers, 1979); James O'Connor, *Natural Causes: Essays in Ecological Marxism* (Guilford, 1997); W. Scott Prudham, *Knock on Wood* (Routledge, 2004); Paul Robbins, *Political Ecology* (Blackwell, 2004); Michael Watts, *Silent Violence: Food, Famine and Peasantry in Northern Nigeria* (University of California, 1983).

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History, Environmental

ENVIRONMENTAL HISTORY IS a study that intrinsically deals with nature and the human being, and the previous interactions between them. In order to understand the changing environment of present and future, it is essential to know about the environmental past. The environmental issues we are confronting today reflect diverse complexities whose roots are both natural and human.

A rapidly increasing interest in the phenomenon of the global environment has developed in the last two decades, along with a belief by some that we have entered an era of environmental crisis. This has stimulated a wider array of academics, scholars, and policy makers to reevaluate their concerns with a more ecological focus.

The prime goal of environmental history is to deepen our understanding of how humans have been affected by the natural environment in the past and how they have influenced that environment and with what outcomes. It provides a landscape record for scientists who intend to understand the current ecological system by learning about the past environmental framework.

Environmental historians typically address three clusters of issues. The first is concerned with the human intellectual realm, which comprises perceptions, ethics, laws, myths, and other mental constructions related to the natural world. The second area is the socioeconomic realm, which has an implication on politics, policies, and the economy through which these notions materialize in the natural world. The third area is environmental history, which concerns understanding nature itself, that is, the natural realm.

In the case of woodland history, environmental history is concerned with the way forest ecosystems have been working in the past, and how they were changed by human actions. The influence of human actions on the natural world causes a feedback that changes our ideas, policies, and economy. Within this structure, we attempt to alter reactions we do not like and continue practices, which in our view, are successful; this model depicts the separation between humans and nature. Although this division is an artificial one, it can be a useful tool for the environmental historian in identifying some key questions, the sources that might be able to answer the questions, and the methods utilized to study these sources.

BUDDING DISCIPLINE

Environmental history is a rather new discipline that came into being during the 1960s and 1970s. It was a direct outcome of the growing awareness of worldwide environmental challenges such as pollution of water and air by pesticides, depletion of the ozone layer, and the theory of a greenhouse effect caused by human activities. In this development, historians started to look for the origins of the contemporary problems, drawing upon the knowledge of a whole field of scientific specialization that had been cultivated during the preceding century. In modern environmental history, ecological concepts are used to analyze past environments and geography utilized to study the ever-changing face of the earth. At the beginning of the 20th century, geographers stressed the influence of the physical environment on the progress of human society.

Two other roots of environmental history are archaeology and anthropology, of which the latter introduced ecology into the human sciences. The emergence of world history put forward interdisciplinary and continental-wide, even world-scale, studies into history. Ecology and the interdisciplinary method later became two prominent features of environmental history.

Evidence of environmental issues is reflected in manuscripts, publications, and historical archives, under labels like public health, nature conservation and preservation, smoke abatement, municipal housekeeping, occupational diseases, water pollution, and air pollution. Most environmental historians have focused on regional or national affairs. Some of these richly illustrated studies trace how the

Field Studies

The field study in environmental history encompasses analysis of data on tides, winds, ocean currents, the position of continents in relation to each other, and geology, as well as covers the history of climate and weather and the pattern of diseases. Environmental history is also the story of human exploitation of the natural world, such as the consequences of agriculture on soil and landscape; the history of forests; the effects of hunting and grazing; and the environmental impact of mining, transportation, urbanization, and industrialization. Furthermore, environmental history is about unmasking myths and distorted perceptions of the past to make appropriate decisions to handle these problems.

Environmental historians sometimes need to apply some principles from the natural sciences like ecology, biology, and forestry to grasp events that happened in the past. However, the ongoing valuation of environmental criteria is different from those used in the past, which poses a threat to the way we interpret and value the past because the facets of sustainability, equilibrium systems, and biodiversity are modern ones. Environmental historians need to be aware that the present and its challenges influence how we perceive the past, and to recognize the historically defined character of values and ideas in historical sources.

natural impulses and resources have shaped societies on a global scale. The use and subsequent abuse of landscapes frequently crosses arbitrary political–cultural boundaries and even continents and oceans.

Some of the broadly shared historical processes that sped environmental change from roughly 1500 to 1800 C.E. include intensified human land use along settlement frontiers, biological invasions, commercial hunting of wildlife, and problems of energy scarcity. These issues are reflected in the case studies of specific places and activities such as the fur trade in North America and Russia, cod fishing in the North Atlantic, and whaling in the Arctic, as well as studies showing how humans altered the material well-being of the natural world through clearing forests; draining wetlands; transporting bacteria, insects, and livestock; hunting species to extinction; and reshaping landscapes.

In equally unprecedented and dramatic ways, humans are extending their reach and their numbers as they intervene in the world's natural environment. Despite the fact that environmental issues have become one of the most substantial parts of the global social fabric, there has been little historical aspect on environmental history until recent times.

The early period of environmental history can be divided into three distinct phases: Ancient Civilizations, Middle Ages and Renaissance, and Enlightenment.

ANCIENT, MIDDLE AGES, RENAISSANCE

In Ancient Civilizations, air pollution was common in large towns long before the Industrial Revolution. The pollution came from dust, wood smoke, tanneries, animal manure, and other things. Israeli and Hindu cities tended to have less water pollution due to strict religious codes about cleanliness. On the other hand, ancient Rome was notorious for sewage-filled streets. Furthermore, timbering stripped the forests of Babylon, Greece, Phoenicia (Lebanon), and Italy with the rise of civilization. While the wood energy crisis led Greeks to use passive solar energy by orienting their cities and houses toward the sun, Romans made some use of solar energy but imported wood for timber and fuel from as far away as the Black Sea. Both Greeks and Romans kept sacred groves of trees from being timbered.

During the Middle Ages and Renaissance, plague devastated Europe, but led to the beginnings of a public health system. Timbering in the forests of England, France, and Germany left large tracts totally denuded by around 1550 in England and the 1600s in Europe, forcing a switch to coal. In this period, soil conservation was not widely practiced in the Mediterranean, but cultures in China, India, and Peru understood the long-term effect of soil erosion and used terracing, crop rotation, and natural fertilizer to prevent it. Further, occupational diseases were investigated and began to be recognized as public health problems.

ENLIGHTENMENT AND PROGRESSIVE ERA

In the era of Enlightenment, reason began to be better appreciated as an antidote toward superstition. Ben Franklin's fight against water pollution, James Lind's fight against scurvy, and the movement to clean up slums and prisons started with an enlightenment philosophy that held individual citizens to be valuable. Nonetheless, food and resources ran out as populations exploded. Over time, new technologies created new pollution: town gas from coal dripped tar into the rivers, vulcanized rubber plants discharged noxious chemicals directly into streams, and coal smoke choked the air in big cities. In addition, chemical factories operated without thought to people downwind.

During the Industrial Revolution, living conditions in urban areas horrified reform-minded commissions in London in the 1840s and America in the 1850s and 1860s. While progress had been slow, the common interest in pure drinking water and sanitation was spurred by epidemics of typhoid and cholera. John Snow, a London physician, traced a part of the cholera epidemic to a contaminated water pump in 1855. Smog episodes also started killing residents of big cities like London. Moreover, conservation of wilderness areas began with the felling of an enormous tree, called the "Mother of the Forest" in 1851. The outrage over the act led to calls for a national park system.

In the Progressive Era, reforms were made in working conditions, slum housing, food adulteration, sanitation, drinking water, polluting industries, and more. Although U.S. President Teddy Roosevelt and forester Gifford Pinchot characterized the era with ideas about conserving large tracts of land and putting other forests to "wise use," John Muir opposed the wise use idea and fought for outright preservation of unspoiled wilderness. A number of new organizations like Women's Club and Sierra Club helped champion natural conservation and municipal reforms as well.

During the 1920s and 1930s, the National Coast Anti-Pollution League was formed under the auspices of municipal officials from Atlantic City to Maine, who were concerned about oil and sewage pollution detracting from tourism. Led by Gifford Pinchot, the league succeeded with an international oil dumping treaty passed by Congress in 1924. Radium Girls were dying of radiation-induced cancer, and court delays seemed outrageous to crusading journalist Walter Lippmann, who worked with Alice Hamilton to bring their case to the public. A settlement at least gave them medical care and compensation for their families. Over this time, while the Civilian Conservation Corps was founded by President Franklin D. Roosevelt during the Depression, the chemurgy movement was a Midwestern populist phenomenon. The major demands of this movement included replacement of petroleum with farm alcohol and other industrial uses for agricultural crops.

During the 1940s and 1950s, American development of synthetic rubber was blocked and leaded gasoline technology was handed over to the Nazis during the prewar honeymoon, and Midwestern corn helped roll allies to victory over the Nazis. Synthetic rubber and chemicals from renewable resources proved vital to winning World War II. The Sand County Almanac by Aldo Leopold, published in 1948 just after his death, expressed an expanding sense of human responsibility, not only for each other but also for the earth. Further, deadly smog episodes in London in 1952 and 1956, in New York in 1953, and Los Angeles in 1954 created the perception that an air pollution crisis was underway. While in 1955, the first international air pollution conference was held, increasing carbon dioxide buildup was one surprising conclusion of Scripps

A wire mill freely spewed smoke along the Monongahela River in Donora, Pennsylvania, in 1910. In the Progressive Era, reforms were made in working conditions, slum housing, sanitation, drinking water, polluting industries, and more.

Oceanographic Institute scientists working on International Geophysical Year projects 1957.

Throughout the 1960s and 1970s, the emergence of the field of environmental history was tied with the rise of the ecological and environmental movements. Rachel Carson's book *Silent Spring* (1962) struck a deep chord in the quickly increasing concerns about the environment. Another notable event took place in 1962: General Motors and Standard Oil (Exxon) sold off the Ethyl Corporation, the child of their partnership in leaded gasoline. The truth about leaded gasoline emerged dramatically in 1965 Senate hearings as scientist Clair Patterson testified about the obvious and apparently deliberate falsehoods in lead industry research. A burning river ended the decade as a dramatic symbol of an environment on the brink. Furthermore, oil and chemicals in the Cuyahoga River in Cleveland, Ohio caught fire in 1969.

BIRTH OF THE EPA

A decade of awakening and cleanup began during 1970-80 with the birth of the Environmental Protection Agency (EPA) and ended with the Appropriate Community Technology demonstration on the Washington Mall. Air pollution was cut back dramatically through use of catalytic converters on new cars that used only unleaded gasoline, but the predicted "pollution free car" proved to be chimerical. During this decade, water pollution was also severely decreased through a massive sewage treatment expansion program. The rivers that were once sewers now began a gradual return from the grave. In addition, toxic chemicals became more troubling. Corporations like Allied (manufacturer of Kepone in the United States) seemed to have deliberately endangered employees and the public for minor increments of profit. During the 1980s, Love Canal and other incidents also led to new regulations. While nuclear power safety was increasingly suspect after the Three Mile Island accident, energy crisis in oil supply led to reversals of some restrictions on refinery and oil pollution.

During the decade 1980–90, disasters showed the tenuous and fragile side of industrial technology. Among them included the Bhopal mass poisoning in India, the Chernobyl nuclear reactor disaster in Ukraine, and the Challenger shuttle explosion and the Exxon Valdez oil spills in the United States. Ozone depletion from fluorocarbons was ultimately taken seriously by world leaders, signified by the signing the Montreal Protocol in 1987. The legislation for cleaning up toxic waste passed Congress as well. In this decade, environmentalists gathered momentum.

Between 1971 and 1991, environmental policies began to have an increasing impact on trade. The impacts of trade on the environment had also become more widespread. This led to huge discussions and debates. For example, in 1987, the World Commission on Environment and Development (WCED) produced a report entitled *Our Common Future* (also known as the Brundtland Report), in which the term *sustainable development* was coined. The report identified poverty as one of the most important causes of environmental degradation, and argued that greater economic growth, fueled in part by increased international trade, could generate the necessary resources to combat what had become known as the "pollution of poverty."

As a result of these developments, the proposal of the Group on Environmental Measures and International Trade (EMIT) met with a positive response. Despite some countries' initial reluctance to have environmental issues discussed in the General Agreement on Tariffs and Trade (GATT), they agreed to have a structured debate on the subject. In accordance with its mandate of exploring the possible implications of environmental protection policies on the operation of the General Agreement, the EMIT group focused on the effects of environmental measures (such as eco-labeling schemes) on international trade, the relations between the rules of the multilateral trading system, the trade provisions contained in the multilateral environmental agreements (MEAs), and the transparency of national environmental regulations with an impact on trade.

A number of important events occurred during the contemporary epoch (1990–present). The Persian Gulf War saw environmental disaster when retreating Iraqi troops set fire to hundreds of oil wells. Ken Sara-Wiwa, a journalist and environmentalist, was executed in 1995 for his outspoken opposition to oil industry practices of Shell Oil in Nigeria. In the

United States, political standoff between conservative and liberal factions in Congress ended more or less in a draw. In addition, despite international protests, construction of China's Three Gorges Dam continued on schedule. Retiring President Bill Clinton set aside 58 million acres of forest and wilderness by the end of his presidency, beating the previous conservation record set in Teddy Roosevelt's administration.

The activation of the EMIT group was followed by further developments in the environmental forums. The 1992 United Nations Conference on Environment and Development (UNCED), also known as the Rio "Earth Summit," drew attention to the role of international trade in poverty alleviation and in combating environmental degradation. Agenda 21, the program of action adopted at the conference, addressed the importance of promoting sustainable development through, among other means, international trade. The concept of sustainable development established a link between environmental protection and development at large.

In most recent years, utility deregulation led to severe price spikes, consumer resentment, and a rethinking of electric utility deregulation. Another phenomenal issue is that poisoning emanating from leaded gasoline is being acknowledged to be crucial in developing countries by the World Bank and World Health Organization (WHO), while a step-by-step switch to other additives ultimately gets underway.

Environmental history is a resourceful collection of inquiries into the transformation of the natural world by human actions and the aftermaths for both nature and people. In a nutshell, it is a relatively new area of inquiry, but one that has much to offer.

SEE ALSO: Cronon, William; Ecological Imperialism; Environmentalism; Policy, Environmental; Farming Systems; Industrial Revolution; Wittfogel, Karl A; Worster, Donald.

BIBLIOGRAPHY. Stephen Bocking, *Ecologists and Environmental Politics: A History of Contemporary Ecology* (Yale University Press, 1997); William Cronon, "The Uses of Environmental History," *Environmental History Review* (v.17, 1993); J. Donald Hughes, *An Environmental History of the World: Humankind's Changing Role in the Community of Life* (Routledge, 2001); John McCormick, *Reclaiming Paradise: The Global Environmental Movement* (Indiana University Press, 1989); John R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (Penguin Books, 2000); James O'Connor, "What is Environmental History? Why Environmental History?" *Capitalism, Nature, Socialism* (v.8, 1997);Michael R. Redclift, *Frontiers: Histories of Civil Society and Nature* (MIT Press, 2006); John F. Richards, *The Unending Frontier: An Environmental History of the Early Modern World* (University of California Press, 2003); Mart A. Stewart, "Environmental History: Profile of a Developing Field," *History Teacher* (v.31, 1998); Donald Worster, ed., *The Ends of the Earth: Perspectives on Modern Environmental History* (Cambridge University Press, 1989).

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Honduras

THE AREA THAT would become Honduras was home to the precolonial city of Copan. The ecology of the region was heavily modified by its pre-Columbian residents, though with the decline of the Classical Mayan civilization, the area was reclaimed rain forest and jungle. The country was later colonized by Spain, but not without the resistance of indigenous Lenca peoples of the central highlands. Following independence in 1821, the country fell under the influence of a number of large plantation-based corporate interests, including United Fruit. The unequal trade relationships and land management initiated in this period had a lasting effect on the socio-ecology of the country even into the late 20th century, when insurgency wracked the country.

The Republic of Honduras is one of the poorest countries in the Western Hemisphere, and 53 percent of the people live in poverty. With a per capita income of $2,900, Honduras is ranked 160th in world incomes. Inequality is rampant, and the richest 10 percent of Hondurans hold 42.7 of national resources. Some 28 percent of the population is unemployed. Around 61 percent of rural Hondurans are engaged in the agricultural sector, and workers involved in agriculture, forestry, and fishing make up one-third of the labor force. Honduran natural resources include timber, gold, silver, copper, lead, zinc, iron ore, antimony, coal, fish, and hydropower; but resources have been overexploited.

Honduras borders the Caribbean Sea and the Gulf of Fonseca in the North Pacific Ocean, resulting in a coastline of 508 miles (820 kilometers). The well-known Mosquito Coast is located along a section of the Caribbean border. Honduras is mountainous with a narrow coastal plain. The climate varies from temperate in the mountains to subtropical in the lowlands. Dry and rainy seasons are unpredictable. The Caribbean coast of Honduras is subject to damaging hurricanes. In 1998, for example, Honduras was devastated by Hurricane Mitch, which took the lives of some 5,600 people and racked up around $2 billion in damages. Although earthquakes are common, they tend to be mild.

The population of 6,975,000 has an increasing rate of HIV/AIDS (1.8 percent) that contributes to lower-than-average life expectancy (69.3) and growth rates (2.16 percent) and to higher than average infant mortality (29.32 per 1,000 live births) and death rates (6.87 deaths/1,000 population). Some 10 percent of the population lacks access to safe drinking water, and 32 percent have no access to improved sanitation. The United Nations Development Program (UNDP) Human Development Reports rank Honduras 116th out of 232 countries on general quality-of-life issues.

The urban population of Honduras is expanding, producing an increase in environmental problems. Massive deforestation is a result of logging and frequent clearing of land for agriculture. Mining, uncontrolled development, and poor agricultural management have led to land degradation and soil erosion. Water pollution is widespread in freshwater sources such as Lago de Yojoa and in rivers and streams. In 2006, scientists at Yale University ranked Honduras 52nd of 132 countries on environmental performance, in line with the relevant geographic group and well above the relevant income group.

In the 1940s, Salvadorans initiated a cotton boom in Honduras that led to the displacement of small farmers. During the 1960s, forests were destroyed to provide pasture for the growing livestock industry. In 1969, the "Soccer Wars" led to the expulsion of Salvadorans as Hondurans reclaimed their land. Both the Salvadorans and the Hondurans engaged in poor agricultural practices, using DDT, dihedron, toxaphono, and parathion. A 1981 study revealed toxic levels of pesticides in the bloodstreams of the population and in surface and groundwater. The production of cotton left a lasting legacy of soil depletion and erosion, increased numbers of harmful insects (leading to greater amounts of pollutants), and land and water contamination.

ENVIRONMENTAL COMPOSITION

Forests that range from montane to rain forests make up 48.1 percent of Honduras. Honduras is losing more forests than any other country in Latin America; from 1990 to 2005, 37.1 percent was lost. The government protects only 6.4 percent of the land, including the Tigra Cloud Forest Park near Tegucigalpa and the Copán National Park, where Mayan ruins are located. The Río Plátano Reserve has also been set aside to promote greater biodiversity, and ecotourism is viewed as a way to preserve the coral reefs of the Islas de la Bahía. Ten of 173 endemic mammal species are threatened, and five of 232 endemic bird species are in endangered.

During the 1980s, environmental groups organized, but internal corruption in the 1990s resulted in a withdrawal of international funding. The Ministry of Natural Resources works with a number of agencies to implement and enforce a body of laws that promote protection, conservation, restoration, and sustainable development. Enforcement of environmental laws has been difficult, due in large part to a lack of funding. Honduras participates in the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: Cotton; Deforestation; Ecotourism; El Salvador; Hurricanes; Pesticides; Pollution, Soil Erosion Timber Industry; Poverty; Water.

BIBLIOGRAPHY. CIA, "Honduras," *The World Factbook,* www.cia.gov/cia (cited April 2006); Country Studies, "Honduras," www.country-studies. com (cited April

2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental Issues* (ABC-CLIO, 2004); Carolina Marui, *Environmental Law Enforcement and Compliance in Central America* (Center for Environment Law, 1996); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); UNDP, "Human Development Reports: Honduras," www.hdr.undp.org (cited April 2006); World Bank, "Honduras" *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Hoover Dam

THIS MASSIVE DAM in the Black Canyon of the Colorado River, on the border of Arizona and Nevada, was built between 1931 and 1936, with a large hydroelectric plant generating electricity for many parts of Arizona, California, and Nevada.

Ideas about damming the Colorado River were realized in the early 20th century to solve two problems. The first was that there were regular floods when snow from the Rocky Mountains melted and the rising river levels would cause floods in farming communities; and the second was that a dam could also provide water for the growing city of Los Angeles, and the nearby areas. The major initial problem was that Arizona and Nevada felt that California would probably take up too much water, so the result was the forming of a commission in 1922 with the state governors of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming meeting to agree on what became the Colorado River Compact, signed on November 24, 1922. Six years later it was finally approved by Congress, and signed into law by Calvin Coolidge. However the first money set aside by the federal government was not allocated until July 1930 when Herbert Hoover was president. A Congressional Act on February 14, 1931, had made the name *Hoover Dam* its official name.

The building of the dam coincided with the start of the Great Depression, and the construction schedule was advanced by the government to provide employment, with a new town called Boulder City established nearby. Work then began on diverting the river from its course, to allow for work to begin on the dam. This saw two massive diversion tunnels built, causing the river to change route. On June 6, 1933, work began on the dam itself. As no project of this size had ever been attempted before,

Elwood Mead

Elwood Mead was a professor, politician, and engineer who oversaw many major projects as the head of the Bureau of Reclamation from 1924 until 1938, including the Hoover Dam.

Elwood Mead was born in 1858 at Patriot, Indiana, and went to Purdue University, graduating with a science degree. He then gained his doctorate in civil engineering from Iowa State College, and taught mathematics at Colorado Agriculture College from 1883–84, and again from 1886–88. In 1888 Mead was appointed the territorial and state engineer of Wyoming, and drafted the water laws for both Wyoming and Colorado, becoming the chairman of the State Rivers and Water Supply Commission in Victoria, Australia, in 1907.

Returning to the United States in 1915, he became professor of rural institutions at the University of California, and then chairman of the California Land Settlement Board. In 1924 he was appointed chairman of the Bureau of Reclamation. It was in that position that he oversaw the building of the Hoover Dam, and also the Grand Coulee and Owyhee Dams.

Mead had a great interest in plans developed by Zionists to irrigate and develop British Palestine, and Mead went there twice: in 1923, and again in 1927. He married twice and had six children. He died in 1936.

there were worries about the stressloading of the concrete. Furthermore, some of the loose rocks on the canyon walls had to be removed in case they fell at a later date. This resulted in men having to scale the rock-face and work in extremely hazardous conditions. In fact, by this time there was massive controversy around the project itself, over its safety record, the low wages for the workers, their poor housing conditions and the lack of facilities for their families.

The dam was completed on March 1, 1936, and by October 26 of the same year was providing energy for Los Angeles. Controversy dogged its name—it was called the Boulder Dam until the death of Franklin Roosevelt, but was renamed the Hoover Dam by Harry S Truman. The dam is 1,244 feet long, and 726.4 feet high, making it the second highest dam in the United States. It contains 4.36 million square yards of concrete, is 660 feet thick at its base, and 45 feet at the crest.

SEE ALSO: Colorado River; Hydropower; United States, Southwest.

BIBLIOGRAPHY. Andrew J. Dunar and Dennis McBride, *Building Hoover Dam: An Oral History of the Great Depression* (Twayne Publishers, 1993); Joseph Stevens, *Hoover Dam: An American Adventure* (University of Oklahoma Press, 1988).

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Huang Ho (Yellow River)

THE ORIGIN OF the Huang Ho, also known as the Yellow River because of the voluminous ochre-colored sediments suspended in its lower course as it meanders through the North China Plain, is in two glacial lakes in the Bayankala Mountains in western China's Qinghai Province. The river begins its 3,400 mile journey by flowing east out of the high elevations and then making an abrupt turn to the north at the city of Lanzou. From this point the Huang Ho begins its circuit around the Ordos Desert, turning to the east and coursing through Inner Mongolia before heading south to its junction with the Wei Ho. At this point the river turns to the northeast and completes its final leg across the North China Plain and empties into the Bo Hai. The river has been alternately called "China's Sorrow" and "China's Pride."

The Sorrow designation is associated with the extensive losses of human life through massive flooding of the relatively shallow river at times in the past. Historians estimate that the severe floods in 1887 and 1931 resulted in the death of between two and six million people as the waters breached the man-made levies and spread quickly across the land.

The invocation of Pride relates to the role of the Huang Ho in agricultural development throughout the centuries and archaeological evidence that the origin of the Chinese civilization can be traced to the area surrounding the confluence of the Huang Ho and Wei Ho. This extremely fertile area is identified as one of the earliest culture hearths and clearly the agricultural region of longest continuous operation in the world. This agricultural center lies at the southern edge of the Loess Plateau, a region of highly fertile soil.

Loess is wind-deposited fine particulate matter deposited by winds coming across the Ordos Desert to the northeast. These winds are slowed just enough by the Tien Shan, a low mountain range south of the Loess Plateau, to allow the deposition of airborne material. Over the centuries, the accumulation of loess in some areas reached 200 feet in thickness. In some parts of the plateau, agriculturalists actually established homes within loess caves, a practice that proved disastrous during major flooding.

There is considerable concern about the fate of the Huang Ho because of a severe drought in the mountainous area where the river originates. The glaciers in the area are receding and the groundwater sources for the river are getting lower. Both of these negative outcomes have been attributed to global warming. Consequently, water availability at points downriver has been diminished. This unfortunate outcome impacts agriculture productivity, which has been a mainstay of the region for millennia. Another, more direct negative impact on the Huang Ho has been the incredible expansion in economic activity along the river and the growth of large urban places where none had existed before the era of rapid and prolonged industrial expansion. In order to meet the needs of agriculture and industry in northern China, there are plans to divert water from the Yangtze River to the Huang Ho through two major man-made canals. Water pollution is widespread within the lower course of the river as industrialization continues its virtually ceaseless expansion while demands for increased agricultural output also expands to keep pace with the growing Chinese population.

Air pollution in the industrial sector, associated with the burning of coal, contributes significantly to the environmental woes of China. The country ranks second only to the United States in the amount of carbon dioxide emitted to the atmosphere. With the Kyoto Protocol not requiring China to reduce emissions, China has been able to expand its industrial base almost at will. As the country's goal, is to develop its economic structure as quickly as possible before the ultimate reductions in working-age individuals necessary begins to fall, the Huang Ho and other areas of the environment will continue to be degraded.

SEE ALSO: Carbon Dioxide; China; Drought; Pollution, Air.

BIBLIOGRAPHY. Justin Hill, *A Bend in the Yellow River* (Phoenix Press, 1998); C.M. Liu, "Drying up the Yellow River: Its Impacts and Countermeasures," *Mitigation and Adaptation Strategies for Global Change* (v. 7/3, 2002); Jim Yardley, "China's Path to Modernity, Mirrored in a Troubled River," *New York Times*, November 19, 2006.

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Human Ecology

HUMAN ECOLOGY IS the study of the mutual interconnections between people and their environments at multiple scales and multiple time frames. The subject is informed by ecological and evolutionary theory in biology and by the concepts of landscape and spatial relationships in geography; but recognizes that humans have gradually achieved partial ecological and geographical dominance through their culturally given but continually changing technology and social, economic, and political arrangements. Human ecology subsumes such specialized approaches to these relationships as cultural ecology, political ecology, geography, ecological anthropology, environmental sociology, environmental economics, environmental psychology, and environmental history.

DRAWING ON HISTORY

Although the neologism "ecology" dates from the second half of the 19th century and the term *human ecology* first appeared around 1908, interest in human environment relationships goes back much farther. For example, the ancient Greeks were concerned with the impact of the environment on human health (*On Airs, Waters, and Places* was written by an anonymous author in the Hippocratic tradition). Plato speculated on the role of humans in reducing the forest cover of Greece. Such cartographers and geographers as Ptolemy and Strabo recognized spatial differentiation. Similar traditions existed in other ancient societies such as China.

Saint Francis's teachings suggested that humans could not consider themselves completely separate from and superior to nature. Chinese philosophy, poetry, and art, building on a base of shamanism, Buddhism, and Taoism, also stressed the relationship between human consciousness, society, and nature. These traditions include little in the way of systematic observation, however, or experimental testing of relationships. One important exception has been the development of agronomy, range science, and forestry based on long-term observations on soil fertility and pest management on the local scale. In societies with a written tradition, this has often resulted in a sophisticated literature; but even in societies with an oral tradition, the resulting "ethnoscience" has often been remarkably insightful. Another important exception has been the almost universal tradition of mapping surroundings using a variety of cartographic methods.

Beginning in the 15th century, European expeditions of discovery and conquest led to some of the first field-based systematic and comparative observations of human–environment relationships at a larger scale. Observers such as Cieza de León (who accompanied the conquerors of the Inca Empire) produced detailed geographic accounts of landscapes, land use, and resource management that are still used by human ecologists documenting environmental history. Colonial authorities produced detailed reports of local resource use (such as the *relaciones geográficas* in the Spanish empire), as well as maps at a variety of scales. European advances in census taking, in both Europe and its colonies, helped John Graunt and Edmond Halley develop some of the basic analytical methods of demography by the 18th century. At the end of the 18th century, Thomas Malthus pointed out the importance of the population resource ratio and warned of the persistent danger of societies overgrowing their resource base.

BIRTH OF THEORIES

Alexander von Humboldt represents the culmination and transformation of the tradition of colonial observers of resource management. His diaries and books based on his travels through the Americas at the end of the colonial period details climate, plants, animals, population, resource management methods, and even archaeology, utilizing the most advanced instruments and collection methods of his time. Moreover, he correlated his results using maps and diagrams, generalizing about both the environmental and political conditions of resource management. He also pointed out in detail the many impacts of colonial policy on resource use. He argued for an expansion of economic freedom, recognizing the importance of state intervention, and argued for a more local level of colonial administration.

Later, 19th century travelers and scientists such as Darwin, Wallace, Bates, and da Cunha further developed ideas essential for the later development of human ecology. Darwin was inspired by Humboldt to perform detailed fieldwork in South America, and was influenced by Malthus in his development of the theory of natural selection in diverse environments to explain the diversity of species. The application of Darwin's ideas to human affairs was at first crude, but by the beginning of the 20th century was an important influence on scientific human ecology. In human ecology, the concept of adaptation did not refer to the survival and reproduction of genetically heritable traits, but rather the continual process of choosing among and refining strategies of making a living (reproducing a way of life) in a changing world. In human affairs, behavior is typically adjusted through the intervention of economic and political incentives long before stark survival is at stake.

Karl Marx asserted that the social arrangements for the harnessing of natural resources (mode of production) have a decisive impact on the rest of society. Although he gave little attention to the role of nature in conditioning human responses, some of his disciples did. Wittfogel, for example, argued that the need for irrigation in dry environments led to "oriental despotisms" in contrast to the more feudal and eventually democratic arrangements in rainier climes.

"Environmental determinism" reached its pinnacle with the works of Ellsworth Huntington at Yale. In contrast, although Ellen Churchill Semple is often considered an environmental determinist, her works on Kentucky mountain folk and on the Mediterranean are nuanced studies of environmental conditions of human life. Her book *Geography of the Mediterranean Region* still provides an excellent background for the environmental study of the area.

The French geographer Vidal de la Blache (1845–1918) is usually credited with the idea of "possibilism," that the environment presents challenges and opportunities, and possibilities for human use, but that it does not per se determine human behavior. His work emphasized the study of regional landscapes (*pays*) in terms of ways of life (*genres de vie*) developed over time; he recognized the importance of long distance as well as local processes in this development. One of his students, Lucien Febvre, went on to write *A Geographical Introduction to History* and to cofound the *Annales* school, which was to focus on the long-term interaction of environmental, demographic, economic, and other factors on the history of places. The most famous member of this school, Fernand Braudel, was influenced not only by Febvre and de la Blache, but also by Semple, in writing his detailed study of the Mediterranean world in the 16th century. More recently, this tradition has included such figures as Immanuel Wallerstein, who has authored influential works developing "world systems theory." Although the sophistication of analysis of environmental factors has tended to weaken over time in this tradition, it still constitutes an important resource for the analysis of human ecology at regional and global scales.

Perhaps de la Blache's closest counterpart in the United States was Carl Ortwin Sauer, who (like Semple) began by studying American mountain folk. He came to focus on Latin America, where he pioneered the study of indigenous resource management and cultural landscapes. He early pointed out the destructive implications of short-term commercial agriculture. The first explicit mention of human ecology goes back to the very beginnings of the discipline of geography in the United States. In 1907 J. Paul Goode, one of the founding members of the Department of Geography at the University of Chicago, announced a course in "plant, animal, and human ecology." Goode defined human ecology as a new hybrid field for "the study of the geographic conditions of human culture" and argued for a partnership between sociologists and geographers to accomplish this goal.

Human ecology studies the mutual interconnections between people and their environments.

The theme remained important at the Chicago geography department, which not only trained Carl Sauer but also Gilbert F. White, whose 1942 doctoral dissertation, *Human Adjustment to Floods* (published in 1945), was highly influential. White argued for the importance of comprehensive adaptation to hazards rather than the deployment of narrowly defined engineering solutions. Through a long career in government and academia he influenced the development of Hazards research as an interdisciplinary subject essential for human ecology.

Parallel themes were developed around the world. For example, in Germany, Carl Troll focused his research on the detailed interaction of climate, soils, and plants at high altitudes, coining the term *landscape ecology* in 1939. He strongly influenced Karl Butzer, who built on Troll's focus on physical environment by adding the long-term analysis of demography, agricultural practices, and environmental impacts in places as diverse as ancient Egypt and colonial Mexico. Out of this work came his book *Archaeology as Human Ecology* (1982).

Sociology students at Chicago were required to take biology, geology, and geography as part of their training. By 1921, Chicago sociologists Robert E. Park and Ernest W. Burgess were arguing for the deployment of ideas from biological ecology as models for similar studies in human ecology. These scholars focused on the importance of fieldwork; some of their most enduring research results concerned the concentric geographical zonation of activities in cities.

The work of Park and his colleagues marked a high point of human ecology in the discipline of sociology; in the 1940s and 1950s sociologists tended to return to a focus on purely social explanations for social facts. In the late 1970s, sociologists William R. Catton and Riley E. Dunlap announced the revival of a "new human ecology" or environmental sociology that would be an improvement on the approach of Park, and discussions of the subject continue in that discipline. However, by the 1950s, anthropologists had taken the lead in developing human ecology and by the mid-1970s had established the key journal in the field.

GROWING IN COMPLEXITY

Anthropologist C. Daryll Forde had found it useful to relate cultures to their habitats, and in the United States, Leslie A. White was an early proponent of the application of evolutionary ideas to the evolution of culture, centered on the technological harnessing of energy (influenced by the Marxist notion of mode of production as well as Darwin). In the 1940s, American anthropologist Julian Steward (who also was trained in biology) was faced with the task of organizing a vast amount of data in editing the Smithsonian Institution's multivolume *Handbook of South American Indians*. During this experience (and previous research with North American peoples), he became convinced that the environment played an important role in the development of societies in particular places. His writings helped create the subfield of Cultural Ecology, which he defined as "the study of the processes by which a society adapts to its environment." He called particular attention to the cultural "core," those practices most directly related to making a living in a particular place (implicitly influenced by Marx's concept of mode of production). He also argued for the importance of "multilinear evolution." By the 1960s, Cultural Ecology was a flourishing paradigm in American anthropology and archaeology.

By the 1970s, the development of human ecology had become quite complex with multiple strands. Some (especially archaeologists, anthropologists, and geographers) pursued the paradigm of cultural ecology with detailed studies of particular cultures and civilizations in environmental context. The influence of Malthus in these studies was tempered by the influential book by the Danish economic historian Ester Boserup, *The Conditions of Agricultural Growth* (1965), which persuasively argued for the ability of farmers to produce more food with increased labor inputs. Chicago-trained anthropologist John W. Bennett's *Northern Plainsmen: Adaptive Strategy and Agrarian Life* (1971) showed how different groups used the same Great Plains environment in different ways. In subsequent publications, Bennett continued to urge the study of human–environment relations in terms of process and behavior, with full attention to questions of identity and long-term change.

Other studies focused on the emergence of the human species, the origins of domestication and agriculture, the rise of cities, and on the conditions and implications of such resource management strategies as mountain agriculture, irrigation, paddy rice, and raised fields. Authors such as Robert Netting also developed broader comparative themes such as the persistence of smallholder agriculture under a variety of larger political regimes. Scholars such as Harold Brookfield (Australia) encouraged the study of the conditions of development in the global south. Many of these studies were based on a methodology combining long-term field research, ethnography, and archival research, in a context of "progressive contextualization."

After World War II, biologists such as Aldo Leopold (*Sand County Almanac*, 1949) and Rachel Carson (*Silent Spring*, 1962) had written popular books arguing for the human stewardship of nature and warning about the destruction of habitat and introduction of untested chemicals into the environment. The greatest impact on human ecology, however, came from biologists Garrett Hardin and Paul R. Ehrlich. Hardin published in his influential article on the "Tragedy of the Commons" in *Science* in 1968, while Ehrlich published *The Population Bomb* in 1968. Both works relied on Malthusian assumptions as to the unlimited propensity to breed, and the limited ability to improve food production with increased labor inputs. Hardin also assumed that human societies historically have lacked the ability to manage common lands. Their works provided a strong stimulus to research, and all three underlying assumptions have been disproved.

Researchers following the lead of Boserup have demonstrated the ability to improve crop yields through labor and capital inputs. Demographer Frank W. Notestein suggested in 1945 that societies normally reduce birth rates as the cost/benefit ratio of having children goes up, resulting in the "demographic transition," even in the absence of modern birth control methods or proscriptive government policy. Many subsequent studies have confirmed Notestein's ideas, and research in traditional and ancient societies has shown that human fertility has seldom been uncontrolled. Finally, research has demonstrated that common lands have been effectively managed by traditional societies and that uncontrolled resource management has been rare in human history.

ECOSYSTEM CONCEPT

Of the many ideas coming from the biological sciences, the "ecosystem" concept has been especially controversial in human ecology. The majority opinion has been that it is useful to think in terms of multiple possible interconnections. The dynamic, adaptive nature of human behavior, however, coupled with the importance of policy and politics in human life and the constantly changing context of adaptation have meant that true stable homeostatic systems have seldom, if ever, emerged in human history.

Anthropologist Roy A. Rappaport in his 1968 study *Pigs for the Ancestors; Ritual in the Ecology of a New Guinea People*, argued that New Guinea society over the centuries had evolved to the point that even ritual was primarily oriented toward the regulation of relations with the environment. Anthropologist Marvin Harris popularized this and similar ideas (with strong Marxist underpinnings) in his popular books *Cows, Pigs, Wars & Witches: The Riddles of Culture* (1974), *Cannibals and Kings: The Origins of Cultures* (1978) and *Cultural Materialism: The Struggle for a Science of Culture* (1979). Most anthropologists and geographers have, however, rejected the notion that the environment has had quite the determinative power that Rappaport and Harris postulated. The notion that the environment provides a key to human history remains seductive, however, as demonstrated by the popularity of the UCLA geographer Jared Diamond's books *Guns, Germs, and Steel: The Fates of Human Societies* (1997), and *Collapse: How Societies Choose to Fail or Succeed* (2005).

POLITICAL ECOLOGY

One of the most powerful recent stimuli for the study of human ecology has been from those calling themselves "political ecologists." Influenced by such works as (Chicago-trained) Susanna Hecht and Alexander Cockburn's *Fate of the Forest* (a study of the long term influence of politics and policy on the Brazilian Amazon), and Michael Watts's *Silent Violence: Food, Famine, & Peasantry in Northern Nigeria*, political ecologists study the impact of colonial, liberal and neoliberal states and multinational corporations on resource management and environmental problems. These scholars have continued the critique of neo-Malthusianism, and have also often urged their own form of activist human ecology built around local identity politics.

There has been a great temptation to reduce human ecology to a subset of a single discipline. The term, however, still has utility in designating the social/cultural/political/environmental/geographical interface. Over time, it has become clear that fieldwork and mapping are important tools for understanding relationships at this interface. It has also become clear that since human ecology involves the interaction of otherwise unrelated systems, it has some surprising elements that do not lend themselves readily to modeling or systems approaches. Recent research suggests that human environmental problems can best be addressed by long term, place-specific research that combines multiple methodologies in a process of progressive contextualization. Furthermore, local people are the key to both understanding and solving environmental problems.

SEE ALSO: Cultural Ecology; Ecology; Historial Materialism; Marx, Karl; Political Ecology.

BIBLIOGRAPHY. Harlan H. Barrows, "Geography as Human Ecology," *Annals of the Association of American Geographers* (v.13, 1923); Karl Butzer, *Archaeology as Human Ecology* (Cambridge University Press, 1982); Matthias Gross, "Human Geography and Ecological Sociology: The Unfolding of a Human Ecology, 1890 to 1930—and Beyond," *Social Science History* (v.28, 2004); Robert E. Park, "Human Ecology," *American Journal of Sociology* (v.42, 1936); Paul Robbins, *Political Ecology* (Blackwell Publishing, 2004); *Human Ecology: An Interdisciplinary Journal* (1973–present).

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Human Genome Project

THE HUMAN GENOME Project (HGP) was a multinational, 13 year long project aimed at identifying the genes within the deoxyribonucleic acid (DNA) within human cells, together with related technical issues. The goals of the project were to identify and specify the 20,000–25,000 genes in human DNA, determine the sequence of the approximately three billion chemical base pairs within that DNA, and find a way of storing this information in a suitable database for which appropriate analytical and data transfer tools are made available. The HGP also aimed to address the numerous ethical, legal, and social issues (ELSI) that were brought about by the project and by the management and ownership of its findings. The U.S. Department of Energy and the National Institutes of Health in the United States led the effort, with the Wellcome Trust in the United Kingdom, and partners in Japan, Germany, China, France, and other countries. The HGP required considerable computational capacity and logistical management and was completed in 2003.

Prior to the launch of the HGP, considerable skepticism was expressed concerning the practicability of completing it, even though the value of the possible output was grasped early in the process. Technology had not yet progressed sufficiently for the genetic sequence of a much simpler organism such as a bacterium to be mapped. However, early proponents such as Walter Gilbert and Robert Sinsheimer were convinced that the project was both possible and necessary, and that the key was not so much in the complexity of the problem, but in organizing a sufficient amount of computing power and organizing networks of researchers to carry out the work in tandem. Managing this required not just organizational skill, but also the ability to persuade small and often fiercely independent research laboratories to work together and to share their results. This method of working was radically different from the usual competetion and pressure to maintain secrecy about their progress.

The commercial applications of the research intensified these concerns. Further, it was necessary to overcome the resistance felt by many that research is best undertaken through providing opportunities and incentives for individual scientists and their support teams to come up with projects on a bottom-up basis, rather than the large-scale, public sector mandated and top-down approach that was successfully managed. This international collaboration provided a model for using distributed facilities (computer-linked, but geographically-remote locations, each with their own responsibilities) to tackle large-scale projects. Even so, numerous interpersonal and interorganizational conflicts occurred during the project and overcoming these required extensive negotiation.

PRICKLY PROPERTY RIGHTS

Among the many thorny ELSIs, perhaps the most contentious has been that of property rights as resulting from the output of the HGP. An important principle within scientific research and intellectual property rights is that the first individual or team to publish in a reputable medium or in some other credible manner announce results has a claim to ownership of those results in any subsequent commercial exploitation. Yet, every person in the world has genetic information embedded within them. Concerns are raised regarding the possible ethical implications of ownership of such information and, particularly, with the exploitation of the knowledge in the future to enable health interventions that are not yet possible.

The HGP aimed to identify human and mouse genetic material in parallel, as well as some bacterial organisms, in order to broaden the methodological and statistical content available. As effective methods of identifying genes has improved, the attention of researchers has been increasingly taken by creating methods of using the data in profitable applications, rather than simply completing the task.

One issue that was persistently difficult to resolve was the fact that individual genetic units were identified in a partly random fashion, which meant that gaps existed between those blocks of data that were identified, and those that emerged. Identifying the remaining data blocks to form contiguous chains was a complex undertaking that prolonged completion of the project. The HGP has been one of the most important scientific undertakings ever, for the scale and scope of its goals and the ways in which it encouraged people to work together. The production of commercial applications, however, is likely to break up many of those partnerships.

SEE ALSO: Genetic Diversity; Genetically Modified Organisms (GMOs); Genetics and Genetic Engineering.

BIBLIOGRAPHY. Bita Amani and Rosemary J. Coombe, "The Human Genome Diversity Project: The Politics of Patents at the Intersection of Race, Religion, and Research Ethics," *Law and Policy* (v.27/1, 2005); Francis S. Collins, Michael Morgan, and Aristides Patrinos, "The Human Genome Project: Lessons from Large-Scale Biology," *Science* (v.300/5617, 2003); Human Genome Project, www.ornl.gov (cited October 2006); Edwin H. McConkey, *How the Human Genome Works* (Jones and Bartlett Publishers, Inc., 2004); Leslie Roberts, "Controversial from the Start," *Science* (v.297/5507, 2001).

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Human Nature

THE GENERIC CAPACITIES and attributes that are universal, elemental, and unique to the human species constitute human nature. From a biological perspective, humans share commonalities with vertebrates, mammals, and primates, but these are not unique to humans. On the other hand, there is a combination of biological attributes that distinguishes the human species as Homo sapiens like habitual erect posture and bipedal gait, the fully opposable thumb allowing precision grip, brain size and structure, and the anatomy of the vocal apparatus.

What makes humans different, as well as the difference this makes, are the two pivotal questions in exploring human nature. A secondary set of questions includes the relative weight and the character of the relationship between these dualistic components that are variously implicated in conceptions of human nature: determinism and free will, matter and mind, nature and nurture, biology and culture, animal and human, natural and supernatural, civilized and primitive, evil and good, selfish and altruistic, competition and cooperation, and war and peace. Such matters have been pursued for centuries by numerous and diverse theologians, philosophers, scientists, and others. Furthermore, any culture or religion, and every ideological or political persuasion, has its own relatively distinctive view on human nature. In short, human nature is a vast, complex, and difficult subject, and there is no single answer to the primary and secondary questions revolving around it.

ONE ANTHROPOLOGICAL ANSWER

While anthropologists have no monopoly on knowledge and understanding about human nature, they certainly do occupy a special scientific and academic niche, because collectively they study humanity in all aspects, places, and times ranging from the local to the global levels. From the perspectives of primates and prehistory, anthropologists can trace the origin and evolution of human nature. Most important, humans lived as hunter-gatherers from some 6 million to about 10,000 years ago, the latter roughly marking the beginning of the emergence of the domestication of plants, animals, and landscapes. Therefore, whatever is universal, elemental, and unique to the human species is most likely related to the hunter-gatherer mode of existence, although human evolution certainly didn't stop there.

Some examples of attributes claimed by Donald E. Brown to be human universals are: fire, technology, artifacts, shelter, sexual modesty, gender, family, kinship, incest prohibitions, socialization, rites of passage, age classification, statuses, subsistence, economy, division of labor, property, reciprocity, food taboos, customs, hospitality, leaders, public affairs, politics, rules, rights, sanctions, conflict resolution, etiquette, morality, folklore, myths, worldview, rituals, magic, divination, medicines, theories of disease and death, mourning rituals, arts, aesthetic standards, body adornment, play, entertainment, stimulants, symbols, gestures, language, color terminology, binary discriminations, personhood, and group identity. Obviously, human universals are general themes, and in practice each is manifest in variations and details associated with particular cultures and their distinctive conditions, including creativity, history, and environment. Indeed, from the perspective of most anthropologists, culture as nurture dominates over biology as nature to an overwhelming degree, thereby rendering the idea of a single human nature a problematic oversimplification. In other words, the some 7,000 cultures existing today reflect as many different human natures.

PRIMITIVES AND "NOBLE SAVAGES"

According to proponents of primitivism, the "primitive" is not simply a more desirable condition for human society, but from an ecological perspective it is closer to nature and more in harmony with it; most primitives live in wilderness. A correlate is that such societies practice nature religion or eco-spirituality. Consequently, implicitly, if not explicitly, the societies and religions of civilization are criticized as unnatural and environmentally destructive. Thus, environmental organizations from the Sierra Club to Earth First! often consider indigenous people to be guardians of nature—so-called green primitivism. New Age religions, including neo-paganism, frequently contain elements of green primitivism.

The opposite of this so-called romantic view is often credited to English philosopher Thomas Hobbes, even though its roots extend far into classical antiquity. In this view "savage" life is poor, nasty, brutish, and short. The Hobbesian imagery of "primitives" is permeated with disharmony, conflict, and violence, both socially and ecologically. In modern literature, the "ignoble savage" is best exemplified by William Golding's allegorical novel *Lord of the Flies*. Most tragically, negative descriptions have often been used by colonials along with ideas of racial superiority as part of their rationalizations to conquer and exploit—if not even exterminate—indigenous societies who become obstacles to their capture of land and resources in frontier zones.

Paradoxically, both the positive and negative extremes are found in the work of a single famous British social anthropologist, Colin Turnbull, the Mbuti pygmies of the Ituri in the Congo region as "noble savages" in his book *The Forest People* (Doubleday, 1961), and the Ik in Uganda as "ignoble savages" in his book *The Mountain People* (Simon and Schuster, 1972). Turnbull describes the Mbuti as the epitome of the "ecologically noble savage" living in harmony in

"Savage" Reflection

Since the ancient Greeks and Romans, and most of all since the discovery of the New World by Christopher Columbus, the "savage" had supposedly reflected the original condition of "man in nature" for Westerners. In the history of anthropology and beyond, the term *savage* delimits "primitive" societies, those that are supposed to represent an early stage in cultural evolution, usually hunter-gatherers subsisting by foraging on wild foods. However, for half a century now the terms *savage* and *primitive* have been dismissed as ethnocentric and racist.

The French philosopher Jean-Jacques Rousseau (1712–78) is usually credited, but not always accurately, with the positive view that the "noble savage" enjoys a life of social and natural harmony. The "noble savage" encompasses a romantic image of a natural humanity that excels in innocence, simplicity, generosity, purity, goodness, peacefulness, and freedom. This ideal variety of humanity is supposed to dwell in a utopian society in a natural paradise during a golden age. This original society was envisioned as an egalitarian communal existence with property held in common instead of privately. "Primitive" societies exemplifying this Arcadian myth were supposedly discovered by European explorers in the Americas, Pacific, and elsewhere.

By the 18th century, this cult of exoticism emphasized self-analysis and self-criticism in scrutinizing European society, morality, and politics by glorifying the "primitive" in contrast to degenerate European civilization. Some primitivists even went so far as to reject civilization in their discourse, although rarely in practice. Most important, such idealistic images offered a set of alternative possibilities for society, identified variously as archetypal communists, ecologists, environmentalists, conservationists, spiritualists, healers, philosophers, and pacifists.

the forest. In contrast, he depicted the Ik as former foragers forced by the government to relocate, settle, and farm under increasing drought conditions with subsequent starvation from crop failure. As a consequence, the Ik degenerated to the point of a bare existence without sociality, culture, morality, and humanity, according to Turnbull.

HUMANITY'S PLACE IN NATURE

In the matter of the relationship between society and environment, the question of the place of humans in nature is vital. In the United States, within the context of the emergence of environmentalism, this question has been discussed and debated at least since the time of George Perkins Marsh, Henry David Thoreau, and John Muir. In recent decades, often this question has involved the issue of the "ecologically noble savage" and the related one of *Homo devastans*, labels coined, respectively, by conservation biologist Kent H. Redford and by ecological anthropologist William L. Balee; although neither agrees with the position that their particular label represents.

Redford was one of the first in recent times to challenge the idea that indigenous societies were necessarily always in harmony with nature. He asserts that indigenes are not necessarily conservationists, although they may be very knowledgeable about the ecology of their habitat. He claims that they have long had significant environmental impacts, even in pre-contact times, and that this increases with Westernization. Redford also asserts that indigenes have the same capacities, needs, and desires as Westerners; and that they have no cultural barriers or controls on their exploitation of natural resources. Any previous sustainability is coincidental because of conditions now rare, including low population density, abundant land, and little involvement if any in a market economy. Redford concludes that indigenes do not provide any viable models for the sustainable use of natural resources and environmental conservation.

Redford's assertions have raised critiques on several grounds. For instance, it is well documented that the environmental impact of many traditional subsistence societies was comparable to natural processes and did not lead to irreversible resource depletion and environmental degradation. Often, such societies have an archaeological and/or historical record extending back centuries or even millennia indicating their sustainability. Also, Western environmental impact is so much greater that it is qualitatively different. Although Redford has tempered his position considerably over time, some of the same thinking remains in various sectors of society and government.

A more recent example of an attempt to totally invalidate the idea of the "ecologically noble savage" is Shepard Krech's book *The Ecological Indian: Myth and History* (1999). He marshals striking negative examples from prehistoric and historic times, ranging from Pleistocene megafaunal extinctions to wasteful buffalo drives over cliffs by Plains Indians to the depletion of beaver populations by natives for the fur trade. In his survey, however, he fails to acknowledge the far more numerous counterexamples in which indigenous societies have achieved some degree of economic sustainability and ecological balance.

Balee adopts the term *Homo devastans* to refer to the extreme position that human nature itself is inherently and inevitably anti-nature, a position apparently held by many contemporary environmentalists. Advocates of this position assert that given a large enough population, advanced technology, and high levels of consumption and waste, then any society can irreversibly deplete its natural resources and degrade or even destroy its environment. Resource competition and human greed are presumed to be universals. In short, no human society is benign in its environmental impact; some are merely worse than others. Such a view can lead to extreme thinking, like the assertion that the only cure for the global environmental crisis is the extinction of the human species. This concept of *Homo devastans* ignores to the point of simplistic reductionism and gross distortion the tremendous variation and variability in cultures and in environments, including the varying vulnerability, resiliency, and other attributes of the latter.

In considerations of the "primitive" as the most basic expression of human nature, the general tendency remains to emphasize one extreme or the other, often to the point of distortion. Such representations need to be critically scrutinized, deconstructed, and demystified. In reality, the world is far more complex, varied, and variable than to sustain such simplistic antithetical postures. It is far more scientific and scholarly to consider the great diversity in the manifestations of human nature through examining particular cases. Human diversity is the practical reality that challenges many attempts at generalizations about human nature as well as about the place of humans in nature.

SEE ALSO: Anthropology; Indigenous Peoples; Noble Savage Myth.

BIBLIOGRAPHY. William A. Balee, ed., *Advances in Historical Ecology* (Columbia University Press, 1998); Donald E. Brown, *Human Universals* (McGraw-Hill, Inc., 1991); Mary E. Clark, *In Search of Human Nature* (Routledge, 2002); Paul R. Ehrlich, *Human Natures: Genes, Cultures and the Human Prospect* (Island Press, 2000); International Union for the Conservation of Nature (IUCN), *Indigenous Peoples and Sustainability: Cases and Actions* (International Books, 1997); Kent H. Redford, "The Ecologically Nobel Savage," *Orion Nature Quarterly* (v.9, 1990); Charles L. Redman, *Human Impact on Ancient Environments* (University of Arizona Press, 1999); Leslie E. Sponsel, "Human Impact on Biodiversity, Overview," in *Encyclopedia of Biodiversity*, Simon Asher Levin, eds., (Academic Press, 2001); Leslie Stevenson and David L. Haberman, *Ten Theories of Human Nature* (Oxford University Press, 1998).

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Humboldt, Alexander von (1769–1859)

ALEXANDER VON HUMBOLDT (1769–1859), a Prussian naturalist and explorer, is one of the founders of modern geography and meteorology. He was born Baron Friedrich Wilhelm Karl Heinrich Alexander von Humboldt in Berlin, Germany on September 14, 1769 as the youngest of two sons of a Prussian army officer and his wife, Elizabeth de Colomb. He lost his father at a young age and was raised by his mother. Humboldt's mother decided to train him for an administrative post in the civil service. It seemed like a good choice for a boy who was often ill and did not learn easily. Humboldt, however, wanted to enter the army. He did not become interested in the sciences until he was 16 and he wound up almost entirely self-taught. Yet, he spent a year at a college in Frankfort-on-the-Oder and then went to the University of Gottingen in 1788 to study engineering. Humboldt spent a further year studying mining and mineralogy at the School of Mines in Freiberg, Saxony.

After leaving school, Humboldt obtained a job in the Prussian government's Mining Department. He worked in the gold and copper mines in the Fichtel Mountains. He also began experimenting with stimulation of nerves by electrical and chemical means. Humboldt's experiments proved that nerves produced a substance that entered the muscle and triggered movement. He continued these physiological studies by investigating the effects of gases and liquids on living animals. The result was the discovery that breathing will stop if the content of carbon dioxide or hydrocarbonic gases in the air exceeds a certain limit. Upon being offered a promotion to director of mining, Humboldt refused the job to travel and conduct research. Always financially well-off, he did not need to work. In 1798, he crossed Spain while taking measurements. Humboldt found both that existing maps of the country were inaccurate and that the interior of Spain forms a high plateau. Humboldt then received permission to travel to the Spanish colonies in Latin America.

EXPLORER OF THE AMERICAS

Humboldt is best known for his explorations of Latin America from 1799 to 1804. With his friend, the French physician and botanist Aimé Bonpland, Humboldt traversed 5,000 miles of some of the most forbidding, dangerous, and bleakest terrain on Earth. They traveled along the coast of Venezuela. They followed the Amazon and Orinoco Rivers and discovered the only natural canal, the Casiquiare Canal, that connects two major rivers. They explored much of Peru, Ecuador, Colombia, and Mexico by the time their journey stopped. The two men collected plant, animal, and mineral specimens. They discovered the first animal that produced electricity, the electric eel. While attempting to explain the dryness of the interior of Peru, Humboldt measured the temperature and clocked the flow of a cold ocean current that runs along much of the western coast of South America. Called the Peru Current, it is now better known as the Humboldt Current although the explorer was not the first to discover it and he objected to being honored in this fashion. Humboldt did discover the importance of guano (the dried droppings from birds) as a fertilizer and gave his name to one of the producers of guano, the Peruvian or Humboldt Penguin.

Although Humboldt has not received the credit due him, he did achieve great fame in his day. Part of his reputation came from his extensive self-published writings of his travels and discoveries. One of his books, *Personal Narrative of Travels to the Equinoctial Regions of the New Continent During the Years 1799–1801*, inspired the English naturalist Charles Darwin. Descriptions, figures, reflections, and history are thrown together without any organization in a mix that is both fascinating and wearying. Running out of money, Humboldt became an advisor to the Prussian ruler in 1827. Invited to tour Russia, he described permafrost and recommended that the Russians establish weather stations across the nation. The stations, created by 1835, allowed Humboldt to use data to develop the principle of continentality, the idea that the interiors of continents have more extreme climates due to a lack of moderating influence from the ocean.

He also developed the first isotherm map, containing lines of equal average temperatures. Humboldt spent much of his later life giving public lectures in Berlin and working on a multivolume work, *Kosmos*, that would summarize everything known about the earth. Before he could complete it, Humboldt died, possibly of a stroke, on May 6, 1859. He is buried in Tegel, Germany.

SEE ALSO: Darwin, Charles; Peru.

BILIOGRAPHY. Gerard Helferich, *Humboldt's Cosmos: Alexander von Humboldt and the Latin American Journey That Changed the Way We See the World* (Gotham Books, 2004); L. Kellner, *Alexander von Humboldt* (Oxford University Press, 1963).

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Bonpland and the Yerba

One of the associates of Alexander von Humboldt was Aimé Bonpland (1773–1858) who was from La Rochelle, France. He became a surgeon in the French army and then traveled to South America where he accompanied Humboldt in his travels in Mexico, Colombia, and Brazil.

Returning to France, Bonpland was given a government pension and made the superintendent of the gardens at Malmaison, the mansion owned by Josephine and where Napoleon often stayed when in Paris. He wrote a number of books on plants and botany, including one on the rare plants at Malmaison.

Leaving Europe in 1816, Bonpland went to Buenos Aires, Argentina, where he became a professor of natural history and was active in botanical circles. In 1821 he went to the borders of Paraguay where he hoped to cultivate yerba, a plant used to make the herbal infusion known as *mate*. It was at that time the main export of Paraguay and the president of Paraguay, José Gaspar Rodríguez de Francia was keen that Bonpland did not manage to get any seeds that could lead to the plant being grown elsewhere, and thus erode Paraguay's major source of foreign currency. Dr. Francia was even more nervous when he heard that Bonpland had brought a large number of armed guards with him.

On the evening of December 8, 1821, four hundred armed Paraguayan soldiers headed over to Bonpland's encampment and on the following morning arrested him. There were protests that this violated international law, and Bonpland remained in Paraguay for ten years, returning to Argentina in 1831. Although many have sought to use the arrest of Bonpland as an example of the despotism of Dr. Francia, Bonpland was well-treated during his time in Paraguay. On crossing the border into the semiautonomous Argentine province of Corrientes, he had his horses stolen. Bonpland wrote in his diary "It was immediately apparent that we were no longer in Paraguay."

Humidity

HUMIDITY IS A measure of the amount of water vapor in the air and is a primary element of climate. Humidity can be expressed in a number of ways, including absolute humidity, specific humidity, mixing ratio, relative humidity, and dew point. Although water vapor rarely accounts for more than 4 percent of the total volume of the atmosphere, it is an extremely important component of the atmosphere. Atmospheric water vapor regulates air temperature by affecting the transmission of radiant energy both to and from the earth's surface and provides latent heat energy to fuel storm systems. The maximum amount of water vapor that the atmosphere can hold is a function of the temperature and pressure of the air. The moisture content of air increases rapidly as the temperature of the air increases. When a volume of air contains the maximum amount of water vapor at a given temperature and pressure, the air is said to be saturated.

Absolute humidity directly measures the amount of water vapor in a given volume of air and is usually expressed in grams of vapor per cubic meter of air. The absolute humidity of an air parcel will change as it expands or contracts even though there is no change in the amount of water vapor. Due to these drawbacks, measurements of absolute humidity are rarely used.

Specific humidity refers to the mass of water vapor in a given mass of air and is usually expressed in grams of water vapor per kilogram of air. Unlike absolute humidity, specific humidity has the advantage of not changing as air expands or contracts. The mixing ratio is closely related to specific humidity and is defined as the mass of water vapor in the air to the mass of dry air. Relative humidity is the most common and frequently used measure of humidity. Relative humidity is the ratio, in percent, of the amount of moisture in the air compared to the amount that the atmosphere can hold at a given temperature and pressure.

The relative humidity of the air changes throughout the day, usually reaching its highest value in the early morning hours and then decreases to a minimum in the early afternoon. Thus, relative humidity indicates how near the air is to saturation rather than the actual quantity of water vapor in the air. Another useful measure of humidity is the dew point, the temperature at which air becomes saturated if cooled without a change in pressure or moisture content. The dew point is always less than the air temperature unless the air is saturated.

Several types of instruments have been created to measure humidity. Humidity measurements are increasingly being recorded by remote sensing packages that transmit upper-air observations back to ground stations. An instrument commonly used to measure humidity is the psychrometer. It consists of a wet bulb thermometer that is kept moist by a wick soaked in water and an unmodified dry bulb thermometer. When the psychrometer is swung freely in the air or aerated by a fan, evaporative cooling lowers the wet bulb temperature. The amount of moisture in the air can be determined by calculating the difference between the dry bulb and wet bulb temperature. The hair hygrometer is another instrument used to measure humidity and is based on the fact that hair expands and contracts in response to changes in humidity.

Humidity greatly affects our comfort and health and can make the warmth of the surrounding air feel as if it is warmer than the actual temperature. If the atmosphere has a high moisture content, the rate of evaporation is reduced, which impairs the body's ability to maintain a constant temperature. Physical strength declines and fatigue occurs more rapidly in a humid environment. A heat index can be used to determine the apparent temperature caused by the combination of heat and humidity.

SEE ALSO: Atmosphere; Climate; Climatology; Precipitation; Remote Sensing; Thunderstorms; Weather.

BIBLIOGRAPHY. Edward Aguado and James E. Burt, *Understanding Weather and Climate* (Prentice Hall, 2004); Howard J. Critchfield, *General Climatology* (Prentice Hall, 1983); Ann Henderson-Sellers and Peter J. Robinson, *Contemporary Climatology* (Longman Scientific and Technical, 1986); Frederick K. Lutgens and Edward J. Tarbuck, *The Atmosphere* (Prentice Hall, 2004); Joseph M. Moran and Michael D. Morgan, *Meteorology* (Prentice Hall, 1997).

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Hungary

PART OF THE Austro-Hungary Empire until the World War I period, Hungary became part of the Soviet bloc at the end of World War II. After the Soviets dispatched troops to prevent Hungary from leaving the bloc in 1956, the government instituted what became known as "Goulash Communism." Following the dissolution of the Soviet Union, Hungary transformed itself into a market economy. Although the Danube and Tisza Rivers divide Hungary into three unequal sections, the country is landlocked. Hungary has a temperate climate with cold, humid winters and warm summers. Half of Hungary's 35,652-square-mile land mass is arable, and the soils are fertile. Other valuable natural resources include bauxite, coal, and natural gas.

After joining the European Union (EU) in 2004, Hungary began upgrading waste management facilities and committed itself to improving energy efficiency and reducing levels of air, water, and soil pollution. In a 2006 study conducted by Yale University, Hungary ranked 33 out of 132 nations in environmental performance. The lowest ranking came in the areas of biodiversity and habitat protection. The Hungarian government has protected 7 percent of its land, but acid rain has endangered large areas of forest. Nine of 83 mammal species are endangered, as are eight of 208 bird species.

The population of 10,007,000 enjoy a per capita income of $15,900, but Hungary has a labor force participation of only 57 percent. The current unemployment rate is 7.1 percent, and 8.6 percent of the people live below the poverty line. Approximately 99 percent of the population have access to safe drinking water, and 95 percent have access to improved sanitation. The United Nations Development Program (UNDP) Human Development Reports rank Hungary 35th among nations of the world on general quality-of-life issues.

Around 66 percent of Hungarians live in urban areas, and less than 4 percent of the labor force are engaged in agriculture. Because of heavy concentration in urban areas, Hungary, like most heavily industrialized nations, has a problem with carbon dioxide emissions. With 259 cars per 1,000 people, Hungary is responsible for .2 percent of the world's carbon dioxide emissions. Until the latter 1980s, almost 40 percent of Hungary's population were regularly exposed to extensive air pollution from electric plants that burned high-sulfur coal. High winds carried toxic fumes into neighboring areas, resulting in widespread pollution.

Water pollution has also posed a major dilemma for the Hungarian government. In 1970, some 52.9 million cubic feet of polluted water were being produced each day. Effluents, which included waste from the chemical, rubber, iron, paper, and food-processing industries, polluted groundwater and caused major environmental damage to the waters of the Tisza, Danube, Szamos, Sajo, and Zagyva. Less than one-third of all waste was treated before disposal, and less than half of the people had access to proper domestic sanitation. During the 1980s, pollution levels in Hungary became even more critical as the government increased revenue by importing hazardous waste from Austria, Switzerland, and West Germany. Hungary was also negatively affected by Romania's practice of dumping phenol, oil, and other pollutants into the shared waters of the Tisza and other smaller rivers. The turning point came in response to public outcry, which forced the government to erect a nuclear waste incinerator.

It was not until the mid-1990s that major environmental progress was made. In 1995, Hungary passed the comprehensive Environment Act. Hungary's environmental policy is based on the premise that polluters should pay to correct the damage they cause and fund preventive technologies, but fines are relatively low. The 1995 law dealt with reducing levels of chemical substances in the environment, improving waste management, reducing pollutants, eliminating radioactive contamination of food, and increasing radiation protection. In 2003, the legislation was updated to bring environmental policy in line with EU standards.

Since joining the EU, Hungary has made great strides in improving its environment, but the government continues to be hampered by funding shortages. The Ministry for Environment and Regional Policy bears the responsibility for overseeing environmental policy, working with the Hungarian Environment Council and various nongovernmental organizations to plan and implement environmental policy.

Hungary has expressed its commitment to global environmentalism by participating in the following international agreements: Air Pollution, Air Pollution-Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. The government has signed but not ratified the Air Pollution–Sulfur 94 agreement.

SEE ALSO: Acid Rain; Carbon Dioxide; Coal; Polluter Pays Concept; Pollution, Rivers; Urbanization; Water.

BIBLIOGRAPHY. CIA, "Hungary," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Library of Congress, "A Country Study: Hungary," www.loc.gov (cited March 2006); UNDP, "Human Development Reports: Hungary," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Hungary," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Hunter-Gatherers

HUNTING AND GATHERING can be defined as a method of procuring food from the environment through the gathering of edible plants and hunting wild game, including fish. For most of human history, human beings survived by foraging and hunting. It was only about 8,000–10,000 years ago when the domestication of animals and agriculture became a major source of food that people began to abandon a hunter-gatherer style of life. Archaeological evidence has greatly advanced our knowledge of hunter-gatherer communities in antiquity. Ethnographic and historical studies provide information about the way of life of both historic and contemporary hunter-gatherers. Hunting and gathering was the only way humans survived for more than a million years until the end of the Paleolithic period (Old Stone Age). During the era of hunting and gathering, humans depended on the year-round supply of wild edible plants and animals that they hunted with rudimentary stone tools and weapons. The roots of culture are attributed to hunter-gatherers who roamed in small bands hunting and foraging over considerable territory.

Contemporary hunter-gatherer societies tend to be relatively mobile, dependent on the ability of a given natural environment to provide sufficient resources. Where resources are scarce, the bands might only contain 10–20 individuals. Where resources are abundant, the bands might be larger,

For most of human history, human beings survived by foraging plants and hunting for wild game and fish.

comprising 100 people or more, and may form semi-permanent settlements. Often, hunter-gatherers shelters are constructed of impermanent building materials such as grass and leaves in rain forest environments, or they may seek caves for shelter in drier and mountainous environments.

Hunter-gatherer communities have simple, nonhierarchical, egalitarian social systems. It has been suggested that egalitarianism was one of several central characteristics of nomadic hunting and gathering societies, since mobility precluded the accumulation of material possessions for any one single member in the band. However, in areas where resources were plentiful, making a more permanent way of life possible, the simple social structure gave way to a more hierarchical social organization.

Furthermore, clear evidence exists concerning the sexual division of labor among hunter-gatherer groups. Females were primarily assigned the food-gathering chore, which resulted in their developing a keen sense for and the greatest familiarity with nutritive plants such as wild fruits and vegetables. Hunting activities became the domain of men. Furthermore the idea that hunter-gatherers lived a "solitary, poor, nasty, brutish, and short life" constantly at the mercy of the environment has been refuted by recent studies. For example, studies of the San people (Bushmen) in South Africa indicate that hunter-gatherer bands live well on the equivalent of a two and half day workweek, which gave them plenty of time to develop skills in working flint and bone tools, in developing regionally distinctive art and sculptures, and in making decorative beads and shells for personal adornment and trade.

Hunting and gathering is not completely gone in contemporary society. Many people, particularly in the developing world, continue to obtain food through gathering of wild edible plants and hunting wild meat. Although perhaps only a few thousand persons worldwide, some societies continue to entirely depend on this system for their subsistence. Usually these are found in isolated and remote pockets of the world such as the interior of New Guinea, interior and inaccessible parts of Southeast Asia, the Amazon tropical rain forest, small and isolated portions of tropical and arid Africa, parts of northern Australia, and parts of the Arctic regions. As a result of the now-global reliance upon agriculture, the few contemporary cultures that practice hunting and gathering usually live in areas seen as undesirable for agricultural use. For many of these peoples, their lifestyle is being modified or lost by contacts with the outside world. Intrusion of modern material goods such as plastics, metal, and clothing into their societies has made them part of the modern market economy and resulted in the erosion of their primitive way of life.

SEE ALSO: Farming Systems; Food; Hunting.

BIBLIOGRAPHY. Robert L. Bettinger, *Hunter-Gatherers: Archaeological and Evolutionary Theory* (Plenum Press, 1991); Hugh Brody, *The Other Side of Eden: Hunter-Gatherers, Farmers and the Shaping of the World* (North Point Press, 2001); Jerome Fellmann, Arthur Getis, and Judith Getis, *Human Geography: Landscapes of Human Activities* (McGraw Hill, 2007); Robert L. Kelly, *The Foraging Spectrum: Diversity in Hunter-Gatherer Lifeways* (Smithsonian Institution, 1995); John E. Pfeiffer, *The Emergence of Man* (Harper & Row Publishers, 1972).

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Hunting

IN VERY GENERAL terms, hunting refers to the activity of pursuing and killing free-roaming animals. It is often assumed that these are wild animals, but that is not necessarily the case. There are many reasons why human beings hunt. These range from a need to obtain protein-based sources of nourishment to the pursuit of recreation or of a thrill. People also hunt to collect raw materials that are used for industrial purposes, as in the case of the fur industry, or to collect trophies, amulets, or the ingredients for magic and aphrodisiac potions. Why people hunt, how they hunt, what they hunt, and what they do with the products of hunting endeavors say a lot about a society's social organization, economic systems, culture, and values. Some people in Western societies condemn hunting as an extremely inhumane form of unnecessary cruelty. Hunting may indeed seem unnecessary and cruel when animals are butchered and left half alive so that humans can extract a small part of their bodies to use as "good luck" charms. However, the social scope of hunting is far too wide to be reduced to such a reality. Three examples illustrate the range of possible forms of hunting and their relation to different societies, cultural premises, and ecological environments.

INDUSTRIAL HUNTING

The industrial hunting of many species of wild animals is directly related to the history of the Industrial Revolution and Western modernization. In this context, some species were hunted to the brink of extinction. Mainly between the 17th and the early 20th centuries, an enormous number of whales were killed so that their blubber could be extracted and for oil. This oil, in turn, was used to illuminate the streets of the world's first major industrial centers. Subsequently, whale-derived oil—especially the spermaceti of sperm whales—was used to lubricate the war machinery of World War II.

Today animals continue to be hunted for industrial purposes. This is the case, for example, of baby seals in Canada, which are hunted for the fur industry. Hunting for industrial purposes has been linked with different moral values at different historical junctures. Between the 17th and 20th centuries, most Western societies saw this activity as a perfectly legitimate means to satisfy human needs. More recently, many people contest industrial hunting as an immoral and selfish feeding of human whims. In either case, those values reflect the cultural worldviews that are most typical of a society at a given point in time.

RECREATIONAL HUNTING

Recreational hunting refers to the pursuit and killing of animals for the purpose of enjoyment. Sports hunting, as exemplified in the well-known case of fox hunting in the United Kingdom, is but one of many forms of recreational hunting. The analysis of recreational hunting can provide fascinating clues about a society's class relations, structures of power, and environmental understandings. The royal hunt, which was pursued in Euroasian countries until the 19th century, is one such example. Besides hunting, it was a means to train armies and to display the military power of a nation. The historian Thomas Allsen has studied the royal hunt extensively. His work shows that this activity also served the purpose of sending diplomatic signals to neighboring powers (as a display of strength) and to assert a ruler's mastery of the forces of nature. Clearly, the cultures of the societies where royal hunts took place viewed the human–environmental relationship as one of domination of people over animals and over nature.

The organization known as Ducks Unlimited is another interesting case that affords a view of a particular perception of the relationship between humans, hunting, and the environmental—although from a different perspective. This is an association of hunters who see their main mission as the conservation, restoration, and management of wetlands that constitute habitats for North America's waterfowl (the animal they hunt). A side effect of the conservationist efforts of this association has been the creation of many natural reserves that actually benefit other species of animals. Group members conceptualize hunting activities as a type of sport that is intimately associated with both a particular lifestyle that comes with the appreciation of nature, and the obligation to engage in sound practices of wildlife conservation.

SUBSISTENCE HUNTING

A third example is subsistence hunting, a practice historically common in many Western societies where most people no longer hunt, yet there are many examples of societies that still obtain most of their protein sources through hunting. The core characteristic of subsistence hunting is that its practitioners hunt for the purposes of feeding and clothing themselves and their community. They normally kill only the number of animals that they need in order to survive. More often than not, waste—hunting more than is needed—is considered immoral. So is the inflicting of unnecessary pain and cruelty on the animals during the hunting process.

Many hunters in subsistence economies perceive their relations with the animals they hunt as reciprocal. From their viewpoint, humans and animals communicate with one another during the hunting process. If the human being follows proper norms of conduct and sticks to culturally accepted values, the animal will collaborate by allowing itself to be killed. The main cultural premise in this context is that humans are not superior to animals, and that therefore humans should not have the right to attempt to dominate animals. These societies are normally structured so that any individual has access to the animals, although people often opt to divide labor between them such that some will hunt, others will gather fruits or grow cereals, others will collect water and so on. The products of these different activities are normally shared by means of reciprocity.

SEE ALSO: Animal Rights; Conservation; Deer; Ecosystems; Habitat Protection; Industrial Revolution; Native Americans; Wetlands; Wildlife.

BIBLIOGRAPHY. Thomas Allsen, *The Royal Hunt in Eurasian History* (University of Pennsylvania Press, 2006); Ducks Unlimited (homepage), www.ducks.org (cited April 2006); Katja Neves-Graca, "'A Whale of a Thing': Transformations from Whale Hunting to Whale Watching in the Azores," Ph.D. diss. (York University, 2002).

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Huntington, Ellsworth (1876–1947)

ELLSWORTH HUNTINGTON (1876–1947), American geographer, was best known as the leading proponent of a school of thought commonly known as environmental determinism. Environmental determinism claimed that geographic controls and related environmental conditions dictated a predictable human response and, consequently, had a profound influence on the development of societies and the course of history. Professional scholars were critical of his work; nevertheless, his ideas had a certain force in the academic world. In addition, the sheer volume of these writings and their popularity with the public ensured a prominent place in the geographic and environmental intellectual milieu of the time.

Between 1897 and 1906, Huntington spent six years teaching, traveling, and exploring in Asia, where he conducted fieldwork in some of the most desolate and inhospitable deserts and mountains on the continent. He became convinced that the climate of Central Asia had become drier and that such desiccation had had a profound impact on the course of history and the development of civilization. These ideas formed the content of his first major book, *The Pulse of Asia*, published in 1907.

Huntington continued to develop his ideas that reached their pinnacle in 1924, in his work, *Civilization and Climate*. In his view, climate had not only impacted the course of history and civilization, it had also affected the character of societies and even individual human behaviors. He argued that civilization had moved from the salubrious climates of the subtropics like Egypt and Greece to the colder, but more "stimulating," climates of northwestern Europe. The cyclonic storm systems of the midlatitudes affect northern Europe throughout the entire year but only affect the Mediterranean region in the cooler part of the year. In his view, these frequent changes of weather provided a psychological stimulus lacking in warmer climates where the weather was more monotonous.

Huntington's last major work was *Mainsprings of Civilization* (1945), in which he argued that civilization derived from three principal pillars. These were genetic heritage, environmental situation, and cultural endowment. Critics came to question these three "pillars," as well as the relationships among them. For example, the critics claimed that Huntington's emphasis on heredity was, in reality, thinly veiled racism. His speculations about environmental cycles of various periodicities further compromised his credibility, especially as paleoclimatology matured. His work was dismissed for drawing too many conclusions from too few facts and for never letting contrary facts get in the way of his sweeping conjecture.

Huntington's work remains important for a few reasons. Writing at the time that he did and, with the recent colonization of much of the world by European powers, his work sheds light onto the relationship between global political economy and the academic and ideological systems that often undergird them. In addition, the work serves as a reminder that strongly held convictions cloaked in scientific credentials can have a strong hold over the popular press and media, as well as circles of policy. Finally, Huntington's work is a study in the dangerous elegance of simple arguments; environmental determinism maybe a discarded relic of the not-so-remote intellectual past, but no one did it better or more convincingly.

SEE ALSO: Climate; Environmental Determinism.

BIBLIOGRAPHY. Ellsworth Huntington, *Civilization and Climate*, *3rd ed*., (Yale University Press, 1924); Ellsworth Huntington, *Mainsprings of Civilization* (John Wiley & Sons, 1945); Ellsworth Huntington, *The Pulse of Asia* (Houghton, Mifflin, 1907); Geoffrey Martin, *Ellsworth Huntington: His Life and Thought* (Archon, 1973).

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Hurricanes

A HURRICANE IS a particularly strong tropical storm; that is, a storm with winds in excess of 74 miles per hour. *Hurricane* is the term used for this type of storm in the North Atlantic Ocean; in the Pacific Ocean, these storms are known as typhoons, and in the Indian Ocean they are known as cyclones. The smallest hurricanes—Category 1 on the Saffir/Simpson scale—are relatively minor, with winds of between 74 and 95 miles per hour and a storm surge of about four to five feet. A Category 5 storm, on the other hand, packs winds of over 155 miles per hour; with a storm surge along the coastline of greater than 18 feet.

Current research suggests that Atlantic hurricanes begin with atmospheric disturbances near north central Africa. These disturbances move across the continent until they reach West Africa, where they can become storms known as tropical depressions, characterized by low barometric pressure. As the depression moves across the Atlantic, the depression can build and gain strength and become a tropical storm, and when it grows to sufficient strength, it becomes a hurricane.

Hurricanes are given names to aid in their identification. Originally they were given only women's names, but since 1979 they have been named for men and women, and in recent years care has been taken to add French and Spanish names to the list, given the fact that hurricanes can strike Spanish- and French-speaking areas in the Caribbean.

The "hurricane season," runs between June 1 and October 30. According to the U.S. Weather Service, an average of two major hurricanes hits every three years, and one Category 4 or greater hurricane strikes every six years. However, there is nothing to prevent a major hurricane from striking the same region two years in a row, or even twice in one season.

Hurricanes tend to strike most often in the southeastern United States. States at greatest risk extend from Texas to the Carolinas. The highest death toll from a hurricane in American history resulted from the 1900 Galveston hurricane, which struck a city that local boosters had claimed could not possibly be hit by a hurricane. When storms turn up the Eastern Seaboard, states from Florida to Maine can be affected, sometimes severely. Long Island (New York) and New England, extending eastward into the Atlantic Ocean, tend to bear the brunt of such storms. Hurricane Gloria in 1985, for example, barely brushed New Jersey, but did substantial damage to Long Island. A very powerful hurricane killed about 600 people on Long Island and in New England in 1938. Today, highly sophisticated weather forecasting and monitoring tools prevent substantial losses of life from hurricanes, because people can be warned to secure their property from high winds, or to evacuate areas that will be particularly hard-hit.

The most damaging hurricane—and the most damaging single natural disaster—in American history is Hurricane Katrina, which struck Louisiana and Mississippi on August 29, 2005. (It passed over south Florida in a much weaker size.) The storm grew to Category 5 before weakening, as many storms do, to a Category 3 storm when it made landfall between New Orleans, Louisiana and Gulfport, Mississippi. While wind damage was quite severe from this storm, particularly along the coastline, the major feature of Katrina was the very large storm surge that hit many buildings, and, in some cases, entire towns—along the Louisiana and

Mississippi coast. The surge pushed boats inland, drove water into buildings, and was so strong that it caused bridges along the Gulf Coast to collapse because of the upward pressure the waves exerted on the bridge decks, rather than the lateral pressure usually seen in high winds.

In New Orleans, the storm surge on Lake Ponchartrain was so great that powerful waves entered drainage and navigation canals. The levees along these canals failed, a result of inadequate design, planning, and maintenance, and about 80 percent of the city was flooded, in some places over 14 feet deep. The possibility of this happening was well known before Katrina, but politics, budget issues, and a lack of attention to the hazard made it impossible to strengthen the system against this storm. The storm surge from Hurricane Katrina was greater than typical for a Category 3 hurricane, which reveals a shortcoming of the Saffir-Simpson scale: the scale measures wind speed, not storm surge; the two are not a direct relation to each other. Some storms, like Hurricane Andrew (1992) in Florida, did most of their damage from high winds. Hurricane Floyd (1999), the most expensive storm in North Carolina history, did its damage primarily inland, when rains caused rivers to overflow and flood many cities and towns, and caused toxic runoff to flow into rivers from farms. Some scientists claim that the numbers and intensity of hurricanes will increase because of global climate change.

SEE ALSO: Disasters; Floods and Flood Control; United States, Gulf Coast South.

BIBLIOGRAPHY. J.B. Elsner and A.B. Kara, *Hurricanes of the North Atlantic: Climate and Society* (Oxford University Press, 1999); Shirley Laska, "What if Hurricane Ivan Had Not Missed New Orleans?" *Natural Hazards Observer* (v.29/6, 2004); NOAA/National Hurricane Center, www.aoml.noaa.gov (accessed August 10, 2006); W.G. Peacock, B.H. Morrow, and Hugh Gladwin, *Hurricane Andrew: Ethnicity, Gender, and the Sociology of Disasters* (Routledge, 1997); R.A. Pielke, *The Hurricane* (Routledge, 1990); R.H. Simpson and Herbert Riehl, *The Hurricane and Its Impact* (Louisiana State University Press, 1981); Bill Swichtenberg, "Hurricane Floods Pose Risk to Environment and Health, New Research Reveals," *Water Engineering & Management* (v.149/4, 2002); I.L. Van Heerden and Mike Bryan, *The Storm: What Went Wrong and Why During Hurricane Katrina: The Inside Story from One Louisiana Scientist* (Viking, 2006).

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Hybrid Vehicle

A HYBRID VEHICLE is any vehicle that utilizes a combination of an internal combustion engine running on traditional fossil fuels and a battery-powered electric motor for propulsion. The most basic and common configuration is to simply place the electric motor in line with the main drive train, and to have the electric motor draw from battery power and aid the internal combustion engine while the vehicle is undergoing acceleration. The act of accelerating burns more fuel than simply cruising at a constant speed, so the assistance of the electric motor during acceleration acts to conserve fossil fuels. Likewise, as the vehicle undergoes deceleration, the reverse rotation of the electric motor acts to recharge the battery. The electric motor is utilized more frequently if the vehicle makes frequent starts and stops; hence, hybrid vehicles tend to have better fossil fuel efficiency in urban driving conditions.

Some hybrid vehicles utilize a transmission system that has a more complex interaction between the electric motor and internal combustion engine. These models are able to run as described above, but also have the ability to engage the electric motor as the primary drive engine while cruising, or to use the internal combustion engine as the sole drive engine while utilizing the electric motor as a generator to recharge the battery.

Hybrid vehicles are considered to be environmentally friendly from two points of view. These vehicles, by having a greater efficiency rating for fossil fuel consumption, have a lower level of emission of greenhouse gases and can therefore slow the rate of global climate change. Second, these vehicles are seen as being beneficial by reducing dependence on fossil fuel consumption, with the additional geopolitical benefit of reducing dependence on imported fuels.

Environmental concerns have been raised in regard to disposal of the batteries these vehicles utilize, once they become spent. Current technology uses nickel-cadmium batteries. Nickel is suspected of being carcinogenic, but is considered to be less of a threat than the lead used in standard lead-acid batteries. In addition to health concerns, environmentalists are concerned about the impact of nickel mining. Nickel-cadmium batteries are expected to be replaced soon by lithium-ion batteries, which are considered to be less of an environment and health risk.

CRITICISMS AND SCRUTINY

Environmentalists are critical of the automobile industry in implementing hybrid technologies. U.S.-based manufacturers have primarily created hybrid versions of their SUVs and light trucks, with a very small net increase in fuel efficiency. Environmentalists assert that this allows automakers to claim to be environmentally friendly with very small gains to overall fuel efficiency. Industry spokespeople counter that demand for hybrid vehicles with significantly increased fuel efficiency are niche markets; the increased costs of these hybrids exceeds the economic savings in fuel consumption and hence only people willing to spend the extra money on environmental values would likely buy them. The industry further argues that net fuel saved through implementing hybrid technologies on their largest-selling vehicles, although modest for any single consumer, would have a greater overall reduction in fuel consumption. Despite industry criticisms, demand for hybrid vehicles has been high, and the industry has not been producing enough to meet the demand.

SEE ALSO: Automobiles; Electricity; Fossil Fuels; Greenhouse Gases.

BIBLIOGRAPHY: Jack Erjavec and Jeff Arias, *Hybrid, Electric and Fuel-Cell Vehicles* (Thomson Delmar Learning, 2006); Hybrid Cars Technology, www.hybridcars.com (cited December 2006); United States Environmental Protection Agency, "Fuel Economy," www.fueleconomy.gov (cited April 2006).

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Hydrogen Fuel

HYDROGEN, DESIGNATED AS H on the periodic table of the elements, is the simplest and most abundant of all the elements. A hydrogen atom consists of a single proton and an electron, and has the lowest density of all known matter. Hydrogen molecules combine to form a stable molecule of two hydrogen atoms and their associated electrons.

Hydrogen is an odorless, colorless, tasteless gas (H_2) that is not very reactive at ordinary temperature levels. It burns with a very hot, almost invisible flame, and can be used as a fuel in nuclear fusion and by chemical reactions. Nuclear fusion occurs with Deuterium combining at the proton level to form helium.

Hydrogen comprises most of the matter in the sun, which generates light by a process of nuclear fusion that combines hydrogen atoms into helium atoms. The amount of energy generated is enormous. Nuclear fusion has been weaponized in hydrogen bombs. However, the process has yet to be accomplished under controlled conditions so that energy can be obtained.

Hydrogen as a part of an energy-providing chemical reaction is simpler to accomplish than nuclear fusion. It is used in the production of synthetic ammonia, methanol, in the refining of petroleum, and as rocket fuel. The combination of hydrogen and oxygen is water (H_2O), which is a clean emission.

Hydrogen in the presence of oxygen is an explosive mixture if a spark ignites the mixture. The combustible nature of hydrogen was demonstrated when the zeppelin *The Hindenburg* exploded on May 6, 1937 at Lakehurst, New Jersey, while attempting to dock, killing 35 people and injuring others. The Hindenburg was held aloft by hydrogen gas, but was not using it as a fuel.

Pure hydrogen is a fuel for the oxygen-hydrogen torch. Pure hydrogen has also been a major fuel in the U.S. space program. Liquid hydrogen and liquid oxygen have been used on the second and third stages of the Apollo mission flights, and in other rockets.

Hydrogen *gas* is rare on earth. It must be extracted from water, hydrocarbons, coal, or biomass. To produce hydrogen from coal, it must be reduced to slurry, then calcium carbonate has to be used in reactions to free the hydrogen atoms. Hydrogen can be obtained from other sources, but most hydrogen is produced from natural gas. Research is being conducted to use one of several species of purple bacteria in the production of hydrogen, and other exotic methods are being explored. Hydrogen is present in most fuels as free hydrogen or hydrogen combined with other elements. Fuels abundant in hydrogen include coal gas, oil gas, natural gas, and other forms of methane.

The storage of hydrogen is a problem because it must be stored as a high-pressure gas or as cold liquid hydrogen and kept at a temperature just above absolute zero. Or, it can be kept as a slush of cold liquid and frozen solid hydrogen.

GREAT PROMISE

Hydrogen has great promises as a fuel that could replace petroleum, but cost has been an inhibiting factor. Fuel cells produce electricity from chemical reactions using a specially designed cell. William Grove invented the fuel cell during the 1830s in London. Fuel cells generate electricity like a battery. However, a fuel cell uses an external source for fuel. If the source is hydrogen, the fuel cell operates cleanly and efficiently. A gasoline engine captures 20 percent of its usable chemical energy, while a fuel cell is three times as efficient.

The simplest form of fuel cell is one that uses hydrogen as a fuel, and some kind of oxidant. Fuel cells, however, are not simply burning hydrogen. Instead, a chemical reaction is stimulated in which the hydrogen combines with oxygen. This chemical reaction imitates the explosive reaction in a gasoline piston. The difference is that an electrolyte solution facilitates the migration of ions and the capture of electrons for energy purposes.

Fuel cells using gasoline convert it to hydrogen, which is combined with oxygen to produce electricity and heat. The heat, unless it is captured by some cogeneration mechanism, is lost. The other exhaust product is water vapor. Because fuel cells using gasoline are not popular with environmentalists, some automakers and political decision makers have been reluctant to press ahead for their development and adoption. However, fuel cells that use ethanol or methanol are being investigated.

The safety of fuel cells is being investigated. Studies have found exposure to a ruptured hydrogen fuel tank that is ablaze is much less dangerous than if a gasoline tank catches fire or explodes.

Research and development of hydrogen cars has been conducted since the 1970s, and several automakers are developing fuel cell cars that have been sold since the early 2000s. It is hoped that once established, fuel cells will be useable in much larger transportation systems such as trains, buses, or even in submarines. In Europe, fuel cell buses operate in Madrid and other cities. Cities scheduled to receive fuel cell buses include Amsterdam, Hamburg, London, and Stockholm. Buses using fuel cells will need far less gasoline or diesel fuel, and they will produce much less pollution. Fuel cells are also being developed for use in buildings. A number of countries have or will soon have buildings that receive energy from fuel cells.

As naturally occurring oil is discovered and exploited, the supplies will inevitably decline. However, hydrogen fuel cells offer a much cheaper energy alternative. Whatever method of production used to produce hydrogen, significant environmental issues arise. Even if hydrogen is accepted as a substitute for gasoline, unforeseen environmental consequences may still occur.

SEE ALSO: Alternative Energy; Automobiles; Fossil Fuels; Gasoline; Petroleum; Pollution, Air.

BIBIOGRAPHY. F.J. Barclay, *Fuel Cells, Engines and Hydrogen: An Energy Approach* (John Wiley & Sons, 2006); R.L. Busby, *Hydrogen and Fuel Cells: A Comprehensive Guide* (PennWell Corporation, 2005); D.M. Haugen, *Hydrogen* (Thompson Gale, 2006); Peter Hoffman, *Tomorrow's Energy: Hydrogen, Fuel Cells and the Prospects for a Cleaner Planet* (MIT Press, 2002); National Research Council, ed., *The Hydrogen Economy: Opportunities, Barriers and R&D Needs* (National Academies Press, 2004); M.A. Peavey, *Fuel from Water: Energy Independence with Hydrogen* (Merit Products, Inc., 2003); Bent Sorensen, *Hydrogen and Fuel Cells: Emerging Technologies and Applications* (Elsevier Science & Technology Books, 2005).

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Hydrologic Cycle

ALSO KNOWN AS the water cycle, the hydrologic cycle is a process of circulation of the earth's water and its storage in reservoirs as a continuous flux, powered by solar energy. In some cases, the term *hydrologic cycle* implies a change of state of water. The water cycle involves considerable exchanges of energy between the atmosphere and the oceans, and significantly contributes to other processes like the alteration and breakdown of minerals and rocks, known as erosion, and the transportation of weathered particles as solids or ions in solution from land surface to the oceans.

Water exists on Earth in the three states of matter: solid (ice), liquid, and gas (water vapor). The processes by which water changes from one state to another are known as evaporation (liquid changing to gas), condensation (gas changing to liquid), freezing (liquid changing to solid), and sublimation (the direct change of ice to water vapor, without first becoming a liquid).

The origin of the earth's water remains a controversial matter over whether it was released during a prolonged volcanic activity during the early stages of Earth, released through an outgassing process about 4 billion years ago, or has an extraterrestrial origin.

More than 70 percent of the earth's surface is covered with water; however, water only represents 0.025 percent of the planet's mass, which indicates the superficial nature of the hydrologic process. The total water circulating in the cycle is 332.5 million cubic miles (1,386 million cubic kilometers), although only 1 percent is in constant movement. Water is held in various reservoirs distributed all over the earth as follows: oceans and seas (96.5 percent), ice caps, glaciers, and permanent snow (1.74 percent), groundwater (1.7 percent), ground ice and permafrost (.022 percent), lakes (.013 percent), atmosphere (.001 percent), soil moisture (.001 percent), rivers (.0002 percent), and biological water (.0001 percent). The percentages of water stored in rivers and the atmosphere are very low and seem to be marginal, yet the relevance derives from the quantity that passes through those reservoirs.

The flux of water among the containers is continuous but highly differs in rate. The residence time measures the average time a molecule of water remains in a reservoir: 3,176 years in the ocean with respect to the atmosphere, 33,750 years in the ocean with respect to rivers, 1 year as soil water with respect to precipitation or evapotranspiration, and 1,377 years as groundwater with respect to rivers. Balances between the different reservoirs have varied as a result of climate change, particularly during glacial ages. During the last peak glaciation (20,000–18,000 years ago), 10.08 million cubic miles (42 million cubic kilometers) of water was trapped in polar ice caps, which lowered sea level by about 393.7 feet (120 meters) relative to the present day. Climate change produced other great modifications of the water cycle, like lower rates of evaporation and less precipitation.

When water vapor rising with air cools and reaches the saturation point, water is released by precipitation.

In the present day, important regional differences in the hydrologic cycle are also observed in regard to evaporation and precipitation, and the balance between the two processes differs at this scale. Evaporation is higher than precipitation in the subtropical areas, while the opposite is true at the Equator and the higher latitudes. Water moves from or reservoir to another by way of evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, melting, and groundwater flow processes.

Water goes into the atmosphere from the evaporation of water on the ocean surface (86 percent), the evaporation of falling rain and snow before the water droplets reach the ground—a phenomenon termed *rain fog*—sublimation in the ice covers, and as a by product from the metabolic processes of fauna and flora (transpiration by plants and respiration by animals). In general, evaporation exceeds precipitation over the oceans while precipitation exceeds evaporation over land areas. While in the atmosphere, water is stored in the form of vapor and small water droplets that form clouds.

Nevertheless, moisture is redistributed all over the world by a process of advection—the horizontal transport of water vapor by moving air masses—that modifies the moisture content of the air. On average, air contains 2–3 percent water vapor, although the variation between regions is broad. Humidity in the tropics is 30 times the humidity at the poles. Aside from air temperature, other factors such as vapor pressure and atmospheric pressure affect the rate and amount of evaporation that takes place. Air becomes saturated at a certain point when it contains the maximum possible amount of water vapor without starting to condense, so warm air can hold higher concentrations of water vapor than cooler air.

The change from a gaseous to a liquid phase is termed *condensation*. Water vapor condenses in the atmosphere on the aerosols—small airborne nuclei of dust, salt particles, or ions—yielding the formation of water droplets, visible as clouds and fog. As the air containing water vapor rises, it cools and reaches the saturation point, and excess water vapor is released in one of several forms of precipitation: rain, snow, or hail, depending on air temperature and atmospheric processes of crystal formation or coalescence. Air lifting is produced by convection when unstable, less dense warm air that is heated by the earth's surface ascends. Other processes that cause air to rise are convergence in cyclones, topographic elevation, and warm and cold fronts.

EVAPORATION-CONDENSATION CYCLE

The evaporation-condensation cycle is a transferring mechanism of heat energy horizontally from region to region and vertically between the earth's surface and the atmosphere. The movement of water vapor entails the transfer of energy in the form of latent heat—the amount of energy released or absorbed during a change of state—which is released into the atmosphere when condensation occurs. The opposite process happens when heat energy is used in the process of evaporation. When liquid water is evaporated, 600 calories of heat are absorbed and later released in the process of condensation.

Similarly, when ice melts, 80 calories of heat are captured and the same amount is released in freezing. The high heat capacity of the oceans, as opposed to the atmosphere, is an energy storage facility that helps to keep the global temperature relatively stable, shaping the earth's climate. This heat is constantly transported by the global ocean currents. Thus, changes in the hydrologic cycle as a result of climate change would cause critical alterations of the fluxes between reservoirs and energy transfer, with direct effects on water availability, weathering rates, nutrient transport, plant development, and indirect effects on agriculture production and economic development.

Rainwater is intercepted in its advance to the ground by canopy leaves and branches, leaf litter, small land formations, or as snow cover, reducing water availability and buffering the surface against erosion. The thin water layer deposited on the vegetation gradually descends to the ground by drippage or stemflow down stems and trunks, but stays exposed to evaporation for a certain length of time.

Infiltration is the process of vertical movement of water into the soil layer, which depends on various factors, such as soil properties, vegetation cover, and topographical properties, besides gravity and capillary action. Flat and rough surfaces with dense vegetation facilitate a prolonged retention of water for infiltration to take place. Next, migration is controlled by several soil features such as moisture content, the amount of open spaces (porosity), the texture, structure, and organic matter content. The rate of infiltration, or soil permeability, decays with saturation as the result of pore filling, expansion of clay particles and packing with small particles.

Soil water is not stationary; it continues moving downward under the pull of gravity and capillary forces. This process called *percolation* follows further the reach of the plant roots toward the bedrock and through the fissures and grains. It reaches the unsaturated zone, where still some air is present, and then forms the saturated zone when it encounters impermeable rock. Aquifers have a larger distribution than surface water, for they are in both dry and humid regions. Eventually, groundwater leaves the aquifer and flows back to the surface through springs or seeps, and discharges into terrestrial waters or the sea.

While at the surface, water is used by plants and eventually returned to the atmosphere by transpiration as water vapor. Plants pull water from the ground through the roots to transport nutrients from the soil, transfer sugars, and transpire water by means of the stomata to cool the leaves.

When the precipitation rate exceeds the infiltration rate of the soil, water accumulates on the surface, and subsequently starts to flow downslope, over land and is eventually channeled in a process termed *surface runoff*. Stream channels are organized hierarchically in networks that carry land water to the oceans or inland seas, a return flow that adds to the groundwater flow. Rivers and minor streams are located in areas of regular precipitation flow, while they exist only intermittently in areas of irregular precipitation.

SEE ALSO: Atmosphere; Groundwater; Oceans; Rivers; Water; Weather.

BIBLIOGRAPHY. Elizabeth A. Berner and Robert A. Berner, *The Global Water Cycle* (Prentice Hall, 1987); Rafael L. Bras, *Hydrology, An introduction to Hydrologic Science* (Addison-Wesley, 1990); Tim Davie, *Fundamentals of Hydrology* (Routledge, 2002); Lawrence Dingman, *Physical Hydrology,* 2nd ed. (Prentice-Hall, 2002); G.M. Hornberger, J.P. Raffensperger, P.L. Wiberg, and K.N. Eshleman, *Elements of Physical Hydrology* (Johns Hopkins University Press, 1998); David R. Maidment, ed., *Handbook of Hydrology* (McGraw Hill, 1993).

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Hydropower

HYDROPOWER INVOLVES CAPTURING the ability of moving water to generate power. This power may be generated in a variety of ways, including the driving of waterwheels and the powering of hydroelectric turbines. The technology has been used for many centuries and has helped to concentrate the settling of populations close to river systems and increased people's reliance on the rivers' predictability. In recent years, new developments have made it more possible to harness the power of tidal streams and of the waves of the open sea.

Waterwheels have been built according to a number of different designs in most civilizations of the world. The basic principle is to use the moving water to drive the buckets or panels that are used to create the wheel so as to power a revolving spindle, which then transfers the power to grinding flour or similar activities. The power provides a cost advantage over other forms of production and is used to replace human or animal labor, which remained in operation well into the industrial age. Waterwheels with a capacity of up to 100 horsepower have been developed.

Although superior to many other types of power production, waterwheels are limited in terms of their location, which may not always be convenient for coordination with other production activities. Even so, the use of water power to drive engines was sufficiently flexible to power iron-casting factories in ancient China, while tidal water wheels in medieval Europe were used to power grain mills. Europe saw the rise in development of the water wheel to its highest extent, perhaps because of numerous suitable locations and because of the rapid decreases of manpower caused by such disasters as the outbreak of Black Death. A single mill, if properly placed and employing the most advanced technology, is estimated to have provided milling capacity sufficient to feed many tens of thousands of people. Water wheels were also used to pump water from deep mines, while the wheels employed in some monasteries were in effect the power sources for very efficient and diversified factories. The potential for a large-scale revival of the use of water wheels and similarly powered turbines is likely to increase as the need for environmentally sustainable energy comes into sharper focus.

MODERN HYDROPOWER

Hydroelectric power uses the power of moving water to drive turbines, which then convert the energy into electricity. Commonly, hydroelectric plants are placed in large dams, which create substantial reservoirs that regulate the flow of water. This requires extensive areas of land, which may force resettlement and large-scale changes in agricultural patterns. Rivers flowing through borders raises issues of ownership of the river and its power, because income and protein supplies of people living downriver may be negatively affected by upriver hydroelectric power plants. The River Mekong, for example, originates in Tibet and China and passes through or along the borders of Laos, Thailand, Cambodia, and Vietnam. Chinese authorities are putting into place a series of dams and hydroelectric power plants on the energetic upstream river, which deny the downriver people of many of the resources of the river. There are many examples of the overextensive use of river water, such that even quite large rivers often cannot reach the sea for extensive periods of the year. These developments have stimulated the creation of large-scale protests against dam building and forcible movements of people.

Another area of concern is some governments' pursuit of hydroelectric power projects without adequate consultation with local people and evaluation of the impact on them and their livelihoods. Some commentators have argued that inadequate attention has been paid to the social and environmental impact of those projects. The accounting systems of these projects are complex and difficult to manage because of vast unknown or unpredictable factors, including future demand for electricity, future rainfall patterns, and the ability of people to adjust themselves to alternative forms of lifestyle.

The ability of dams to regulate water flow on rivers where the seasonal flow varies significantly and can lead to flooding or droughts is clearly beneficial. Even so, it does lead to changes in the lifestyles of river-dwelling people and may also affect a river's ecosystem in unpredicted ways. For example, preventing fish or other creatures from following their usual movement patterns can interrupt their breeding customs and interfere with the river food cycles.

Alternative energy sources include the creation of electricity via wave and tidal power, which also have the benefit of not emitting greenhouse gases or the other negative effects of hydrocarbon fuels. Unfortunately, it has yet to be demonstrated that they can be profitable without significant levels of government subsidy. Even so, future demands for nondamaging energy production may require such subsidies as a necessary investment. Small-scale energy production of this type can focus on local provision and meeting neighborhood demand rather than being distributed long distances or even across borders. New accounting methods may be required to take account of the opportunity costs associated with enhanced water management. An additional issue to consider is that of aesthetics, since a number of people complain about the impact of wind or water mills on the landscape and related issues concerning the value of their own property.

SEE ALSO: Black Death; Dams; Electrical Utilities; Renewable Energy; Rivers.

BIBLIOGRAPHY. International Hydropower Association: www.hydropower.org (cited November 2006); International Rivers Network: http://www.irn.org (cited November 2006); Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (International Rivers Network, 2001); Anthony D. Owen, "Evaluating the Costs and Benefits of Renewable Energy Technologies" *The Australian Economic Review* (v.39/2, 2006); Terry S. Reynolds, *Stronger than a Hundred Men: A History of the Vertical Water Wheel* (Johns Hopkins University Press, 2003); Swiss Centre for Development Cooperation in Technology Management (SKAT), "The Role of the Private Sector in the Small-Scale Hydropower Field" (SKAT, 2002).

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Ice Ages

ICE AGES ARE times in earth history when earth's climates were appreciably colder than normal and glaciers covered significantly larger areas of the earth compared to today. Ice ages represent conditions associated with the extreme cold periods and global cooling of an otherwise normally fluctuating global climate system. During an ice age, ice sheets, which normally occur only in high latitude areas close to the north and south poles, extend farther into the lower latitudes. Alpine glaciers, which normally exist at higher elevations, extend to much lower elevations during ice ages.

Ice ages occurred as far back as the Precambrian, and occurred sporadically until the present. Major ice ages occurred during the late Precambrian (800–600 million years ago); late Ordovician and early Silurian (460–430 mya); Pennsylvanian and Permian (350–250 mya); in addition to the Pliocene and Pleistocene (last 3 million years). The most recent Ice Age is the most well-known. The Pleistocene Ice Age, and probably also the ancient ice ages, had several glacial and interglacial episodes. Many consider the current warm global climate episode as being an interglacial episode following the last glacial episode.

Evidence of the Pleistocene Ice Age is found in the many glacial landforms in different parts of the world. For example, in the United States, glacial moraines that can be found as far south as Long Island, NY, and extending along a line that generally passes westward through most of the northern tier of states. North of this line, areas are covered with glacial tills and moraines, and bedrock surfaces are marked by glacial striations. This indicates that areas north of this line, including the northern tier of the United States, almost all of New England, and all of Canada were covered by an ice sheet. Similar Pleistocene glacial features are found on other Northern Hemisphere continents. In the Southern Hemisphere, the only continents close enough to the South Pole to be glaciated were Antarctica and Tierra del Fuego at the southern tip of South America. Ice ages older than the Pleistocene have been recognized based on more subtle evidence. Glacial tillites are interbedded with fossiliferous marine deposits or other deposits that can be dated, thereby establishing the age of glaciation.

Glacial deposits of Permian age are found on several continents. When these continents are viewed in the Pangean position (during the Permian), the glacial deposits cluster around the paleo-south pole.

In the oceans, seawater contains a certain ratio of two oxygen isotopes (O^{16}), and the heavier isotope

(O^{18}). During an ice age, when seawater is cooler, the evaporation ratio of these two isotopes is different than during warmer intervals. Therefore the oxygen isotope ratio of seawater, as well as minerals and shells that precipitate from seawater during glacial intervals, reflect this isotopic difference. As such, oxygen isotope ratios of ancient fossils and minerals may serve as a proxy for recognizing ancient ice ages.

There are several possible causes for global cooling. Milankovich cycles are oscillations in global temperatures that are caused by variations in the rotation of the earth and the revolution of the earth-sun system. Global temperatures are warmer during times when there is more carbon dioxide (CO_2) in the atmosphere (greenhouse conditions), and cooler when CO_2 levels are lower (icehouse conditions). Global temperatures are cooler when the atmosphere contains a lot of particulate matter from volcanic eruptions or meteorite impacts. "Glaciation" may also be more prevalent during times in earth history when continents drift into polar locations. It is thought that the Ice Ages may correspond to times when several of these causal factors coincide.

During an ice age, or even during times when global climates are generally cooler, several effects may result. Sea level drops as water in the global water budget shifts from the oceans to glaciers. During the Pleistocene, sea level was approximately 200 meters lower than today and most of the continental shelves were exposed as coastal plains. Because terrestrial and marine temperatures become cooler over the entire globe during an ice age, global climate belts shift toward the equator. Similarly, terrestrial and marine species and ecosystems shift toward the equator during ice ages. Atmospheric and oceanic circulation patterns—especially those that are driven by temperature or density differences—change during an ice age.

SEE ALSO: Glaciers; Global Climate Change; Global Warming.

BIBLIOGRAPHY. John Imbrie and Katherine P. Imbrie, *Ice Ages: Solving the Mystery* (Harvard University Press, 2005); J. Douglas Macdougall, *Frozen Earth: The Once and Future Story of Ice Ages* (University of California Press, 2004); Paul S. Martin, *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America* (University of California Press, 2005).

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Ice Core

ICE FORMS AT different rates and in different ways. Over time, the ice recrystallizes and traps small amounts of air, which vary according to environmental conditions. Since new layers form over the top of existing layers of ice, it is possible to obtain an accurate historical record of the past by drilling an ice core sample through a long-standing ice field. The best places to take these samples are in polar regions where the ice has been undisturbed for thousands of years.

One of the most famous examples of ice core drilling and analysis was the Greenland Ice Core Project. Visual records of the past stretching back hundreds of thousands of years have been obtained using this method. Such ice core samples may be several miles in length or longer. Analysis of such samples must consequently be a cooperative affair. Identifying particles of dust, nuclear radiation, and different isotypes of, for example, oxygen and the cross-referencing of the presence of these particles with other known records (including sediments) helps to triangulate the data for even greater reliability. An ice core analysis enabled scientists to determine that the earth's climate is subject to sudden, abrupt changes such as the one that ended the last ice age within just three years. It has also been an important tool in determining the extent and rate of change of climate change in the modern world.

Mountain glaciers can also provide useful information. Global climate warming is putting these records at risk, however. Obtaining ice core samples necessitates burrowing deep down into the ice with a powered tube, which requires considerable amounts of power and expense. The retrieved ice core is extruded from the drilling device and sliced into convenient lengths for processing and analysis. Contamination and decompression of the sample are threats to the integrity of the ice. Chemical analysis, chromatography, and mass spectrometry are among the techniques that are employed to determine the contents of the core. Changes due to dramatic events such as volcanic eruptions and the dust produced by volcanoes may be evident in an ice core sample.

SEE ALSO: Climate, Arctic and Subarctic; Global Warming; Ice Ages.

BIBLIOGRAPHY. Richard B. Alley, *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future* (Princeton University Press, 2002); C.D. Charles, J. Lynch-Stieglitz, U.S. Ninnemann, and R.G. Fairbanks, "Climate Connections between the Hemisphere Revealed by Deep Sea Sediment Core/Ice Core Correlations," *Earth and Planetary Science Letters* (v.142/1, 1996).

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Iceland

ACCORDING TO THE United Nations Development Program (UNDP) Human Development Reports, the Republic of Iceland has the second-highest standard of living in the world. The country is greatly admired for its high income and literacy rates, long life spans, strong social cohesion, and extensive social welfare programs. One hundred percent of the population has access to safe drinking water and improved sanitation. Iceland is one of the few European countries that have elected not to join the European Union (EU). Surrounded by the Greenland Sea, the North Atlantic Ocean, and the Denmark Strait, Iceland has 3,081 miles (4,970 kilometers) of coastline. Because of the North Atlantic, Iceland's climate is temperate with mild, windy winters and damp, cool summers. The capital city of Reykjavik is the northernmost capital in the entire world.

Iceland is a land of kinetic steam because of its active volcanoes and geysers. The Askja volcano is one of the most important geographic features of the country. In 1875, fallout from this volcano created major economic upheaval as 20 percent of the population fled to Canada and the United States. Earthquakes occur on a daily basis in Iceland, producing new fissures. As a result, the landscape of Iceland rapidly changes as new islands appear and gradually erode to extinction. The country is mostly flat with intermittent peaks and ice fields, and the coast is broken up by bays and fiords.

Modern Iceland has embraced a vast range of new environmental technologies, and was one of the first countries to begin planning for the elimination of fossil fuels. The proposed 700-megawatt Karahnukar Hydropower Plant, consisting of nine dams, three reservoirs, seven channels, and 68 miles (110 kilometers) of underground tunnels, is planned to supply electricity for large-scale aluminum smelting. Environmentalists have strongly opposed the project, citing the potential environmental damage

Iceland is a land of active volcanoes and geysers; earthquakes occur on a daily basis.

caused by massive redirection water flow from rivers and tributaries.

With a per capita income of $34,600, Iceland is the 11th richest nation in the world. The most significant resource is the fish that produces 70 percent of all export earnings. Other resources include hydropower, geothermal power, and diatomite. Approximately 10 percent of the workforce is involved in agriculture, including the 8 percent involved in fishing. Over 90 percent of the population of Iceland live in urban areas. With 561 cars per 1,000 people, Iceland produces 7.7 carbon dioxide emissions (metric tons) per capita. The government has protected 9.8 percent of the land in Iceland. As a result, none of the 93 bird species endemic to Iceland are endangered, but six of the 11 endemic mammal species are threatened with extinction.

Environmentally, Iceland suffers from water pollution caused by fertilizer runoff and inadequate wastewater treatment. A 2006 study by Yale University ranked Iceland 13th among 132 nations in overall environmental performance, slightly higher than average among countries in the same income and geographic groups. The Icelandic government has pressured the owners of power plants and aluminum smelters to employ the most environmentally friendly technology in order to reduce toxic emissions and has enacted fines to force polluters to pay for cleanup.

In 1990, Iceland created the Ministry for the Environment and charged the minister with environmental monitoring and surveillance, as well as oversight of conservation, outdoor recreation, the protection of animals, wildlife management, pollution and fire prevention, weather forecasting, and protection from avalanches. Between 1990 and 2000, the government passed a body of environmental legislation that included the Fishery Management Act, Protection and Hunting of Wild Species Act, Organic Farming Act, Foodstuff Acts, Farm Afforestation Act, Act on Financial Support to Municipalities for Sewage Control, Act on Special Fee on Hazardous Waste, Nature Conservation Agency Act, Southland Afforestation Act, Public Health and Pollution Control Act, Public Lands Act, Nature Conservation Act, and the Environmental Impact Assessment Act. In 2003, the government also introduced a major conservation plan.

Iceland's commitment to the global environment is demonstrated by participation in the following international agreements: Air Pollution, Air Pollution–Persistent Organic Pollutants, Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Transboundary Air Pollution, and Wetlands. The government has signed but not ratified the Environmental Modification and Marine Life Conservation agreements.

SEE ALSO: Earthquakes; Fisheries; Hydrogen Fuel; Hydropower; Polluter Pays Concept; Pollution, Water.

BIBLIOGRAPHY. CIA, "Iceland," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry for the Environment (homepage), www.eng.umhverfisraduneyti.is (cited March 2006); Alanna Mitchell, *Dancing at the Dead Sea: Tracking the World's Environmental Hotspots* (University of Chicago Press, 2005); OECD, "Economic Survey of Iceland, 2005," www.oecd.org (cited March 2006); UNDP, "Human Development Reports: Iceland," www.hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Iceland," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Ideology

THE WORD *IDEOLOGY* was first used by the French philosopher Antoine-Louis-Claude Destutt de Tracy during the French Revolution; he called it his "science of ideas" and intended that his study of ideas would transform France into a scientific and rational society.

While Destutt de Tracy enjoyed initial years of popularity, he was eventually scorned by Napoleon, who blamed his military defeats in part on intellectuals and the *ideologues*. The history and subject of ideology has since been controversial and the word may be used both formally or informally, positively or pejoratively.

Modern philosophy generally describes ideology in both positive and pejorative terms. In a positive sense, ideology is a system of values, beliefs, and ideas, unconscious or conscious, which organize and shape understandings and perceptions of the political and social world. It acts to justify, recommend, and implement collective action aimed at influencing public thought or political and institutional social structures. It is a set of ideas used to address truth and conduct, and that speaks for a class, nation, or other body of believers.

Anthropologists commonly describe ideology as a set of explanatory cultural beliefs that serve to unify morals, goals, and social relations and without which civilization would be impossible. Ideology is an ordered set of linguistic and cultural symbols through which people interpret and make meaning of the world. Every society has an ideology, and it forms common sense and public opinion. In this view, ideologies are beliefs that are consciously held. They enable groups of people in society to act in unison to direct societal and political change.

In a more subtle sense, anthropologists and sociologists describe how ideology and the sense of normalcy remain invisible to most people in society. They are unquestioned and taken for granted in our norms and assumptions. Seeing past this invisible and internalized logic requires an active process of analysis.

IDEOLOGY AND POWER RELATIONSHIPS

From a more critical position, the word *ideology* can be used as a pejorative whereby adherents are described as distorted, uncritical, and suffering under a delusion in something akin to superstition. In this view, ideology serves as much to conceal and mislead as to reveal and coordinate. Karl Marx adopts this view of ideology, concluding that ideology serves to conceal, and thus, identification of ideology is the first important step toward overcoming oppression.

Most ideologies emphasize social order and power relations as well. However formal or informal, ideology is concerned with intellectual and social order, rationality, power, conflict, coercion, and the subsequent authorized use of force. In modern times wars are rationalized by "isms." The balance of power is commonly fought amongst communism, socialism, capitalism, authoritarianism, anarchism, fascism, Nazism, and terrorism. Most ideologies contain an element that strives to recruit members to their perspective and gain commitment. The comprehensive nature of ideology frequently leads to extremism and violence.

Ideological systems contain the assumption that now that this (natural) state of affairs has been reached, things should be that way forever (externalization). For example: "Technological development is the system that can best address an environmental crisis; human history and evolution is a history of human technological developments; if enough resources are provided for new technological developments crisis will be avoided." We *assume* that technology is the best response to environmental crisis; we *interpret* history as one of technological development; we *assume* that more technology will solve an environmental crisis. These assumptions are ideological.

ANALYSIS AND POLITICAL IDEOLOGY

An ideological analysis of a text asks the following questions: What are the presumptions about what is right, just, and natural? What harmful elements are ignored? What do these assumptions conceal and distort? How is power and tradition made to appear good, normal, and unexamined? How is rhetoric like "good us" and "evil them" used and what is devalued? What experiences, classes, people, and values are silent? Who profits from this ideology?

A purely or rigidly ideological mind often alienating and distrusts, attacks, and questions other centers of power. It is totalistic in its aim to influence entire social systems, and it is futuristic in its belief that it is working toward a possible utopian ordering in which a "good" society will result. However, uncomfortable dissonance results when there is a discrepancy between what one believes *through* an ideology and what science or experience establishes as real. A common way to avoid uncomfortable dissonance is to selectively ignore those things that do not agree with the ideology, emphasize some aspects more than others, and frame questions and analysis so that discrepancies in the ideological system remain hidden. For example, the pro-technology ideology substantially exaggerates the contribution of technology while underplaying and ignoring the many technological disasters and challenges of the nuclear age.

ENVIRONMENTAL MOVEMENTS

Environmentally oriented ideologies include environmentalism, green politics, and bioregionalism. They are ideologies in that they represent unique valuing schemes with coherent systems of thought that organize and unite persons toward a common vision while offering consistent critique of other systems.

Environmentalists and environmental sociologists describe the culture of the Western world and the sources of U.S. environmental problems in both cultural and structural terms. Environmentalists see the structural sources of U.S. environmental problems in the laissez-faire capitalist economy, the polity of unrepresentative government that has an amicable relationship with large industrial polluters, and the system of social stratification that lends itself to environmental racism. They describe basic ideological cultural elements as a cornucopia view of nature, faith in technology, a growth ethic, materialism, and a belief in individualism together with an anthropocentric perspective.

Environmentalism is a social movement that uses education, activism, lobbying, and protest to influence the political process to protect the environment. While there is tremendous diversity within the environmental movement and related green politics, common positions include stances against nuclear waste, solid waste, water and air pollution, chemical pollution, population growth, genetically engineered foods, ozone depletion, the creation of greenhouse gasses, global warming, degradation of the land, deforestation, and unsustainability.

An environmentalist adheres to the goals of environmentalism and is frequently cautious about new technology because of concerns about how it will affect the environment. Environmentalists commonly adhere to the precautionary principle, which maintains that if the results of an action are unknown, but are judged to potentially have irreversible negative consequences, then it is best to avoid that action.

Politically active environmentalists commonly have strong views about the environment and identify themselves as *greens*, meaning they have green politics and may formally be members of a Green Party. The term may also be used to describe environmental scientists with a conservationist's view, a view that advocates for enhancement, restoration, or protection of the environment.

GREEN POLITICS

Green politics is a body of ideas within the environmental movement that strives to make sustainability a political goal. Green politics actively critiques what it sees as unsustainable practices. Green political thinkers also generally want an end to the war on drugs, which is seen to have a negative environmental impact and to be a violation of civil liberties and a waste of resources. They want an end to corporate welfare and subsidies to dirty industries. They are critical of pro-business, voluntary approaches to solving environmental problems. They think that environmental problems are not confined within political borders and that bad environmental policy leads to negative international implications and ultimately wars over precious resources. Many greens are also involved in the antiglobalization movement because they feel globalization is antienvironmental in that it is energy-intensive, creates social stratification, empowers global capital, weakens environmental and labor laws, works against bioregionalism, and rides roughshod over local environmental concerns.

Bioregionalism (or bioregional democracy) is the belief that social organization and environmental policies should be based on the bioregion rather than on a political or economic region. It is a group of reform movements intended to strengthen the political process to better protect the environment and sustainability on a local level. There should be local control over natural commons and resources; resources should not be controlled in the name of globalization.

Many of the positions supported by environmentalists are also commonly associated with feminism, pacifism, social justice movements, and liberal religious groups. Environmentalists with green politics commonly value and advocate for grassroots democracy, conservation, a green tax shift, increased consumption taxes, strong environmental protection and labor laws, moral purchasing decisions, full cost accounting, measuring well-being in quality-of-life terms instead of Gross National Product (GNP) or the consumer price index, heavy investments in human capital, investments in mass transit instead of highways, investments in cities instead of urban sprawl and land speculation, accounting reforms that would advantage small business and environmentally friendly industries, long-term vision, bioregionalism, and a biocentric perspective. The perspective of environmentalists is powerful, contains comprehensive theory, a defined set of values, and is supported by much empiricism. Environmentalism is thought by many to hold the prescription for a better and sustainable world.

As with any ideology, however, where environmentalism as a helpful, organizing intellectual tool leaves off and where bias and muddy minds begin has been a riddle of modern sociological thought. In heated discussion between individuals with different ideologies, one person's carefully thought-out empirical system is another person's naiveté, uncritical delusion, and indoctrination. Ideology can organize empirical inquiries but cannot be a substitute for empiricism.

SEE ALSO: Bioregionalism; Environmentalism; Environmentality; Feminist Political Ecology; Globalization; Green Movement; Green Revolution; Justice; Lobbyists; Marx, Karl; Political Ecology; Sustainability.

BIBLIOGRAPHY. Ian Adams, *Political Ideology Today* (Manchester University Press, 2002); Clifford Geertz, *Interpretation of Cultures* (Basic Books, 2000); Alvin W. Gouldner, *The Dialectic of Ideology and Technology* (Oxford University Press, 1982); Andrew Gyorgy and George D. Blackwood, *Ideologies in World Affairs* (John Wiley & Sons, 1975); Graham C. Kinloch, *Ideology and Contemporary Sociological Theory* (Prentice-Hall, 1981); George Lichtheim, *The Concept of Ideology* (Random House, 1967); Donald Gunn MacRae, *Ideology and Society* (Heinemann, 1961); Martin Seliger, *Ideology and Politics* (Free Press, 1976).

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India

MODERN INDIA IS blessed with some of the most diverse and rich environmental resources of any nation in the world. It has long had many environmental problems, however, stemming from its long colonial domination by foreign powers and mismanagement of resources after independence.

The oldest known civilization in India, located in the Indus Valley, flourished from 2500 until 1800 B.C.E. The reasons for its collapse is unclear, but environmental change may have been as conclusive factor, along with tectonic shifts in river course, and the onset of floods which ruined a large amount of agricultural land. The rise of a civilization of ethnolinguistic Aryan immigrants in the centuries following decline of the Indus "Harappans" has led to speculation that the alter civilization drove out the earlier one, though there certainly is no evidence of interaction, let alone warfare.

During the period from 1500 B.C.E., with the formation of Hindu India—and the introduction of the caste system—until the creation of colonial India, waves of invasions and wars between the various rulers of the subcontinent caused many problems but also led to rich hybrid cultural interactions and many environmental innovations and management systems, ranging from the use of the Perisan Wheel in agriculture to the magnificent Mughal Gardens, where complex water lifting and distribution systems were used to naturally air condition palaces and provide diverse and productive botanical gardens.

The arrival of the Portuguese, and later the British, Dutch, and French, saw the introduction of European cultures and values, and also the imposition of dramatic new political and economic systems, which stressed local environmental resources and led to dramatic changes in land use and productivity.

In 1827 and again in 1839 there were significant cases of wheat rust in India. There was a large cholera pandemic in India in 1891. The Spanish Influenza Epidemic of 1918–19 affected much of the world but India was the country worst affected. It seems likely that as many as 17 million people died, which represents about 5 percent of the entire population.

Other environmental problems caused regular famines in India—there were problems during the British takeover of India, and also after the Indian

Mutiny of 1857, when many of the crops were lost. A major famine took place in 1943 during World War II when India was facing a possible Japanese invasion, and large numbers of men were involved in the British war effort. This saw the deaths of 5 million people, being the most destructive of the famines in India before independence. Since the creation of independent India in 1947, there have not been any famines, with surplus stored in years of plenty and transferred around the country to feed people when harvests fail. Events such as the poison gas emissions at Bhopal have been highlighted as problems with Indian environmental protection legislation.

Weather conditions in India have presented problems since ancient times. There have been many stories set around the lives of people awaiting the monsoons each year. The Green Revolution has seen a huge increase in agricultural production throughout India, with increased rice crops, and this has alleviated problems that had been caused by the weather. Simultaneously, however, the high-input crops have led to soil exhaustion in many places and declining aquifers, raising questions about the sustainability of technology-centered solutions to India's agrarian development challenges.

Development and government mismanagement has placed a great strain on wildlife in India, with tigers and other wild animals finding their hunting areas significantly encroached upon. This has led to tigers attacking livestock and farm animals, and sometimes humans. At the same time, the value of tiger skin and bone products in adjacent China and elsewhere has led to increased poaching. As agricultural land has expanded, as a result of new irrigation technologies and expansion of export markets, coupled with increasing food demands, wildlife habitat has also been threatened, although a large number of national parks have been established throughout the country.

Reverence for animals in Indian culture means that many animals, wild and domesticated, live in the countryside and often within urban areas, including the ubiquitous cattle population in the streets of cities, towns, and villages, and countless temples dedicated to other animals such as monkeys, bats, and rats, which are free to roam about.

In recent years, with the establishment of national parks in India, there has been an increase in the number of ecotourists visiting the country. Large numbers of World Heritage sites exist throughout the country, ranging from the world-famous Taj Mahal, through to the cities of Jaipur and Jodhpur, the caves of Ajanta, and also many less well-known sites. These environmental locations draw many international tourists, though the booming indigenous middle class population of the country has become the mainstay of national tourism. The pressure of domestic and foreign visitors on ecotourist destinations raises questions about the sustainability of the industry.

Population and the Poor

As the second most populous country in the world, overpopulation has long been considered a problem in some parts of India. It has long been a country with vast differences between the wealthy and the extremely poor, and this trend has accelerated in recent years as globalizing India enthusiastically embraces world trade. However, most cases of hunger or resource scarcity are largely understood to be a product of poor distribution networks and unequal allocation of infrastructure and resources. Since independence, there have been attempts to reduce the birth rate, including the well-publicized campaigns by Indira Gandhi during the 1970s, with doctors performing sterilization vasectomy operations on men and women, especially among the poor and in country areas. The government of Kerala, in the south of India, has long believed that female education is a major influence on the birth rate, as do social policies such as better heath care and opportunities for women to work, leading to later marriage. Their policies have borne fruit with a dramatically reduced birth rate and near universal education, literacy, and access to health care.

SEE ALSO: Birth Rate; Cash Crop; Famine; Fertility Behavior; Green Revolution; Livestock; Monsoon; National Parks; Overpopulation.

BIBLIOGRAPHY. Frederick F. Cartwright and Michal D. Biddiss, *Diseases and History* (Hart-Davis, MacGibbon, 1972); O.H.K. Spate and A.T.A. Learmonth, *India and Pakistan: A General and Regional Geography* (Methuen & Co Ltd., 1967); Mortimer Wheeler, *The Indus Civilisation* (Cambridge University Press, 1968).

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Indian Ocean

NAMED FOR ITS proximity to the subcontinent of India, the Indian Ocean is the world's third-largest ocean. It stretches from Africa to Australia and Indonesia and from Asia and the Middle East to Antarctica. The Indian Ocean's marginal water bodies include the Andaman Sea, Arabian Sea, Bay of Bengal, Great Australian Bight, Red Sea, Gulf of Aden, Gulf of Oman, and Persian Gulf.

Continental shelves beneath the Indian Ocean widen to include Madagascar and Sri Lanka, the largest islands in the ocean. The Andaman and Nicobar Islands are also continental islands. The massive submarine Mid-Ocean Ridge divides the ocean floor into three parts of about equal size. A few peaks along the ridge's crest emerge as islands. The Seychelles and the Kerguelen Islands are examples. The Laccadives, the Maldives, and the Chagos are low coral islands. Mauritius, Réunion, Heard, and McDonald Islands are high, solitary volcanic cones. Featureless abyssal plains and low hills dot much of the ocean floor. A prominent exception is the Indus Fan, the world's largest deep-sea or submarine fan. Sediments carried by Indus River from the Himalayan Mountains to the ocean are building the fan. The greatest depth is in the Java Trench, south of Java, an island of Indonesia. The Sunda Trench, which lies west of Sumatra (another island of Indonesia), was the site of the devastating 2004 Indian Ocean earthquake that spawned the world's deadliest tsunamis, killing about 200,000 people.

The ocean's main surface currents are parts of a counterclockwise gyre (a large water-circulation system), which lies south of the equator. The gyre consists of an equatorial current, the Agulhas Current, the Antarctic Circumpolar Current (West Wind Drift), and the West Australian Current. A monsoon wind regime dominates the climate of the ocean. A dry northeast or winter monsoon emanating from a

Christmas Island Crabs

Christmas Island, in the Indian Ocean, was spotted by a British sea captain on Christmas Day, 1643. The first landing was in 1688 but it did not become a British possession until 1888. Nine years later, settlers started arriving to work for the Christmas Island Phosphate Company Ltd. It became a part of the Straits Settlements, administered from Singapore, and is now an Australian territory. About 12 percent of the island is covered by a National Park, which will eventually extend to cover 65 percent of it. Although there are thousands of birds on the island, Christmas Island is the home to about 120 million crabs. Indeed, crabs regularly appear on Christmas Island postage stamps.

There are, altogether, 14 terrestrial crab species on Christmas Island, and most of these are the Christmas Island red crab (*Gecarcoidea natalis*), which also lives on the Cocos (Keeling) Islands. Normally the crabs live in burrows, and breathe through gills, meaning that they have to keep themselves moist at all times. The crabs are well-known for an annual migration at the start of the monsoon season in November each year. During this time they leave the land to lay their eggs in the ocean. This results in millions of crabs packing the routes to the coast so densely that the numbers can be seen from the air. It is not unknown for crabs to clog the roads and have to be shoveled off them to allow cars to navigate the island. Although the red crabs are common, there are regular sightings of blue crabs, which are heavily protected. The crabs mostly live from eating fallen leaves and flowers, but they can also eat small animals, especially carcasses, and also are known to eat other crabs.

high-pressure air mass over Tibet and eastern Asia reduces precipitation over the ocean from December to April. The pressure over the land decreases from June to October, so that a moist southwest or summer monsoon flows from the western side of the ocean to India and Southeast Asia. The southwest monsoon supplies valuable rain to the Asian mainland. It also causes significant upwelling of cool water and nutrients for fish in waters east of the African and Arabian coasts. The seasonal reversal of the monsoons imparts a reversal in the direction of small gyres in the Arabian Sea and the Bay of Bengal. In summer, the gyres flow clockwise, but in winter, they flow counterclockwise.

The temperatures of the Indian Ocean are highest in the poorly circulated marginal seas of the Arabian mainland and lowest in the southern latitudes, where ships encounter pack ice and icebergs. Brine pools in the Red Sea have the highest salt content. Salinity is lowest in the Bay of Bengal due to a voluminous discharge of freshwater from the Ganges-Brahmaputra river delta. The Indian Ocean supplies energy (latent heat of evaporation) and moisture to extratropical and tropical cyclonic storms.

Regardless of the time of year, satellite images reveal a west-to-east passage of one or more extratropical storms in the Southern Hemisphere's zone of prevailing westerlies (40 degrees to 60 degrees South latitude). Australians call these storms willy-willies. Most of these storms do not make landfall because large landmasses generally do not exist where they travel.

Tropical cyclones (huuricanes) form closer to the equator in the summer and early fall over warm tropical waters off the northwest coast of Australia, in the Bay of Bengal and the Arabian Sea, and east of Madagascar. Like their North American cousins, Indian Ocean cyclones cause severe wind damage, coastal flooding, and human devastation wherever they arrive on shore.

The Indian Ocean has been strategically important historically for its location along seafaring trade routes between Asia and Europe. Marine resources of the region include oil and gas fields, fish, shrimp, sand and gravel aggregates, placer deposits, and polymetallic nodules. The Indian Ocean has serious environmental problems as well. It is home to several endangered marine animals, including the dugong, seals, turtles, and whales. Oil pollution is also a problem in the Arabian Sea, Persian Gulf, and Red Sea.

SEE ALSO: Continental Shelf; Currents, Ocean; Endangered Species; Hurricanes; Monsoon; Oceanography; Oceans; Oil Spills; Persian Gulf; Tsunamis.

BIBLIOGRAPHY. Robert E. Gabler, James F. Peterson, and L. Michael Trapasso, *Essentials of Physical Geography* (Brooks/Cole, 2004); Harold V. Thurman and Allan P. Trujillo, *The Essentials of Oceanography* (Prentice-Hall, 2004); Matthias Tomczak and J. Stuart Godfrey, *Regional Oceanography: An Introduction* (Daya Publishing House, 2003).

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Indicator Species

SOME SPECIES ARE highly sensitive to toxic chemicals or changes in temperature or humidity, and others are particularly sensitive to changes in soil or water pH. Such species, when monitored regularly, can function as indicator species, analogous to water-salinity meters or pH readers. In 1989, for example, the *Exxon Valdez* oil spill in Prince William Sound, Alaska, devastated marine habitats and wildlife, and created conditions that demanded systems of monitoring to determine the extent of the problem and the effects over time of ameliorating efforts. In this case, mussels were sought, and their abundance and distribution were used to indicate the extent and change in environmental pollution.

The concept of indicator species has been welcomed by managers of protected areas because it allows the focusing of conservation efforts through the monitoring of particular species. The assumption is that an increase or decline in abundance of an indicator will point to similar changes in other species within that community of organisms. For example, declines in amphibian populations have led calls for frogs and toads to be recognized as indicators of wetland health, and many research studies have since resulted on amphibian diversity and ecology in the tropics. The concept of indicator species has its opponents too. Doubts were expressed by some biologists when the threatened northern spotted owl *Strix occidentalis* was designated an indicator species by the United States Forest Service. The objection was that the species did not satisfy the condition of strongly ecological association with other species. *Ecosystem health* may mean different things to different people, species richness being critical for some, while others believing in strict protectionism. Yet others, such as tribal people resident in or near a protected area, would see a forest full of edible fruit, seed, and root as a healthy ecosystem. The question of what exactly needs to be monitored and indicated has many interpretations; hence, the application of the concept of indicator species to conservation biology has been troublesome.

Certain species have been studied in detail and are widely accepted as environmental indicators. Prime examples are rock lichens, such as the endangered rock gnome lichen *Gymnoderma lineare*, known to be sensitive to heavy metals, ozone, and sulphur dioxide, a common air pollutant in industrial and automobile emissions. In aquatic systems, mollusks, which tend to concentrate toxic pesticides and heavy metals in their tissues, are considered indicator species, and include clams, oysters, and snails. Disease and organ failure resulting from toxins leads to a decline in the abundance of mollusks, indicating high levels of pollutants in the water. In Southeast Asia, butterflies, sensitive to changes in the structure of their habitat caused by logging, have been studied as indicators of biodiversity and forest disturbance. Some biologists also believe that monitoring the status and abundance of butterflies can indicate whether communities of plants and animals will remain stable or start to collapse by losing species over a period of time. The proposition that a single species or even a group of species from the same taxonomic group can indicate the richness or diversity within a whole ecological community is less and less promising. Instead, biologists are searching for indicators of species richness that are effective within geographic and taxonomic limits. Recent emphasis on the conservation of complete landscapes is a challenge to the rationale and necessity of discovering and monitoring indicator species for biodiversity conservation.

SEE ALSO: Butterflies; Exxon Valdez; Heavy Metals; Northern Spotted Owl; Wetlands.

BIBLIOGRAPHY. John M. Hellawell, *Biological Indicators of Freshwater Pollution and Environmental Management* (Elsevier Applied Science Publishers, 1986); Reed F. Noss, “Indicators for Monitoring Biodiversity: A Hierarchical Approach,” *Conservation Biology* (v.4, 1990); Richard B. Primack, *A Primer of Conservation Biology* (Sinauer Associates, Inc., 2004); Daniel Simberloff, “Flagships, Umbrellas, and Keystones: Is Single-Species Management Passé in the Landscape Era?,” *Biological Conservation* (v.83, 1998).

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Indigenous Peoples

INDIGENOUS PEOPLES ARE often considered synonymous with aboriginal, tribal, or native peoples, and some would characterize the phrase even more broadly. There have been countless attempts to define the term “indigenous peoples,” yet in today’s complex world of interwoven ethnic identities, no one definition has ever been agreed upon. According to the Office of the United Nations (UN) High Commissioner for Human Rights, “there are an estimated 300 million indigenous people in more than 70 countries worldwide.” The UN clearly distinguishes “indigenous peoples” from “indigenous people” because the plural form carries a distinct legal meaning according to Article One, which recognizes the “principle of equal rights and self determination of peoples.” The phrase *indigenous peoples* refers to groups of people who share the same ethnic or tribal identity and who either currently inhabit or are descended from a known geographic area of their home country, often referred to as their ancestral lands. The UN International Working Group on Indigenous Affairs states that: “Today many indigenous peoples are still excluded from society and often even deprived of their rights as equal citizens of a state. Nevertheless they are determined to preserve, develop, and transmit to future generations their ancestral territories and their ethnic identity...” The UN also recognizes that indigenous peoples “are descendants of groups which were in the territory of the country at the times when other groups of different cultures or ethnic origins arrived there.”

Indigenous peoples traditionally live in a range of types of societies with varying strategies of adaptation to their environments. Due to a variety of factors, including loss of land to neighboring or dominant societies, most indigenous peoples are no longer able to rely on their traditional methods of subsistence, but in some cases they still adhere to these ways of life when possible. These include:

Foragers (also called hunters and gatherers) lived in small kin-based groups, had nomadic or seminomadic lifestyles organized into bands, and have no formal leader.

Horticulturalists (smale-scale farmers) cultivate crops using only human labor, practice shifting cultivation, and usually belonged to a larger tribe and had a formal or informal leader

Pastoralists survive primarily on herding animals such as sheep, goats, or cows, are nomadic, and usually belong to a larger tribe with a leader or chief determined by heredity.

Agriculturalists practice farming with the use of animal labor, are sedentary, often practiced irrigation, and have a class or a caste system and one or more leaders or chiefs. Agriculturalists come in a variety of types and political systems. There were even empires comprised of several chiefdoms and required that tribute be paid to their leaders through a centralized system of redistribution.

In the late 1800s and throughout the 1900s, anthropologists traditionally studied indigenous peoples in their homelands throughout the world and the effects that colonization by dominant societies had on their traditional ways of life. Beginning a few centuries earlier, and throughout this period, colonizers—primarily from European countries—attempted to conquer and control indigenous peoples they encountered in their explorations of other continents and islands in Asia, Africa, and the Americas. Once most indigenous peoples came into contact with those from an industrialized society, they usually suffered increased disease and deaths. Furthermore, indigenous peoples have been victims of intentional genocide since colonialism began.

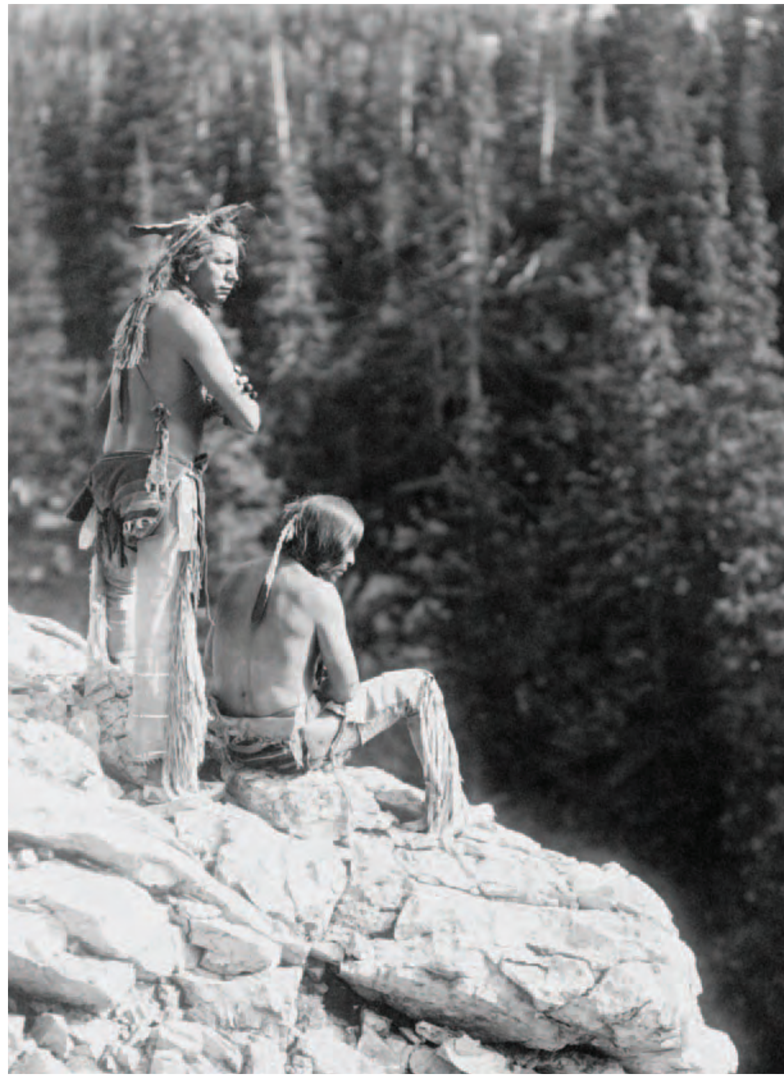
Prior to colonization by Europeans, indigenous peoples had their own problems of warfare and conflict, often resulting from similar quests for resources or territories, and also resulting from varying religious beliefs and ongoing feuds. For their part, European colonists justified their control of indigenous peoples because they believed that their model of society was far superior. These indigenous peoples did not cover themselves with as much clothing and did not yet live in an industrial, mechanized world. They were thought to be “primitive” or even “savage.”Throughout the 1800s and early 1900s, governments from Europe as well as the United States attempted to control territories occupied by Native Americans and indigenous peoples throughout the world.

As attempts were made to control native peoples, the United States—immersed in civil war and Indian wars—enacted legislation to create the first national parks and later served as an example for other nations interested in so-called “wilderness preservation.” The first parks were Yellowstone (1872) and Yosemite (1890), and were established with grave consequences for indigenous peoples of the areas who were expelled, starved, or burned out of their lands. Thus, the notion of a “protected area” as lands that are not occupied by any humans was embedded into the world’s view of nature preservation and exported from the United States throughout the world. It was further codified as stated in the 1964 U.S. Wilderness Act, which defines wilderness as a place “where man himself is a visitor who does not remain.” Throughout the 1900s, indigenous peoples throughout the world were evicted from their aboriginal territories to make way for protected area “nature” conservation. As indigenous peoples were forced to leave their traditional territories, policies and treaties in the United States as well as other nations began to establish lands, sometimes known as reservations, where they could live. National governments established agencies to oversee indigenous peoples and some were required or allowed to set up their own tribal governments.

In the 1960s and 1970s, anthropologists became interested in the subject of how indigenous peoples adapted to their environments, and researchers in the fields of ecological anthropology, cultural ecology, and ethnoecology realized that many groups of indigenous peoples had in—depth complex knowledge of the natural world that usually exceeded the level of knowledge western scientists had of those same geographic areas. Furthermore, as modernization progressed throughout the world, anthropological field researchers noted that there were many indigenous peoples who were able to survive using traditional small-scale shifting agricultural methods, or efficient hunting and gathering techniques that maintained a generally healthy environment for humans and landscapes. Yet, we also know that indigenous peoples did not always live in harmony with their environment. In fact, some groups of indigenous peoples, such as those called Ancient Pueloans (Anasazi) at Chaco Canyon, New Mexico, and inhabitants of Easter Island in the Pacific, were found to have overutilized natural resources to the point of causing irreversible environmental degradation and likely contributed to the collapse of their entire society.

In spite of some examples indicating indigenous peoples' practices as contributing to environmental degradation, a large number of studies found that indigenous peoples had successful adaptations to their environments, as demonstrated by cultural ecologists. These studies coincided with an earlier environmental movement of the 1970s; were later embraced and transformed by a resurgence of environmentalism in the 1990s; and were often a basis for environmentalist representations of indigenous peoples as "ecologically noble savages." Scholars and advocates have debated the validity and potential harmfulness of the use of this image in indigenous and environmental causes for over a decade. Nonetheless, indigenous peoples at times leverage this romanticized image of themselves as natural stewards of the environment to advocate for land claims and struggles for other human rights and social justice causes.

Indigenous peoples throughout the world continue to be displaced and marginalized due to encroachment of environmental degradation in the areas they occupy. Unfortunately, indigenous peoples also engage in conflicts with each other, especially when resources such as water and land are scarce. Despite some countries' offering reservations or territories to indigenous peoples, they have consistently had little control over the implementation



Colonists justified their control of indigenous peoples with the belief that their model of society was far superior.

of laws or policies which grant them territories. Throughout the 1980s and gaining momentum as a result of the 1992 UN Conference on Environment and Development (UNCED, also known as the Earth Summit), indigenous peoples began forming their own nongovernmental organizations (NGOs) or working with NGOs established by others to fight for indigenous rights. These organizations participated in a conference parallel to the Earth Summit, called the Global Forum. Despite the creation of some disingenuous NGOs, collectively NGOs have had considerable success in fighting for indigenous rights worldwide. Thousands of NGOs throughout the world have now been created by indigenous peoples. Official tribal organizations have also joined the fight for indigenous rights, including First Nations of Canada, the Navajo Nation of the United States, and the Aboriginal Government of Australia.

SEE ALSO: Cultural Ecology; First Nations; Knowledge; Noble Savage Myth; Nongovernmental Organizations (NGOs); Protected Areas; Shifting Cultivation.

BIBLIOGRAPHY. H. Bodley, *Victims of Progress* (Mayfield, 1982); K. Coates, *A Global History of Indigenous Peoples* (Palgrafe Macmillan, 2004); M. Colchester, "Indigenous Peoples and Protected Areas: Rights, Principles and Practice," *Nomadic Peoples* (v.7, 2003); J. Diamond, *Ecological Collapses of Pre-Industrial Societies. The Tanner Lectures on Human Values* (Stanford University, 2000); Ramachandra Guha, *Environmentalism, a Global History* (Longman, 2000); C. Kottak, *Anthropology, the Exploration of Human Diversity* (McGraw-Hill, 2006); P. Nadasdy, "Transcending the Debate over the Ecologically Noble Indian: Indigenous Peoples and Environmentalism," *Ethnohistory* (v.52, 2005); M.P. Park, *Introducing Anthropology, an Integrated Approach* (McGraw-Hill, 2006).

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Indonesia

IN 1949, INDONESIA achieved independence from the Netherlands with the help of the United Nations (UN). The years following that event have been filled with poverty, terrorism, corruption, colonial revolts, shifting political alliances, and major natural and environmental disasters. In addition to these problems, the government has been forced to deal with separatist movements in Aceh and Papua. Indonesia's substantial oil resources have begun to decline, and the government was forced to import oil in 2005. This move led to a fuel price increase of 126 percent. In response to several terrorism incidents, the tourist industry also began to decline.

With a per capita income of $3,700, Indonesia ranks as the 150th wealthiest nation in the world. Indonesian income is unevenly distributed, with the wealthiest 10 percent of the population sharing 28.5 percent of available resources. More than 15 percent of the population of 241,974,000 live in poverty, which is particularly prevalent in rural areas. Indonesia is highly dependent on agriculture, in which 45 percent of the workforce is engaged. The high unemployment rate (10 percent) is indicative of deeper societal problems. The UN Development Program (UNDP) Human Development Reports rank Indonesia 110th of 232 countries in overall quality-of-life issues.

Located in southeastern Asia in an archipelago of 17,508 islands (only 6,000 are inhabited) between the Indian and Pacific Oceans, Indonesia has 33,924 miles (54,716 kilometers) of coastline and a total area of 741,096 square miles (1,919,440 square kilometers). An abundance of natural resources includes petroleum, tin, natural gas, nickel, timber, bauxite, copper, fertile soils, coal, gold, and silver. Most of Indonesia enjoys a tropical temperature, but the weather is more moderate in the highlands.

The land is composed of coastal lowlands with interior mountains on the larger islands. Elevations range from sea level to 16,498 feet (5,030 meters). Indonesia is subject to occasional flooding and severe droughts as well as to earthquakes, volcanoes, tsunamis, and forest fires. A volcanic eruption on Mount Tambora on April 10, 1815, killed more than 88,000 people. In December 2004, the infamous Indian Ocean tsunami hit Indonesia particularly hard at a cost of 131,000 known dead and another 37,000 people missing. Property damage was estimated at $4.5 billion, and environmental damage was incalculable.

Some 22 percent of the Indonesian population lacks sustainable access to safe drinking water, and 48 percent have no access to improved sanitation. As a result, Indonesians are at high risk for contracting food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A and E, and typhoid fever. In certain areas, Indonesians are also vulnerable to vectorborne diseases that include dengue fever, malaria, and chikungunya. Some 100,000 Indonesians are living with HIV/AIDS, which has killed 2,400. A number of avian influenza cases were reported in Indonesia in 2005, creating a public scare.

Indonesia is currently facing a number of major environmental problems. First among these have been repeated widespread forest fires, massive enough to cast a pall of smoke over the southern Pacific Ocean for months in their wake. El Niño weather conditions set the stage for these fires, which created drought throughout Southeast Asia during the early 1980s and late 1990s. The fires, however, were almost exclusively anthropogenic, and set by plantation companies and large agribusinesses attempting to clear land for the plantation and extraction of palm oil, wood pulp, and rubber. Many of these firms, moreover, went unregulated in their activities, due to to their close and largely corrupt relationship to the ruling party.

These and their related deforestation have played havoc with the biologically diverse tropical forests. In 1983, for instance, 7.4 million acres (3 million hectares) of tropical forests were destroyed by fire in Kalimantan Timur Province. During the 1980s, Indonesia had the highest rate of deforestation in Southeast Asia. This process was checked to some extent through a joint Department of Agriculture/World Bank forestry management plan, but illegal logging continues to deplete Indonesian forests. It is estimated that 58 percent of Indonesian land is now forested. Even though the government has protected over one-fifth of the land area, wildlife is seriously endangered. Of 515 mammal species endemic to Indonesia, 147 species are threatened with extinction. Similarly, of 929 endemic bird species, 114 are endangered.

Extensive water pollution has occurred as the result of the indiscriminate use of agricultural pesticides, off-shore oil drilling, industrial effluents, and overall improper waste management. Air pollution is severe in urban areas, where 45.5 percent of the population resides. Indonesia generates 1.2 percent of the world's carbon dioxide emissions. This rate is expected to decline with the recent banning of leaded gasoline. The frequent forest fires generate smoke and haze in the air. Fish stocks have declined drastically, and the terburuk fish has virtually disappeared in some areas. Milkfish and young shrimp have been killed in Java. Coral reefs have been destroyed by silt deposits.

In January 1975, lasting environmental damage occurred when a Japanese supertanker spilled oil into the Strait of Malacca. In 2006, a study at Yale

Daendels in Batavia

The administrative capital of the Netherlands East Indies was the city of Batavia (modern-day Jakarta), established by the Dutch in 1619. By 1808 it was a city of 2,000 Europeans and 45,000 Asians, with effluent in the canals that cut through the residential areas.

In 1807 Herman Willem Daendels (1762–1818) was appointed as the 36th Governor General of the Netherlands East Indies by Louis Bonaparte, the French having recently taken over the Netherlands. Daendels arrived in Batavia on January 5, 1808, and found it an incredibly unhealthy city. His task was to modernize the defenses of the city in case of attack by the British, and also improve its sanitation. A massive barracks at Meester Cornelis was established south of Batavia, and housed most of the soldiers, who were previously garrisoned in the old castle close to the coast.

The other major change that Daendels organized was the clearing of many of the canals, a large number of which were stagnant. He also supervised the creation of the main square outside the Stadhuis, the residence of the governor. Nearby he also built a new hospital and drainage system.

Within the grounds of the city there had been a small cemetery that by this stage was not only full, but causing environmental problems for the people in the city. It was where many of the early governors–general of the Netherlands East Indies had been buried, and also where one of the survivors from the Mutiny on the Bounty had been interred. However pollution from it had affected the water supply of the city, resulting in Daendels closing and clearing the cemetery, and building the Museum of Old Batavia on the site.

He also established a new one at Taman Prasasti, near where the National Museum is now located. Many of the gravestones from the old cemetery were moved there, but some remain at the site of the old cemetery, now the basement of the Wayang Museum.

University ranked Indonesia 79th of 132 nations in environmental performance, below relevant income and geographic groups. Indonesia's rating was particularly low in air quality.

In 1997, the Indonesian government enacted Law No. 23, the Law Concerning Environmental Management, which provides a framework for all Indonesian environmental laws and regulations. The Minister for Environmental Affairs was charged with oversight and implementation. However, as Indonesia's economic situation has deteriorated, enforcement of environmental laws has been placed on the back burner. Some businesses no longer even attempt to meet environmental codes. Indonesia participates in the following international agreements: Biodiversity, Climate Change, Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands. The Marine Life Conservation agreement has been signed but not ratified.

SEE ALSO: Coral Reefs; Deforestation; Drinking Water; Drought; Endangered Species; Fire; Floods and Flood Control; Pollution, Air; Pollution, Water; Tourism; Tsunamis.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apfell-Marglin, eds., *Rethinking Freire: Globalization and the Environment Crisis* (Lawrence Erlbaum, 2005); Lester R. Brown, *Outgrowing the Earth: The Food Scarcity Challenge in the Age of Falling Water Tables and Rising Temperatures* (Norton, 2004); CIA, "Indonesia," *The World Factbook,* www.cia.gov (cited April 2006); Country Studies, "Indonesia: Environment," www.country-studies.com (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993); UNDP, "Indonesia," www.hdr.undp.org (cited April 2006); World Bank, "Indonesia," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Industrial Ecology

INDUSTRIAL ECOLOGY IS a concept that advocates converting "waste outputs" into "resource inputs" to reduce the economic, social, and environmental costs of waste disposal while simultaneously preventing the need to take more raw materials for use in production. A 1974 paper by Harry Evan in the *International Labour Review* introduced the term as follows: "The term 'industrial ecology' might appropriately be applied to an interdisciplinary systems approach to environmental problems arising from industrial activities, i.e., the production, consumption and disposal of manufactured products and their raw material and energy inputs, as well as from related mining, agricultural, transportation and construction processes." According to Jouni Korhonen, industrial ecology uses "nature's model of material recycling, energy cascading and solar energy-based sustainable ecosystem in transforming unsustainable, fossil fuel-based and wasteful industrial systems into more ecosystem-like systems."

These definitions, and others, are based on the idea that the traditional model of industrial activity is immature and wasteful and should be changed to an integrated industrial ecosystem. This means that they should optimize the consumption of energy and materials, minimize waste generation, and use the effluents of one process as the raw material for another process. For example, while in natural systems the energy and/or matter produced by one species is consumed by another, surplus heat from industrial processes is commonly dissipated in the atmosphere and potentially recyclable products simply disposed of as waste.

This concern has led many leading environmentalists to critique both capitalist and socialist modes of economic production as being expansionist and linear. Pierre Desrochers used empirical analyses of earlier industrial eras and specific industrial activities to demonstrate that the perception of a linear process does not always accord with the historical evidence—many industrial practices in the late 19th and early 20th centuries involved extensive recycling behavior and the use of by-products in a myriad of ways.

Much work on industrial ecology tends toward the normative, analyzing what could be done in particular industrial situations. In policy terms, there has been a focus on implementing industrial ecology through the creation of linkages between firms in a specific geographic area. This latter vision, known as an eco-industrial park (EIP), E. Cohen-Rosenthal defines as a "community of businesses that cooperate with each other and with the local community to efficiently share resources (information, materials, water, energy, infrastructure and natural habitat)… leading to economic gains, gains in environmental quality and equitable enhancement of human resources for the business and local community."

Industrial ecology involves going into networking activities between firms. Jouni Korhonen labeled these approaches as the "product" (that is, the technical exercise within a corporation) and "geographical" approaches and notes that while these approaches are compatible in some ways, there are also tensions between them. EIPs can vary in form from a Green Industry Park (where individual industries are clean but have no synergies with other sites), to Integrated EIPs (geographic concentration of firms and synergies between facilities), to the Networked Eco-Industrial System (synergies but spread over a metropolitan or larger area). The challenge has been to develop suitable role models of EIPs. One model example often cited is Kalundborg, Denmark, which has developed around a coal-fired power station where a web of waste and energy exchanges has developed between the power plant, the local city administration, a refinery, a fish farm, a pharmaceuticals plant, and a wallboard manufacturer. However, Kalundborg relies upon nonrenewable fossil resources and produces carbon dioxide emissions, neither of which are compatible with the principles of industrial ecology.

The Kalundborg industrial complex emerged over a period of about 30 years and was achieved without consultants designing potential interactions, government financial support to encourage interactions, or a higher level of administration to oversee the interactions. While much of the literature has focused on emulating the design and interactions present at Kalundborg, Pierre Desrochers focuses on the processes of private sector investment and argues that rather than being an example of designed symbiosis, Kalundborg is a contemporary example of industrial symbiosis that has been occurring "long before the advent of modern environmental consciousness and regulation." While gradual evolution is one characteristic that is identified in nature and transferred to industrial ecosystems, there is nothing in nature to indicate whether this gradual evolution should be facilitated primarily through private planning, design, urban planning, or a combination of economic geography and urban planning/urban governance.

SEE ALSO: Ecological Modernization; Ecosystems; Green Production and Industry; Industrial Revolution; Industry; Sustainable Development.

BIBLIOGRAPHY. Clint Andrews, "Putting Industrial Ecology into Place: Evolving Roles for Planners," *Journal of the American Planning Association* (v.65, 1999); E. Cohen-Rosenthal and Judy Musnikow, eds., *Eco-Industrial Strategies: Unleashing Synergy between Economic Development and the Environment* (Greenleaf Publishing, 2003); Herman Daly, *Beyond Growth: The Economics of Sustainable Development* (Beacon Press, 1996); Pierre Desrochers, "Eco-Industrial Parks: The Case for Private Planning," *Independent Review* (v.5/3, 2001); Pierre Desrochers, "Industrial Ecology and the Rediscovery of Inter-Firm Recycling Linkages: Historical Evidence and Policy Implications," *Industrial and Corporate Change* (v.11, 2002); Pierre Desrochers, "Natural Capitalists' Indictment of Traditional Capitalism: A Reappraisal," *Business Strategy and the Environment* (v.11, 2002); Harry Evan, "Socio-Economic and Labour Aspects of Pollution Control in the Chemical Industries," *International Labour Review* (v.110/3, 1974); Robert Frosch and N.E. Gallopoulos, "Strategies for Manufacturing," *Scientific American* (v.261, 1989); Thomas Graedel and Braden Allenby, *Industrial Ecology* (Prentice Hall, 1995); Jill Grant, "Industrial Ecology: Planning a New Type of Industrial Park," *Journal of Architectural and Planning Research* (v.17, 2000); Paul Hawken, *The Ecology of Commerce* (HarperBusiness, 1993); Paul Hawken, Amory Lovins, and L. Hunter Lovins, *Natural Capitalism: Creating the Next Industrial Revolution* (Little, Brown, 1999); Jouni Korhonen, "Industrial Ecology in the Strategic Sustainable Development Model: Strategic Applications of Industrial Ecology," *Journal of Cleaner Production* (v.12, 2004).

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Industrialization

INDUSTRIALIZATION IS A process that introduces new technologies of production in a region or a country to increase the output of goods. Industrialization is strongly associated with the Industrial Revolution in England in the 19th century, where capital and resources from colonial expansion, technological innovations like steam power, and labor dispossessed from land or access to markets combined to create large-scale factory production. The shift from handmade manufacturing to machine production yields major changes in the societal division of labor in two ways. Increased use of machinery tends to make homogenize the types of labor performed by each worker (deskilling), and alter the gender division of labor by incorporating women into the paid workforce. Industrialization under capitalism affects relations between owners and workers by generating a supply of labor that is employed according to market forces, mobile within a nation-state, and often restricted in terms of international mobility.

ENVIRONMENTAL IMPACTS

Intensification of production generates pollution—including increased emissions, water and soil contamination—as well as unsustainable resource extraction. While industrial production is commonly evaluated in terms of growth and increased efficiency, the environmental cost is considered a secondary spillover effect, referred to in mainstream economics as a *negative externality.* Proponents of environmental regulation argue that the cost of pollution should be internalized, either through incentives that reward cleaner industries or punitive fines for polluters.

Mainstream environmental economists have constructed powerful models like the Environmental Kuznets Curve to assert that industrial growth and environmental protection are not opposite processes. They argue that while environmental damage is inevitable in the "take off" period of industrialization (low-wage, low-technology, polluter phase), once a certain level of per-capita income is reached, economic growth can be channeled toward cleaner industrial technologies (high-wage, high technology, "cleaner" industrial period). This view assumes that poor countries are primarily polluters, the market is capable of self-regulation, environmental regeneration is guaranteed, and the effects of environmental damage on the livelihoods of affected populations are reversible. This assumption is facilitated by a strong link between the concept of industrialization and key ideas like progress, development, and modernity in Western thinking.

This idea of stage-like industrial development works poorly when considering economic development in former colonies, often referred to as the global South. Colonial capitalism fostered both dependency on primary products (natural resources and cash crops) and a global economic system that devalued so-called "primary" products. This colonial production—including resource extraction and plantation agriculture—was in many cases industrial, involving expensive technologies, capital investment, as well as a complex division of labor, both free and slave.

These industries were part of a system that extracted wealth exclusively for local elites and the "mother" country, in turn creating conditions for industrialization in Europe. For many former colonies, shifts in global production as a result of decolonization were associated with deindustrialization, capital flight, and a more informal economy. Oft-cited examples include the Zambian copper belt in southern Africa and the Caribbean plantation system.

In the post-World War II period, industrialization became synonymous with development policy dominated by a debate between two strategies: import-substitution industrialization (ISI) and export-oriented industrialization (EOI). In both cases, industrialization refers to shifting economic activity from agricultural production to manufactured goods. Both strategies face the challenge of generating or attracting capital investment, technology, and business organization—a process that often leads to dependence on foreign banks and multinational corporations. The difference between the two approaches lies in their market "orientation." ISI encourages domestic production for the national market through industrial subsidies and protective trade barriers to reduce the level of imports. EOI subsidizes domestic and foreign investment in sectors that can produce goods for foreign markets with more purchasing power, like the United States and Europe. Struggles over EOI versus ISI generally do not address the question of environmental impacts of industrialization.

Another use of the term "industrialization" in post-World War II development policy refers to the promotion of "scientific" or "industrial" agriculture in the global South, a strategy referred to as the Green Revolution. New technologies—such as hybrid seed varieties, fertilizers, pesticides, and mechanization—were introduced with significant negative impacts on the environment, patterns of land tenure, and women's central role in small-scale agricultural production.

SEE ALSO: Industrial Ecology; Industrial Revolution; Modernization Theory.

BIBLIOGRAPHY. Karl Marx, *Capital: A Critique of Political Economy, Vol. 1* (International Publishers, 1967); Sydney W. Mintz, *Sweetness and Power: The Place of Sugar in Modern History* (Penguin Books, 1985); Philip W. Porter and Eric Sheppard, *A World of Difference: Society, Nature, Development* (Guilford Press, 1998); R. Kerry Turner, "Markets and Environmental Quality," in G. Clark et al., eds., *The Oxford Handbook of Economic Geography* (Oxford University Press, 2000); Richard York, Eugene A. Rosa, and Thomas Dietz, "Footprints on the Earth: Environmental Consequences of Modernity," in *American Sociological Review* (v.68, 2003).

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Industrial Revolution

THE TERM *RÉVOLUTION industrielle* was first used by French historians at the beginning of the 19th century, but later on it became a widespread phenomenon. *Industrial Revolution* became well known, especially by the Arnold Toynbee's *Lectures on the Industrial Revolution in England* published in 1884. His term referred to the application of power-driven machinery to textile manufacturing in Britain. In the 18th century, all of Western Europe (especially England) experienced the process of rapid economic change that transformed all aspects of human life.

Toynbee was not a historian, and his ideas have been criticized by leading historians such as Rondo Cameron and A.P. Usher, but his ideas have largely influenced our understanding of modern history. None can deny the profound and aggressive economic and social change in Britain, which has never been seen anywhere else before and created the modern framework of capitalist economies. During the decades of rapid economic, social, and cultural changes, a number of new inventions were contrived and utilized in industrial production. At the same time, an accelerated urbanization took place and new centers of industrial production were created, worsening the working conditions of workers and the necessitating child labor. At the same time, many argue about the revolutionary nature of those changes, since the growth of economy and the transfer of technology was much slower than in contemporary economies.

One of the key reasons why the industrial unfolding happened in Britain was the lack of timber and the large deposits of coal in the country. English forests begin to vanish by Roman times, and the size of forested territory has not changed much since the Middle Ages. Timber was an expensive commodity, and chimney smoke shadowed the sky in 13th-century London and other cities all around Europe. Parisians faced serious wood shortages already in 1595, when bakers had to use alternative materials to provide adequate amount of fresh bread. However, there was an abundant labor supply to mine coal and iron, a large fleet, science-based technical know-how, and colonies to provide raw materials and merchants with capital to invest. The utilization of that scientific knowledge accelerated throughout the period and by the late 19th century; theories of chemistry and electrical engineering created the basis of new production methods and branches of industry.

The English countryside changed as well between 1760 and 1830. The open-field system of cultivation gave way to compact farms and enclosed fields, which led to migration to cities. The present rural landscape dominated by large open fields, hedges, and fences are all originated from this time.

A number of agriculture-related inventions appeared. Nitrogen-fixing agricultural advancements led to the growth of agricultural productivity. Jethro Tull not only popularized the importance of root crops such as turnips and potatoes, but was an inventor of the seed drill and horse hoe. Townshend, another agricultural reformist, was famous for his introduction of the four-course rotation of wheat, turnips, oats, and barley. Robert Bakewell pioneered in the field of systematic stock breeding for food. Intensifying discourse over agricultural advances led to the establishment of the Board of Agriculture in 1793. Growing agricultural productivity had a great importance of the changing human relationships with nature.

FROM STREAM TO STEAM

New methods of glass and clock making had already appeared in the 17th century, but a more profound change followed the diminishment of guilds in England and the arrival of a new power source. Wind and hydropower were used in mills, sailing, and even in industrial production, but the steam engine became the landmark of the industrial development. Refining the principles of Thomas Newcomen's bulky 1705 invention, in 1763 James Watt designed his steam engine, which revolutionized production methods in the next 100 years. Watt built over 500 of them in 25 years by 1800.

Water power continued in use, but the factory now had an alternative. Steam engines were large, heavy, and hardly transportable, but still successfully used in ships and mines. Robert Fulton made a successful experiment with a steam vessel on the Hudson in 1807. Many entrepreneurs recognized the importance of the steam engine, and the use of such machines in manufacturing was becoming widespread by the beginning of the 19th century. Since steam engines had a number of technological problems, they were first only supplemental power sources. Their efficiency was also low, and therefore burned tons of coal per day and produced high emissions. Despite of all the disadvantages, they were used successfully in pottery and grinding, and revolutionized the textile industry along with a number of other inventions.

By the time steam engines became more efficient, their importance in transportation began to be recognized. Since the large steam engine required a significant amount of coal, attempts to adopt steam vehicles for road transportation failed notoriously.

The arrival of the railroads facilitated industrialization in Europe, but had serious social and environmental implications. During the early 19th century, mine tracks were transformed into transportation corridors around and between commercial and industrial centers. By the early 1830s, George Stephenson's famous train pulled cars from Liverpool to Manchester.

The railway boom came to Britain by the mid-1850s, when cheap raw materials and adequate technology enabled investors to compete successfully with other means of travel. Soon trains were faster, safer, and more convenient than any other way of traveling. Information spread faster along railway, which made business safer. Trains were fast, although none of them could cover more than 45 miles per hour. The invention of the telegraph quickened information flow, and by the 1870s, telegraph cables connected continents and global transactions took only minutes. At the same time, steamships became more and more widespread in international waters. By the 1840s, technical problems with the flammability of vessels and bulkiness of machinery were solved. Soon, transatlantic travels became regular, which hastened the transportation of goods from both sides of the Atlantic.

Until the 19th century, most of the world's population was rural and urban places had limited importance. However, factories and commercial centers created a never-before-seen demand for a labor force in urban areas. By the mid-19th century, half of England lived in cities, and Britain's population increased more rapidly than ever before. By the beginning of the century, a similar phenomenon was observed in most European countries and in the east coast of North America. However, earning a living in an English city during that time was not an easy task.

According to the 1851 census abstracts, 22 percent of the total 9.4 million population of Britain earned its living from agriculture; at the same time, 39 percent were engaged with manufacturing and 25 percent with services. Only 50 years later, in 1901, services became predominant and only 9 percent of the total population was engaged with agriculture in Britain. Industry was producing a wide range of products from textile products to metals and from food products to chemicals.

During the course of the 19th century, services became more and more important as transportation, banking, and trade developed. Cities became crowded. The scale and the type of industrial pollution that appeared during the late 18th century was unprecedented. Besides small workshops and domestic users, large factories gained their energy from burning coal. Smokestacks became landmarks and sources of smoke, which shadowed the sun regularly. Emissions from factories found their way into rivers and polluted them constantly.

Cheap, company-built housing was inevitable for workers, but factory owners gained a strong control over communities by ownership. A great proportion of the workforce was engaged with low-paying jobs and lived in overcrowded and poorly lit accommodations. Sanitation conditions were poor in these areas, with bathrooms often shared by many members of various generations. Such conditions resulted in high rates of mortality and disease among workers. These classic slums were characteristic in all cities of Britain. The inadequate understanding of hygiene worsened the situation, but the association between ill health and poor living conditions soon became evident for much of the society.

in 1763 James Watt designed his steam engine, which revolutionized production methods in the next 100 years.

By the 1830s, many British towns suffered of cholera, smallpox, and other epidemics. At the same time, many workers were affected by industrial pollution caused by dusty and damp conditions in factories. Many of the locals united in campaigning groups. Local physicians organized Boards of Health, often following after epidemics, to improve living conditions. These boards pointed out the importance of hygiene and that many of the cotton mills and factories were the hotbeds of epidemics.

During the early days of industrialization, a number of children were also employed within such conditions, which reduced their life expectancy significantly. Health conditions had improved by the contribution of cleanness campaigns, efforts of sanitation engineers for better drinking water and sewage services, and individual achievements such as garbage bins with lids to keep flies out. The well-organized collection of horse manure was also essential for the city's health, but created serious disposal problems. Furthermore, untreated effluent running into rivers posed further problems of water pollution and urban water supply. Many of the large industrial centers were suffering from polluted waters, such as Manchester, London, and Chicago. To gain improvements in sanitation and sewage, sophisticated infrastructures were created.

The environment saw unprecedented changes during the years of the Industrial Revolution. After 1750, the large number of industrial cities grew and aroused a number of problems of the relationship between the society and environment. Remarkable growth of production and population created the need for a number of infrastructural developments, such as expanded canals and railway lines throughout Britain.

Water pollution resulted from the increased amount of solid and dissolved industrial and household waste being discharged into rivers. Waste accumulated in some of the river basins and caused a thick scum of dirty froth, unpleasant smells, and problems during floods. Despite all the negative effects, the politicization of such environmental issues did not make waves until the 1960s. However, many citizen groups became concerned about the environment through human health issues or social problems.

As early as the Middle Ages, problems with air were reported in some of the big cities due to the increased use of charcoal and wood for heating. But in the 19th century, significant problems with air pollution led to related health issues such as bronchitis and other respiratory ailments. Air pollutants came both from industrial sites and domestic hearths. The rise of the steel industry caused further troubles for many cities all over the world in the beginning of the 20th century. Concentrated point source emissions of steel factories, chemical plants, and electric power stations did not end until the 1980s in many Western European and American cities. Britain's Manchester, Germany's Ruhr region, France's northern east in Europe, and Pittsburgh, Milwaukee, east Chicago, and Gary in the United States experience similar environmental problems during the 20th century.

SEE ALSO: Coal; Hydropower; Nonpoint Source Pollution; Point Source Pollution; Pollution, Air; Pollution, Water; Urbanization.

BIBLIOGRAPHY. Thomas Brinley, *The Industrial Revolution and the Atlantic Economy* (Routledge, 1993); Laurie Collie and Kevin Hillström, eds., *The Industrial Revolution in America* (ABC-CLIO, 2005); Chris Freeman and Francisco Louçã, *As Time Goes By: From the Industrial Revolution to the Information* (Oxford University Press, 2001); Eric Hobsbawn, *The Age of Revolution 1789–1848* (Vintage Books, 1996); Pat Hudson, *The Industrial Revolution* (E. Arnold, 1992); Thomas K. McCraw, ed., *Creating Modern Capitalism: How Entrepreneurs, Companies, and Countries Triumphed in Three Industrial Revolutions* (Harvard University Press, 1997); Peter N. Stearns, *The Industrial Revolution in World History* (Westview Press, 1993); Peter Stearns, *Interpreting the Industrial Revolution* (American Historical Association, 1991); Mikuláš Teich and Roy Porter, *The Industrial Revolution in National Context: Europe and the USA* (Cambridge University Press, 1996).

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Coalbrookdale

This settlement in the parish of Madeley, Shropshire, in the west of England, was one of the birthplaces of the Industrial Revolution.

There had long been an iron industry at Coalbrookdale, with a large furnace, known as the "Old Furnace" built there by Sir Basil Brooke in 1638, just before the English Civil War. In 1709, Abraham Darby built a furnace there to make iron goods. Darby lived at Madeley Court and was from a prominent local Quaker family. Six years later, he built another furnace, but his death two years after that saw the works end up in the hands of Thomas Goldney of Bristol, and managed by Richard Ford.

They brought back Abraham Darby's son, also called Abraham Darby, and started making steam-engine cylinders. All these people were Quakers, and indeed Quakers were to have a major impact on the industrial revolution elsewhere in England and also in the United States.

It was in 1768 that the forges at Coalbrookdale started to produce iron rails for railways. Coalport China was also made there. Ten years later Abraham Darby III, grandson of the man who built the furnace in 1709, started work on the first cast iron bridge—Iron Bridge—which opened in 1780 and was to lead to the settlement of Ironbridge. It was from this that Thomas Telford gained the inspiration for his projects that followed, including the nearby Buildwas Bridge. Telford also redesigned the parish church of Madeley. In 1837 Charles Hulbert, a visitor to the area, described it as "the most extraordinary district in the world." The Ironbridge Gorge Museums record the first decades of the Industrial Revolution, and are major tourist sites for the region. The whole area is now a part of the township of Telford.

Industry

INDUSTRY IS THE term used to describe all of the businesses making a particular product or providing the same service. Product industries include the automobile industry, munitions industry, textile industry, construction industry, shipbuilding industry, and thousands of others. Service industries include the insurance industry, banking industry, stock brokerage industry, retail industry, and real estate industry.

Historically, most goods before the Industrial Revolution were part of a cottage industry, in which goods were made in private homes of the poor. The Industrial Revolution took vast number of poor people from small villages, farms, and cottages and put them into large-scale production centers. The first industry organized in this way was the textile industry.

Wool production increased dramatically with the enclosure movement, which drove small-scale farmers off of their lands and into growing factory towns like Birmingham, England, which were located near sources of cheap energy such as water power or coal. They were soon filled with cheap housing that disintegrated into slums. The factory system had many negative consequences for workers, but the factory system created a huge flow of cheap finished goods for the global market.

MODERN INDUSTRIAL NEEDS

Natural resources use by industry are either renewal or nonrenewal. Corn is a renewable resource that can be planted every year to make corn syrup or a great many other products. In contrast, the resources needed by the service industry, such as financing or insurance, are far fewer.

Capital is a resource needed by industry to build capital goods like production machinery and to hire people as managers or laborers. The canning machinery or the electrical motors for running an operation are also capital goods. Some industries are capital-intensive, such as an oil refinery, which requires few very skilled workers but a vast investment of money for the oil refinery equipment.

Industry needs at least some human labor. In labor-intensive service industries such as hospitals or law firms, a large number of skilled workers solve medical or legal problems. They are also capital intensive in regards to human capital.

Management in industry is typically highly skilled to supervise the vast number of steps in the making of complicated goods or the delivery of services. Each worker in an assembly line or in the manufacture of other goods does only a small part of the total part of the work; this specialization of labor magnifies human productivity. This was recognized by Adam Smith in his book, *The Wealth of Nations*. Smith concluded that the wealth of nations was the productivity of their people; he described his visit to a highly productive pin factory, where its productivity would have been a great deal less if each single worker had to undertake all of the steps in making a pin.

Technology is composed of the unique skills acquired from practice, tools, machinery, and techniques used by industry. Technology also multiplies the productivity of an industry.

In the developed countries of western Europe, North America, and Japan, industries have employed people almost since the beginning of the Industrial Revolution. In other regions, such as Asia, Africa, or Latin America, there are still huge populations in rural villages. Since China changed its economic policy to promote a market economy, thousands of industries have opened. Industry in the Third World or developing world has been undergoing developmental problems since its beginnings. One of the major problems is the environmental impact of consuming huge quantities of raw materials.

Another major problem is supplying energy to the great new cities of Asia. Japan is increasingly supplied by nuclear power, but in China, with huge supplies of coal and also with the damming of a number of rivers, including the Three Gorges Dam, there has been an enormous increase in energy supplies.

As China, Japan, and other newly industrializing countries prosper, there is also an increase in the demand for transportation and consumer goods, including automobiles. This makes necessary the building of new roads and railroad lines.

The environmental impact of industry, whether in manufacturing or in farming since the end of World War II, has been tremendous. The used of pesticides, herbicides, and the burning of fossil fuels have had negative consequences for the environment. In order to deal with the pollution created by industry, great expenditures have been made for eliminating or cleaning up pollution such as chemical waste dumps.

Food industries, such as cattle ranches, poultry farms, and hog operations, have all become industrialized with the use of exact mixtures of feeds, as well as vitamins and antibiotics to prevent disease. While keeping the cost of meat low and feeding billions of people, these industrial farms also generate huge quantities of waste that must be disposed of safely.

Debates, political strife, and lawsuits have been part of the response of those concerned about the pollution caused by modern industry. However, the money made from industry, as well as the global competition for jobs, has made this difficult. Industry can relocate from a country with strict environmental protection laws that require costly capital investments to environmentally lax countries of the developing world, where jobs are more important in the beginning than the environmental consequences.

"Making a living" also implies ethical treatment of people and of the environment. The excuse that pollution is necessary to meet the competition is a rationalization to justify harming people, plants, and animals. The challenge is clean industry, which does no harm but is also one that is highly productive and profitable.

SEE ALSO: Capitalism; Industrial Revolution; Industrialization.

BIBIOGRAPHY. Andres R. Edwards, *The Sustainability Revolution: Portrait of a Paradigm Shift* (New Society Publishers, 2005); Daniel Esty and Andrew S. Winston, *Green to Gold: How Smart Companies Use Environmental Strategy to Innovate, Create Value, and Build Competitive Advantage* (Yale University Press, 2006); Paul Hawkin, *Ecology of Commerce: A Declaration of Sustainability* (HarperCollins, 1994); Paul Hawken, Amory Lovins, and L. Hunter Lovins, *Natural Capitalism* (Little, Brown & Co., 2000); William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (Farrar, Straus and Giroux, 2002); Andrew W. Savitz and Morgan McVicar, *The Triple Bottom Line: Why Sustainability Is Transforming the Best-Run Companies and How It Can Work for You* (John Wiley & Sons, 2006).

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Infant Mortality Rate

INFANT MORTALITY REFERS to the death of infants in the first year of their life. It is measured by the infant mortality rate (IMR), which is the ratio of the total number of deaths to the number of children under the age of one year for every 1,000 live births. IMR is often broken down into three components based on time of death. First, the perinatal mortality rate measures the ratio of the number of late-fetal deaths (at or after 28 weeks gestation) and deaths within the first 7 days after birth per 1,000 live births. Second, the neonatal mortality rate refers to the ratio of the number of deaths within 28 days after birth (per 1,000 live births). Third, the postneonatal mortality rate is the ratio of the number of deaths from 28 days to the end of the first year per 1,000 live births. The distinction between perinatal, neonatal, and postneonatal mortality is important because the risk of death is higher close to the delivery date, and the causes of death near the time of birth/delivery are quite different from those later in infancy.

Though the world's infant mortality is 54, differences across the world are substantial. Africa's rate (88) is 15 times higher than the average rate (6) for developed countries. Sierra Leone has the highest rate of IMR (165) in Africa. Though on average, the rate for Asia is 56, Afghanistan has highest IMR (172) in the world. On the other hand, Hong Kong's rate (3.2) is very low, illustrating that the most variation in infant mortality level occurs in Asia. Both Europe and North America have low levels of infant mortality, with average rates well under 10.

While the causal relationship between infant mortality and level of socioeconomic development and environmental conditions is not perfect, the infant mortality rate is commonly used as a general indicator of socioeconomic well-being and of general medical and public health conditions in a country. IMR is included as one of the components of "standard of living" evaluations of countries. Developed countries can provide the basic requirements for infant survival namely clean water, sanitary surroundings, adequate food, shelter, and access to basic health care services. On the other hand, the major proportion of infant mortality in underdeveloped countries is due to improper sanitary practices and inadequacies in the diet of mothers, resulting in infectious and communicable diseases.

The causes of infant mortality vary over the time of infant deaths and between developed and underdeveloped countries. Postneonatal mortality, which is predominantly due to socioeconomic and environmental conditions, is more common in underdeveloped countries than developed countries. The major causes are infectious diseases, such as pneumonia, tetanus, malaria, and dehydration. These diseases are in turn consequences of improper sanitation at the place of delivery; traditional types of attendants and practices during prenatal, natal, and postnatal periods; poor nutritional status of lactating mothers; age of mothers; income; and educational levels. At the individual level, mothers (and fathers) with lower income and education are less likely to possess knowledge of sanitary behaviors and the money for adequate food. In addition, they are less likely to take their babies to a health service if needed. This is especially important for information about Oral Rehydration Therapy, which is effective in saving babies from dying from the dehydration that accompanies diarrhea.

Another cause of infant mortality is violence. Research conducted in two areas in India show that wife beating, closely linked to patriarchal social structures, leads to both pregnancy loss and infant mortality. Other violence, such as infanticide, the deliberate killing of infants, is extremely difficult to document, but it seems likely that some portion of the "missing girls" in India and China were the victims of infanticide. When infanticide is practiced, it is most likely a response to difficult economic circumstances (and coercive population policy, in the case of China) in conjunction with male-child preference.

Neonatal mortality, in contrast to postneonatal mortality, is less likely to be the direct result of socioeconomic and environmental conditions. Major causes of neonatal mortality include low birth weight, premature birth, congenital malformations, and sudden infant death syndrome (SIDS). In developed countries, most infant mortality is concentrated in the early neonatal period, with the aforementioned causes of death predominant.

SEE ALSO: Birth Rate; Fertility Behavior; Fertility Rate.

BIBLIOGRAPHY. Shireen J. Jejeebhoy, "Associations Between Wife-Beating and Fetal and Infant Death: Impressions from a Survey in Rural India," *Studies in Family Planning* (29, 1998; Michael Lewis, "A Path Analysis of the Effect of Welfare on Infant Mortality," *Journal of Sociology and Social Welfare* (26, 1999); Population Reference Bureau, *World Population Data Sheet 2005,* www.prb.org; World Health Organization, "Effect of Breastfeeding on Infant and Child Mortality Due to Infectious Diseases in Less Developed Countries: A Pooled Analysis," *Lancet* (355, 2000).

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Influenza

INFLUENZA IS AN extremely contagious disease caused by the influenza virus. It causes infection of the respiratory tract and can affect millions of people every year. There are three types of influenza viruses. The influenza type A virus can infect humans and other animals, while influenza B and C viruses can only infect humans. Type A is responsible for the annual outbreak of influenza; the virus was first detected by a British bacteriologist Wilson Smith in 1932. Effects of the influenza virus C are very mild and do not cause epidemics. Influenza viruses are constantly changing, producing subtypes or strains. These strains are different from the main viruses, but retain some of their characteristics. These influenza strains may vary year to year, requiring flu vaccine modification every year.

In the Northern hemisphere, influenza epidemicity occurs during October–March. With the warming trends, the episode dies down. It surfaces in the tropics in March and April and during their rainy season. In May and August, the influenza episode moves to the southern hemisphere. By September, the episode comes back to the tropics. This annual cycle of influenza persists, and is different from measles, vermicelli, mumps, rubella, infestus, hepatitis, and smallpox.

Influenza usually is much more severe than the common cold. The virus takes about 1–2 days from the time of exposure to develop symptoms. This period is known as "incubation period." The influenza (flu) comes on suddenly, causing symptoms such as fever, often as high as 104 degrees F, severe sweating, body and muscle aches, headache, fatigue, loss of appetite, dry cough, nasal congestion, and sore throat. The illness lasts up to 1–2 weeks, although fever generally lasts only 3–8 days. Most people recover without problem, but sometimes the ailment can lead to a bacterial infection such as bronchitis and ear/sinus infection.

One of the most severe complications of flu is bacterial pneumonia caused by *streptococcus pneumoniae* (the pneumococcus) and *staphylococcus awieus*. Pneumonia caused by flu is not common, but requires immediate hospitalization. Each year about 10,000–40,000 Americans die of influenza or influenza-related pneumonia, and over 90 percent of deaths occur in the 64+ age group. Influenza can be prevented by getting immunized with an influenza vaccine each year in the months of October and November. FluMist, a live virus vaccine in the form of nasal spray, can be an alternative to flu vaccine for healthy children and adults between the ages of 5–49, excluding pregnant women.

Scientists are actively looking for new drugs to prevent or treat flu. Two drugs such as Nimantadine and Amantadine have been in use for a number of decades. They are only effective against influenza type A and not type B. These drugs stop the flu from producing copies of itself once it has invaded the human cells. Zanamivin (trade name Relenza) and Oseltamivir (trade name Tamiflu) are the most recently discovered drugs, and are used to treat both flu types A and B.

Bird flu (avian influenza) is caused by complex flu viruses with a number of subtypes and strains. These viruses are classified as having high to low chance of causing disease. Scientists do not yet know just how these subtypes affect humans, but

Spanish Flu Pandemic

Flu epedemics have occurred in the world with great severity in a 5–10 year span. The “Spanish Flu Pandemic” of 1918–19 is estimated to have killed between 50–100 million people worldwide, and is commonly thought to have died out after 18 months.

The pandemic did not in fact originate in Spain, but gained the title because of the massive publicity given to the disease in Spain, which had not taken part in World War I. Allied governments prohibited printing of negative materials so that troop morale remained high.

It is believed that virus might have originated from Fort Riley, Kansas, where poultry was raised for the local market. The disease then “jumped” from birds to humans and quickly spread around the world. Portugal was also struck followed by Denmark, Norway, Sweden, and the Netherlands. After Bombay, India received a ship from Europe, the flu affected men working in the dockyard; the disease then spread to the city. Long-distance rail connection from Bombay to Calcutta, Madras and Karachi brought the disease to these cities following an expansion–diffusion route. From Calcutta, the disease was carried to Rangoon by boat. Soon, the disease spread to Shanghai in China, New Zealand, and Australia, following the routes of oceanic lines. With the movement of the British Fleet, disease was also carried to Algeria, Egypt, and Tunisia. Raging by the end of October 1918, before the end of World War I in Europe, the close proximity of large numbers of men on troop ships—possibly with their immune systems weakened by combat and chemical warfare, as well as the dislocation of the population from war—exacerbated the disease.

In the United States, it is estimated that 28 percent of the population suffered from the influenza virus, with between 500,000–675,000 dying. In France, a country already devastated by war, 400,000 died, with 200,000 in Britain and 10,000 in Australia. In Fiji, some 14 percent of the population died in a fortnight, and 22 percent of the people in Western Samoa succumbed.

The country worst affected was India, where it is estimated that 17 million died—about 5 percent of the total population at the time. It particularly affected returning soldiers, their families, and people living nearby.

highly pathogenic viruses cause serious problems with a large number of deaths occuring both in animals and humans.

The virus does not infect people easily, and it almost never spreads to other humans. Bird Flu is mostly an avian disease. It has infected tens of millions of birds, but fewer than 200 people; and almost all of then caught it from birds. When a very nasty bird flu virus, A(H5N1) infects people, it can kill young people, devouring their lungs. The 2005 bird flu virus, A(H5 N1), has been steadily advancing from China to other parts of Asia, then to Europe and Africa. The latest country to report human cases is Azerbaijan, where out of seven people infected, five have died.

SEE ALSO: Disease; Epidemic; Health.

BIBLIOGRAPHY. John M. Barry, *The Great Influenza: The Epic History of the Deadliest Plague in History* (Viking, 2004); Edgar R. Hope-Simpson, *The Transmission of Epidemic Influenza* (Plenum Press, 1992); Remco S. Schrijver and G. Koch, *Avian Influenza: Prevention and Control* (Springer-Verlag, 2005).

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Insects

INSECTS ARE INVERTEBRATES that are divided into 36 groups called *Phyla*. Phylum Arthropoda includes the class Insecta, which is further subdivided into 29 orders. Diptera (flies), Coleoptera (beetles), Phasmida (stick insects), Dictyoptera (cockroaches and praying mantids), Hymenoptera (wasps, ants, and bees), and Lepidoptera (butterflies and moths) are some examples. About 95 percent of all the animal species on earth are insects. They have a very small body, can survive on very small amount of food, and can multiply very quickly.

All insects have three body parts: a head, thorax, and abdomen. They have six jointed legs, two antennae to perceive the world around them and an exoskeleton (outside skeleton). The multilayered exoskeleton, which is composed of hardened layers of protein and chitin, form their body shape. The exoskeleton has the capacity to protect the insect from the environment or natural enemies and has several sense organs for detecting light, pressure, sound, temperature, wind, and smell, which makes them very successful survivors. Most insects have one or two pairs of wings, but wings are not an essential characteristic to be classified as insects.

Insects use their head for eating, sensing things, and gathering information. They use their antennae to feel, smell, and taste. The thorax is where three pairs of jointed legs, and in many insects, one or two pairs of wings are located. The abdomen has the organs of digestion and reproduction. Insects have open circulatory system and its body fluid circulates around inside the exoskeleton. It has a heart and a few blood vessels, but blood simply flows around inside the body cavity.

Air enters through spiracles located in the exoskeleton and circulates through the breathing tubes, which spread out everywhere in the body. The digestive system is very simple, consisting of a long tube. This tube is usually divided into three parts. The brain is very small and is located in the head, and processes information, but some information is also processed at nerve centers at different places in the body. The nervous system sends messages from the sense organs to and from the brain. Insects have compound eyes, containing thousands of six-sided lenses, each of which can work independently. There are some insects that can perceive ultraviolet light, which is invisible to humans.

INSECT TYPES

Five groups of insects are based on their food habits and nutrition intake. Scavenger insects feed on waste material such as decomposed animal and plant material, and even products from other insects like oils and waxes.

Omnivores such as cockroaches seem to eat just about anything, from bookbindings to fellow insects. Herbivore insects eat leaves, and include caterpillars, butterflies, and bees. Carnivore insects are blood suckers and also feed on other insects.

Parasitic insects obtain nutrition from their hosts. The true parasites, like fleas and lice—as well as parasitoids—are only parasitic as larvae.

POSITIVE EFFECTS ON ENVIRONMENT

Insects contribute to maintain ecological balance. Plants and insects are important to each other's existence. Insects transmit pollen from plant to plant as they feed on the plant's nectar. Insect diversification may have led to the radiation of flowering plants.

Insects keep earth clean by means of an efficient recycling system, because of their ability to reprocess dead plants and animals. Several insects work as decomposers. The carpenter ants, wood-boring beetles, and termites reduce logs, limbs, and leaves, which fall on the forest floor. Insects also eliminate animal waste, but in the case of fly larvae, it can also be a way of spreading disease. Decomposer insects can also improve the texture and quality of soil by adding humus (decayed vegetable and animal matter). The humus provides nutrients for the plants and improves the soil's ability to retain water. Some ant species of Panama build their nest in the shape of an upside-down arrowhead to let the rain slide off, showing an adaptation to nature. These ants are natural enemies of termites and protect the trees against their insidious invasion. Humans are also greatly benefited by insects, as they produce honey, silk, wax, and other products.

DETRIMENTAL EFFECTS

Insects are also major pests of humans and domesticated animals because they destroy crops and carry different types of diseases as transmitters or vectors. The World Health Organization identifies eight major insect-borne diseases. Sleeping sickness is transmitted by the tsetse fly, with 55 million people in Africa at risk. Leishmanisis causes elephantitis and disfigures legs, arms, and genitals, and is transmitted by culex mosquitoes that infect about 120 million people in Africa, South and South East Asia, the Pacific Islands, and Latin America. Chagas disease (American trypnosomiasis) is caused by *T. cruzi,* transmitted to humans by a bloodsucking traitomine bug, and infects 18 million people in the Americas, excluding Canada. Malaria is caused by a bite from an infected female mosquito when human blood is infected with malarial parasite, and is endemic to about 90 countries, mainly in Africa and South and East Asia. Dengue fever is caused by viruses transmitted by the andes aegypti mosquito, affecting 100 countries except Europe with 20 million cases annually. Yellow fever virus is carried by haemagogus mosquitoes and transmitted to humans in tropical South America and Africa, causing illness to 200,000 people annually. The mosquito vector *culex tritaeniorhynous*, associated with rice-producing areas of

Many insects are major crop-destroying pests, such as these Mexican fruit flies laying eggs in grapefruit.

the world, transmits the Japanese encephalitis virus to humans, causing sickness to an estimated 43,000 occurrences. And Plague, which caused Black Death and wiped out about one-third to half of the European population in the 14th century, is caused by the bacterium *yersinia pestis*. Rat fleas carry this pestis to other rats and humans. The world is mostly free of this deadly disease now except for an occasional outbreak. Although misery delivered by insects to humans is tremendous, only 1 percent of the world's insects are considered pests.

Changing climatic conditions resulting from global warming have enabled different disease-carrying insects, including mosquitoes, to survive and multiply in colder northern latitudes and higher elevations all over the world, which increases the possibility of spreading tropical diseases to temperate regions. Global warming has affected the population of a particular migratory bird, the pied flycatcher, and subsequently its prey, the caterpillar. The flycatchers' population has plummeted to an astonishing 90 percent over the past two decades in some parts of the Netherlands. When hatchlings emerge, the parents feed them mostly with caterpillars, which are most abundant during an approximately three–week period after Dutch plants have flowered. However, due to warming average temperatures, plants in some parts of the Netherlands flower an average of 16 days earlier in the spring, knocking the prime caterpillar season off by nearly a week. This creates inadequate nourishment, leading to the death of birds and falling population.

SEE ALSO: Black Death; Disease; Pesticides.

BIBLIOGRAPHY. A.D. Imms, *Insects Natural History* (Collins Cear-Type Press, 1973); M.D. Lemonick, "Bye Bye Birdies," *Time* (May 15, 2006); V.A. Little, *General and Applied Entomology* (Harper & Row, 1963); World Health Organization, *The World Health Report 1996, Fighting Disease Fostering Development* (WHO, 1996).

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Institutions

INSTITUTIONS ARE SOCIALLY constructed relationships that form the foundations of societies. They shape contemporary environment-society interactions by framing the behavioral opportunities and expectations of individuals and organizations. Institutions explain, for example, when it is acceptable to take whales for human consumption and when it is not. They dictate how much of an ecosystem can be transformed for, say, a housing development, and still maintain its status as an ecosystem. Institutions can be formal (laws) or informal (the 50-year tradition of science, natural or economic, as an adjudicator of environmental policy decisions). They can be created by political fiat, or evolve over time through experience (such as private property rights). Thus they include the laws that are codified through the courts (common law), laws developed by administrative agencies and legislative bodies, (statutory law and regulations), or they can be comprised of organizational entities. The state is an institution. There are also private institutions, such as the International Standards Organization (ISO), which acts as a certification and oversight agency for firms who seek to have higher worker safety and environmental protection standards.

As mechanisms that mediate our daily life, institutions are highly contingent. The European Union is clearly different from the United States, and Massachusetts differs from Oklahoma. Moreover, different states may view the same institution differently. Massachusetts and Oklahoma, for example, may interpret the role and intent of the Endangered Species Act differently in their efforts to protect red-tail hawks. This contingent nature of institutions has more conceptual implications for environment-society analysis.

Institutions are important analytical entry points for environmental analysis because they can reveal the embeddedness of a society's most tacit assumptions about environment/society relationships (such as the relationship between climate change and industrialism) as well as provide a key for understanding historical change and explain differences among institutional practices.

The earliest work on institutions comes from the neoclassical economic tradition, particularly the work of Thorstein Veblen. It was his research into the "conspicuous consumption" of American elites in the 1890s that led him to come out against the neoclassical orthodoxy and suggest institutions, not individuals, could best explain economic activity—an important break from traditional social and later environmental analysis. Until Veblen, neoclassical economists had largely focused their analyses on optimal structures of exchange.

OPTIMAL STRUCTURES OF EXCHANGE

In the conventional sense, optimal structures of exchange are those market conditions that enable individuals to generate the most wealth from finite resources. In terms of the environment, wealth maximization typically comes when the environment is a factor of production, such as a primary commodity like timber, gold ore, or land that is transformed for agriculture or housing. If, through the institution of property, an individual has knowledge of possible land use, and what the responsibilities to adjacent landowners are, then a decision that maximizes the value in the land can be made. The important tacit assumption for institutional analysis is the social origins of the institution of property remains unexamined. Institutions are not understood as socially constructed. Rather, they are formulaic relationships between trans-historical economic agents that define clear, rational guidelines.

The institutionalist position, in contrast, positions institutions and people in a historical context. Institutions, then, "are patterns that evolve over time and form the necessary background for any intelligible action at all," according to T. Barnes. The cultural elements involved in the theoretical scheme, elements that are of the nature of institutions, human relations governed by use and wont, are not subject to inquiry, but are taken for granted as preexisting in a finished, typical form and as making up a normal and definite economic situation, in terms of which human intercourse is carried on.

For Veblen, institutions are those tacit "noneconomic" relationships or "settled habits of thought" that neoclassical economists take for granted in their mathematical models of supply and demand. As Rostein put it in 1977, mathematical functions squash flat difference, making nonmarket institutions appear as "fictitious or ephemeral in nature" rather than the concrete and enduring phenomena that institutionalists consider them to be. Institutions thus provide the rationale for activities that seem "radical" such as mountaintop removal in coal country in the eastern United States, or compulsive corporate buy-back legislation in Germany, and those that appear prosaic, such as the use of pesticides on the American lawn. They are the crystallization of certain habits, customs, and instincts that form the basis of our environmental relationships.

COUNTER-ORTHODOX APPROACHES

Despite the work of the institutionalists throughout the 20th century, the concepts of rationalization, equilibrium, and maximization remained dominant in economics. By the 1990s, though, resurgence in counter-orthodox approaches emerged, including a renewed interest in institutions—most recently, the revival of indeterminate analysis of the institutionalists in economics. In contrast to the early institutionalists who had theoretical and epistemological concerns, the scholarship of this coterie of resurgent institutionalists gyrates around traditional economic concepts such a property, price, and firm relations.

An understanding of neoclassical debates and approach to institutions is crucial for students of environment/society analysis. Neoclassical economics has been so dominant in Western public policy and institutions that many subsequent environmental analysts have responded to the limitations of the neoclassical philosophy and approach. Neoclassical economic thinking has been institutionalized in Western environmental policy and practice. Risk assessment, toxic substance policy, wetlands protection, and Western water allocation practices are all founded on various neoclassical institutions such as private property, maximization, and wealth generation. While social-environmental analyses exist largely outside the neoclassical approach, they do bear Veblen's mantle that institutions, whatever their form, are socially constructed and have empirically observable economic implications.

In the 1960s, the geographer Gilbert White was increasingly concerned with the use of America's publicly owned natural resources, especially for what he called the widening gap between knowledge and practice. White recognized that from economic perspectives, efficiency criteria for public investment had been advanced in recent years. Yet, White observes, "These improved methods of weighing various resource allocations nevertheless leave much to be desired in explaining present allocations and in indicating the conditions in which wiser allocations might be achieved." For White, the poor allocation decisions needed an explanation and a policy response.

In his analysis, White focused on the individual natural resource managers in public institutions. For White, then, resources were identified by their "human assessment of possible use." These assessments were codified in various laws, from the General Mining Law of 1864 to the 1960 Multiple Purpose Forest Act. But resource managers are not omniscient economic agents. This is significant in terms of an institutional analysis because, for White, resource managers have a limited knowledge (a "practical range of choice") of the options they have for making resource allocation decisions. Because managers are restricted in their knowledge, they mediate the optimal structure of exchange. Thus, regardless of the institutional goal of efficiency, in practice, the knowledge of actors involved in allocation decisions affects the final policy outcome.

SAME GOAL, DIFFERENT BASIS

Another important form of institutional analysis from an environment-society perspective is the way different institutions with ostensibly the same substantive goals can alter natural resource allocations. Analysis of water allocation regimes in the Great Plains region of the United States examined the differences between the form of common law (through the concept of "reasonable use") and the statutory law in the allocation of stressed resources. Previous work examined the substantive institutional changes, such as shifts from common law approaches to improving air quality, and statutory approaches serving the same end. In contrast, their form and function analysis revealed that these institutions have distinct ideological underpinnings, even when seeking to promote the same goal.

They also examined how reasonable use differs in terms of function. In the case of common law, the courts adjudicate claims on a case-by-case basis, thereby ensuring the rights of individuals. Statutory law, in contrast, establishes concrete rules that are administered by expert agencies. One farmer could take, for example, three acre-feet of water per year and no more. In theory, the administrative function would apply the same rule to all users. In each case, what is "reasonable" has different implications for individual rights and despite their similar interest in local community stability.

Ideology has shaped the final focus of environmental institutional analysis. A contemporary view of institutions that comes from post-structuralist and network theory posits that institutions are not just containers of historical perspectives and actions; rather, they focus on the dynamic and contingent role of actors in shaping institutional responses. In particular, this view focuses on the social construction of networks and the ability of individuals to use these networks to contingently create meanings.

This view allows for analyses beyond range of choice, to the realms of power, gender, and science. One study of the Kumbhalgarh Wildlife Sanctuary in India shows, for example, that the state does not act at the exclusion of local people; rather it "seizes and reproduces locally powerful knowledges and enforces management through alliances with locally powerful groups." In another case, examination of the institutional construction of nature in Montana's gold mining laws shows how the agency of nonstate actors, discourses of the environment, and even the agency of nature has implications for the taking of certain resources for human use.

SEE ALSO: Common Law; Critical Environmental Theory; Economics; Environmental Organizations; Land Use Policy and Planning; Policy, Environmental.

BIBLIOGRAPHY. M. Aokim, *Toward a Comparative Institutional Analysis* (MIT, 2001); T. Barnes, *The Logics of Dislocation* (Guilford, 1996); T. Eggertsson, *Economic Behavior and Institutions* (Cambridge University Press, 1990); J. Emel and Elizabeth Brooks, "Changes in Form and Function of Property Rights Institutions under Threatened Resource Scarcity," *Annals of the Association of American Geographers* (v.78/2, 1988); G. Hodgson, *The Evolution of Institutional Economics* (Routledge, 2002); R. Krueger, "Relocating Regulation in Montana's

Gold Mining Industry," *Environment and Planning* (v.34, 2002); P. Mirowski, *Against Mechanism: Protecting Economics from Science* (Rowan and Littlefield, 1998); D. North, *Institutions, Institutional Change, and Economic Performance* (Cambridge University Press, 1990); P. Robbins, "The Practical Politics of Knowing: State Environmental Knowledge and Local Political Economy," *Economic Geography* (76/2, 2000); A. Rostein, "Innis: The Alchemy of Fur and Wheat," *Journal of Canadian Studies* (v.12, 2002); T. Veblen, "The Limitations of Marginal Utility," *Journal of Political Economy* (v.17, 1909); G. White, "The Choice of Use in Resource Management," *Natural Resources Journal* (v.1, 1961).

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Instrumentalism

BROADLY SPEAKING, THE term *instrumentalism* is a view that all ideas (theories, laws, concepts, beliefs, identities, and so on) have value beyond their precision or ability to espouse truths. Instead, ideas hold value as instruments serving a larger purpose or agenda. Instrumentalism, similar to pragmatism, rejects the notion that ideas are best evaluated in terms of their ability to represent reality. This stands in contrast to scientific realism, which holds that scientific inquiry in its most accurate form produces theories and laws that exactly describe reality.

Instrumentalism holds a second broad meaning in the context of the environment. Natural resources are used instrumentally to support the foundations of economic growth and to uphold the economic ideologies that stand behind such development. Under this logic, it is the property-owning ruling class that stands to benefit most from these uses. In this sense, instrumentalism contrasts with pluralism and other forms of egalitarian approaches to distributing wealth.

In the philosophy of science, instrumentalism is the view that although theories are typically produced to explain some aspect of the world and are legitimated by their accuracy, ideas also hold value in their ability to explain and rationalize other phenomenon. An example is the discovery of the persistent, cyclical relationship among ultraviolet light, chlorofluorocarbons (CFCs), and stratospheric ozone (O_3). While this finding revealed a series of important chemical reactions, its meaning held wider value in discussions by scientists on the behavior of CFCs in the stratosphere. The findings were instrumentalized to support a larger set of scientific theories concerning the persistent contribution of CFCs to ozone depletion—despite substantial skepticism over the accuracy of long-term CFC observations.

In a more political sense, instrumentalism considers theories valuable in their ability to reach the political ends they were meant to serve. Consider two opposing plans for the Arctic National Wildlife Refuge (ANWR). The preservationist will espouse theories of ecological fragility and costly impediments to development in order to prevent drilling for oil. The development agency will appeal to public sentiment citing theories of low impact drilling and U.S. oil independence. In this case, both groups articulate theories to the public about ANWR that may or may not be entirely true. Under an instrumentalism view, the validity of these claims is less important than their ability to advance the larger ideological agenda they are reaffirming. Both the preservationist and development interest groups use their theories as instruments for advancing a particular agenda and discrediting the agenda of their adversaries.

While theories about the environment are used as instruments to uphold political agendas, nature in its material sense is controlled, manipulated, and used as an instrument of economic growth. Diverting, damming, and channeling water; mining for minerals and metals; grading and displacing soil; and logging forests are all examples of converting nature into an economically productive form.

One of the most common applications of instrumentalism as a lens for viewing society–environment interactions is in the context of rapidly urbanizing areas. Cities face pressure to meet the service-oriented and infrastructural demands of fast-paced regional, national, and increasingly global economies. Over the course of their history, major metropolitan areas are literally carved out of and built into the surrounding environment in order to keep up with these demands. The exploitation of nature, as a "natural resource," is instrumental to meeting the demands of scalar economic growth and the ideologies driving such economic policies. Often this leads state and private interests to secure property rights over valuable resources such as water and lumber. Under elite control, environmental resources become instruments for securing and consolidating material wealth among the capitalist ruling class.

SEE ALSO: Arctic National Wildlife Refuge; Chlorofluorocarbons; Economics; Ideology; Ozone and Ozone Depletion; Political Ecology; Political Economy; Urbanization.

BIBLIOGRAPHY. Jody Emel, "Resource Instrumentalism, Privatization, and Commodification," *Urban Geography* (v.11/6, 1990); David Harvey, *Justice, Nature and the Geography of Difference* (Blackwell, 1996); W.H. Newton-Smith, *A Companion to the Philosophy of Science* (Blackwell, 2001); Andrew Sayer, *Method in Social Science: A Realist Approach* (Routledge, 1992).

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Integrated Pest Management (IPM)

INTEGRATED PEST MANAGEMENT (IPM) is a collection of techniques used to control pests in agricultural production while protecting against long-term damage to the environment, human health, and property. In contrast to conventional pest control, which has relied heavily on chemical pesticides and short-term economic return, IPM involves the use of a combination of nonpesticide methods for the reduction and control of pests.

IPM relies upon both preventative methods for avoiding pest problems along with biological, mechanical, and cultural controls for addressing pests. It is a system in which pest problems are controlled and reduced to acceptable levels, but not necessarily eliminated. Acceptable levels of crop loss are established in advance, and then a program is implemented to manage pests accordingly.

No unified program exists in IPM; the combination of approaches used in different cases depends upon the specific conditions in a particular growing area. Thus, careful monitoring and ongoing study is needed in order to implement the ideal combination of techniques in a given area facing a particular pest problem. Growers must carefully monitor their crops and maintain accurate records. Intimate knowledge about pest life cycles, reproductive habits, feeding preferences, and predators is then used to limit pest problems.

The first element of any IPM program is preventative: to grow crops species or varieties that are suited to the particular environment and that are resistant to pests common in the area. Maintaining healthy crops through proper irrigation, fertilization, and pruning also serves to guard against pest vulnerability. When pest issues do arise, mechanical, biological, and cultural approaches are the preferred means to address them. Mechanical pest control methods can involve simple manual removal of pests by hand or with the use of mechanical devices such as vacuums. Pest traps can also be used as part of an IPM system as can the construction of physical-barrier designs.

Biological controls can include the introduction of predators that feed on pests in order to reduce the pest population. The release of sterile pests can also be used to disrupt reproduction and lower pest populations. Cultural controls are also used to disrupt pest reproduction in IPM systems. Crop rotation can reduce pests by interrupting pest life cycles as host plants are replaced with alternatives that do not support the pest species. Tilling can also be used to undermine pest reproduction.

IPM systems can also involve the use of chemical pesticides, but this is undertaken according to pre-established guidelines that specify when pesticide use is necessary, and are viewed as a strategy of a last resort. Even when synthetic materials are used, however, efforts are made to limit their health and environmental consequences. Pesticides that are the least toxic alternatives, as well as those that most narrowly target the pest species without harming other plant or animal life, are used. The application of pesticides is also minimized in terms of frequency and area. Although the other elements of IPM systems are commonly used in organic farming, pesticides are not used in organic agriculture.

Because of its environmental, health, and economic benefits, the U.S. government has encouraged IPM research and implementation for over 30 years.

Yet, while many growers claim to be using some variant of IPM, some research suggests that the full implementation of IPM programs is very rare and that most growers in the United States are still overly reliant on synthetic pesticides. The same is true in other parts of the world, such as in Africa, although elsewhere, IPM is widely practiced. IPM has been adopted by many small rice growers in Asia.

SEE ALSO: Farming Systems; Insects; Organic Agriculture; Pesticides; Pests, Agricultural; Predator/Prey Relations; Shifting Cultivation.

BIBLIOGRAPHY. Lester E. Ehler, "Integrated Pest Management: A National Goal? *Issues in Science & Technology* (v.22/1, 2005); Robert M. Faust, "Integrated Pest Management Programs Strive to Solve Agricultural Problems," *Agricultural Research* (v.52/11, 2004); National Science Foundation Center for Integrated Pest Management homepage, www.cipm.ncsu.edu (cited April 2006); Alastair Orr, "Integrated Pest Management for Resource-Poor African Farmers: Is the Emperor Naked?" *World Development* (v.31/5, 2003); University of California–Riverside, Agriculture and Natural Resources: Statewide Integrated Pest Management Program, "What Is Integrated Pest Management?" www.ipm.ucdavis.edu/ (cited April 2006).

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Interdependence

INTERDEPENDENCE IS THE doctrine of mutual dependence among all of the actors within a situation for the survival and success of that situation. It is most commonly used to mean that the people of the world and the institutions they have created both depend on and are depended upon by the earth's environment. Consequently, it is necessary for any decision related to economics also to integrate the environmental impact into the decision-making process, while decisions relating to the environment cannot ignore the economic aspects. In practical terms, it is necessary to cultivate a holistic mindset that can integrate all aspects of society and all aspects of the surrounding environment in order to determine optimal forms of behavior.

This form of thinking can be applied to a wide range of disciplines, including international relations, poverty alleviation, globalization, and democratization. While empirical research can be difficult to manage according to this paradigm, some studies suggest that the intuitive concept of interdependence does have some valency in complex situations. Interdependence is abundantly relevant to natural environmental situations in which negative impacts on one species of flora or fauna can have significant and often unanticipated results for many other species occupying the same or related system.

Religious, philosophical, and social thinkers have talked about the importance of interdependence for centuries, but often from metaphysical perspectives that are not widely considered to be relevant to the modern world. At the same time, the importance of animals and the natural world was often downplayed or else assigned to the control of humanity as a chattel. James Lovelock's concept of the earth as the Gaia system represented a breakthrough in popular thinking in terms of interdependence. The growth of low-cost international travel and the prevalence of the Internet have helped people to understand cultures and societies from around the world and begin to appreciate how actions in one place resonate in others.

Attempts to create international organizations, which could represent the viewpoints of the people of the different countries of the world, have proved to be of only limited success. The United Nations has helped to create agencies that have raised standards of living for many people around the world in different ways, as for example with the case of the International Labor Organization and the Food and Agriculture Organization. However, the World Trade Organization has been bedeviled with arguments and the unwillingness of some members to accede to multilaterally reached decisions. In the 21st century, the willingness of the executive of the United States to act unilaterally has significantly damaged the ability of international organizations to deal with interdependence in the world system, with often-disastrous results.

SEE ALSO: Gaia Hypothesis; United Nations; World Systems Theory; World Trade Organization.

BIBLIOGRAPHY. Robert O. Keohane and Joseph S. Nye, *Power and Interdependence*, (Pearson Education, 2000); James E. Lovelock, *Gaia: A New Look at Life on Earth* (Oxford University Press, 1982); Jim MacNeill, Pieter Winsemius, and Taizo Yakushiji, *Beyond Interdependence: The Meshing of the World's Economy and the Earth's Economy* (Oxford University Press, 1991); John R. O'Neal and Bruce M. Russet, "The Classical Liberals Were Right: Democracy, Interdependence, and Conflict, 1950–85," *International Studies Quarterly*, (v.41/2, 1997).

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Intergenerational Equity (IE)

INTERGENERATIONAL EQUITY (IE) broadly refers to theories, principles, laws, and economic models concerned with the issue of equity and fairness to future generations. IE emphasizes that future generations have a right to at least the same general level of ecological, cultural, and economic resources enjoyed by preceding generations. Many argue that IE is the central idea behind demands for sustainable development: ensuring a clean environment with adequate resources so that future generations have the capacity to lead meaningful lives. Thus, IE is relevant to issues such as the conservation of biodiversity and cultural diversity, the maintenance of ecological health, and equal access rights to the product of past generations.

Researchers have pointed out that most previous generations were considerably poorer and had lower living standards, yet left considerable infrastructure and probably saved more in relative terms. However, over the past century there have been significant increases in population growth and affluent consumption, along with the development of resource-intensive and potentially destructive technologies. The combined effect has been a fantastic rise in human resource consumption and waste generation (as well as a decrease in saving), raising concern about the implications of continued growth for ecosystem health. This concern, and subsequent ecological research, led to debates over the "limits to growth" of modern economies. These debates called into question the assumption of infinite economic growth, and forced recognition of resource limits and the irreversible modification of ecosystems essential to human welfare. One of the many concepts that emerged out of the debates was IE.

Following the publication of *Our Common Future*, many environmentalists seized upon the concept of IE, arguing that it is fundamental to building a sustainable society. A popular quote argues for "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Integrating IE into policy discussions increases the time horizon when considering social and ecological impacts and can therefore profoundly influence the path of technological development and social organization.

Regarding energy production, for instance, governments would shift decisively away from excessive use of nonrenewable resources, such as coal, oil, and nuclear, and focus instead on expanding the potential for solar, wind, tidal, and other renewable energy sources. In this case, IE necessitates reducing nonrenewable energy sources because of potential adverse future effects, such as irreversible changes to the global climate and the harsh reality of millions of years of radioactive waste storage. For environmentalists, as well as ecological economists, IE is an ethical issue informed by scientific consensus.

Proponents of IE have strongly criticized the conventional economic practice of "discounting" because it is seen as a major obstacle to incorporating sustainability principles into economic decisions. For economists, discounting provides an objective, though clearly contentious, approach to the problem of valuing future resource flows. Under certain key assumptions, such as the substitutability of money for any resource, a short-term time horizon, net present value (NPV), and steady, continued growth in the economy, a case can be made for individual discounting. One practical argument for discounting is that people do it "naturally" as a result of time preference. For example, there is typically little concern about events that will happen long after a person dies and access to certain goods now, even with interest, are worth less in the future.

Difficulties arise when individual, short-term discounting is distinguished from *social discounting*, defined by Herman E. Daly and Joshua C. Farley as "a rate of conversion of future value to present value that reflects society's collective judgment, as opposed to an individualistic judgment, such as the market rate of interest." While most economists agree with the latter distinction and have attempted to construct alternative models, recent ecological work (e.g., ecological footprints) implies that critical assumptions of the "objective" social discounting approach must be jettisoned completely. This comes with recognition of finite growth, limited substitutability via technology, decreasing opportunities for productive investment, and "profitable" investments today resulting in future ecological costs.

Some have expressed concern over the efficacy of IE in the context of alarming poverty growth, or intragenerational inequity. Recent developments around the issue of global climate change bring this criticism into sharp relief. On December 7, 2005, Inuits submitted a nonlegally binding petition to the Inter-American Commission on Human Rights urging that the United States—as the largest emitter of greenhouse gasses—cooperate on the Kyoto protocol. This came after a four-year, 15-country study undertaken by 300 scientists warned that the Artic is especially vulnerable to warming and mammalian extinctions, threatening not only the integrity of ecosystems but the very existence of Inuit in the Arctic. The debate raises critical questions about the role of IE in international law and global governance.

Since at least 1988, proponents have argued for the integration of IE into international law, highlighting the temporal aspects of the Universal Declaration of Human Rights. While a limited "intertemporal" doctrine (connecting past to present) already exists, IE proponents are seeking to strengthen and broaden this doctrine to include the relation between present and future generations. Given the fact that people in poverty, by definition, have less access to sustainable resources and are disproportionately impacted by ecological imbalances, these efforts recognize the critical importance of an intragenerational dimension in crafting new law. That there has been little progress applying IE in international law, especially regarding issues like global climate change, is unsurprising considering that powerful nations consume most of the world's resources.

SEE ALSO: Biodiversity; Brundtland Report; Club of Rome; Discount Rate; Ecological Footprint; Ethics; Externalities; Sustainable Development.

BIBLIOGRAPHY. Sudhir Anand and Amartya Sen, "Human Development and Economic Sustainability," *World Development* (v.28/12, 2000); Ginanne Brownwell, "We Won't Sink with Our Ice," February 3, 2005, www.msnbc.msn (cited June 2006); Daniel D. Chiras, *Environmental Science: Creating a Sustainable Future* (Jones and Bartlett, 2004); Herman E. Daly and Joshua C. Farley, *Ecological Economics: Principles and Applications* (Island Press, 2004); John Pezzey and Michael A. Toman, eds., *The Economics of Sustainability* (Ashgate-Dartmouth, 2002); Catherine Redgwell, *Intergenerational Trusts and Environmental Protection* (Juris, 1999); Prue Taylor, *An Ecological Approach to International Law: Responding to Challenges of Climate Change* (Routledge, 1998); Edith Brown Weiss, *In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity* (United Nations University, 1988); World Commission on Environment and Development, *Our Common Future* (Oxford University Press, 1987).

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Intergovernmental Panel on Climate Change (IPCC)

THE INTERGOVERNMENTAL PANEL on Climate Change (IPCC) was established in 1988 by the World Meteorological Organisation (WMO) and the United Nations (UN) Environment Program (UNEP) to assess the growing body of scientific evidence related to human-induced climate change. The mandate of the IPCC is to assess all the scientific, technical, and socioeconomic evidence of climate change, establish what its likely impacts would be, and what options are available to the world on how to mitigate emissions and adapt to any changes.

Membership of the IPCC is open to any member country of the WMO or the UNEP. The structure of the panel consists of a plenary, bureau, and three working groups. The plenary meets yearly and has the power to make major decisions affecting the workings of the IPCC. The bureau membership consists of 30 experts in the field of climate science. The three working groups represent the IPCC's core objectives. Members of Working Group 1 review all the scientific data, members of Working Group 2 assess all of the information related to climate change impacts and how to adapt to it, and members of Working Group 3 focus solely on mitigation.

In 1991, the IPCC formed a task force to establish National Greenhouse Gas Inventories. The aim of the task force was to develop a globally-consistent methodology for all nations that will measure and report on emission levels of climate changing gasses and how effective mitigation strategies are.

The IPCC does not produce any of its own science. It reviews and synthesizes the peer-reviewed data that is produced by the world's scientific community. Since its formation in 1988, the IPCC has reported three times on its assessment of risks associated with human-induced climate change. The first set of assessment reports were published in 1990 and formed the basis of the UN Framework Convention on Climate Change. These reports found that human activities were greatly increasing the amount of greenhouse gases in the atmosphere and that they were responsible for causing (and would continue to), a warming of the Earth's surface. Importantly for policy makers, the reports established that global emissions of long-lived greenhouse gases, particularly carbon dioxide, would have to be reduced by 60 percent to stabilize at 1990 levels.

The second set of assessment reports were published in 1996 and formed the foundation for negotiations of the Kyoto Protocol. The third report was published in 2001 and found that the evidence of warming was much stronger, confidence to predict future scenarios of climate change had increased and that global average temperatures were expected to increase by 1.4 degrees C to 5.8 degrees C by the year 2100. The IPCC is expected to release its next assessment on the state of knowledge on human-induced climate change in the first quarter of 2007.

SEE ALSO: Global Warming; United Nations Framework Convention on Climate Change

BIBLIOGRAPHY. W. Easterling and M. Apps, "Assessing the Consequences of Climate Change for Food and Forest Resources: A View from the IPCC," *Climate Change* (v.70, 2005); J.T. Houghton, G.J. Jenkins, and J. Ephraums, eds., *Scientific Assessment of Climate Change—Report of Working Group 1* (Cambridge University press, 1991); IPCC, *First Assessment Overview and Policymaker Summaries and 1992 IPCC Supplement* (IPCC, 1992); IPCC, *IPCC Second Assessment—Climate Change 1995* (IPCC, 1995); IPCC, *Climate Change: The IPCC 1990 and 1992 Assessments* (IPCC, 1992); J. Mog et al., *Impact Assessment of Climate Change—Report of Working Group 2* (Australian Government Publishing Service, 1991); R. Watson and the Core Writing Team, eds., *Climate Change 2001: Synthesis Report, Summary for Policymakers* (IPCC, 2001); R. Watson et al., *The Regional Impacts of Climate Change: An Assessment of Vulnerability, a Special Report of the IPCC Working Group 2* (Cambridge University Press, 1998).

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Intermediate Disturbance Hypothesis

THE INTERMEDIATE DISTURBANCE hypothesis (IDH) predicts that the highest levels of biotic diversity are to be found at intermediate levels of disturbance and at intermediate time spans following the disturbance. Other influential ideas about species diversity include island biogeography theory, the time hypothesis, niche partitioning/diversification, and productivity–stability hypothesis.

Disturbances to ecological systems can emanate from diverse sources that may be natural or anthropogenic, including fire, wind, grazing and predation, human management regimes, land cover change, chemical, and thermal contamination, tides, floods, tectonic activity and other forces. According to IDH, relatively low numbers of species may be expected to prevail in ecological systems that are undisturbed or usually subject to very low levels of disturbance, as well as in ecosystems that suffer highly frequent or intense disturbances. Ecosystems characterized by intermediate levels of disturbance, by comparison, are predicted by the IDH to exhibit the highest species richness and diversity (species richness and abundance). A graphical representation of the diversity–disturbance relationship, according to the IDH, would approximate an inverted U-shape when diversity is mapped along the Y/vertical axis, and disturbance intensity/frequency along the X/horizontal axis.

NONEQUILIBRIUM THEORY

The theories explaining the IDH and its inverted U-shaped relationship between disturbance and diversity are linked to concepts derived from community ecology and ecological succession, and the IDH may be seen as one among several nonequilibrium theories of biodiversity. In the IDH view, the prevalence of disturbance in ecological communities prevents them from reaching equilibrium states. Disturbance in a system results in the creation of gaps and spatial heterogeneity, and opens up spaces for various species to colonize. The gaps and the ecological community then begin a trajectory along a new successional sequence, or revert to a sequence similar to the pre-disturbance succession.

At very high levels of disturbance, the ecological community and its gaps do not progress beyond the pioneer stage of the successional sequence. The species composition is dominated by a few early successional, pioneer species often referred to as "r-strategists" for their life history strategies geared toward high population reproductive rates (r) rather than adaptations geared toward competitive advantage. Such dominance leads to low species diversity.

At very low levels of disturbance, on the other hand, successional pathways are quickly followed to the final climax/equilibrium stage. This leads to the dominance of later successional species, often referred to as "K-strategists" for their prevalence at or near the population carrying capacity (K). Such species are adapted to compete successfully for limited resources, and thus exclude other species, leading also to low species diversity overall in the ecological community.

At intermediate levels of disturbance, neither pioneer nor late successional species manage to dominate, and the species mix reflects a higher diversity than expected under lower or higher levels of disturbance.

An early formulation of the IDH was presented by J.H. Connell (1978), who studied species diversity patterns within local areas rather than across large-scale geographic gradients such as temperate to tropical ecosystems. Specifically, Connell focused on tropical forests and coral reef ecosystems, hypothesizing that such systems were characterized by disturbances that maintained them in nonequilibrium states, which helped maintain and explain their high levels of biotic diversity. He also sounded a cautionary note about human disturbance, stating in his article that although the IDH proposed diversity benefits of disturbance regimes, many anthropogenic disturbances—such as mass-scale tropical deforestation or chemical pollution—were in fact qualitatively different from many natural disturbance regimes to which organisms had the opportunity to adapt over long periods of time. Therefore, he warned, such human-caused disturbances had the capability to cause species extinctions, particularly in highly diverse tropical ecosystems with low species populations.

Since Connell's article, several studies from marine and freshwater ecology as well as terrestrial ecology have produced evidence corroborating IDH, while others have presented empirical data and/or simulation models contradicting the hypothesis. For instance, disturbance in the form of selective logging often leads to a loss, rather than an increase in the number of understory deciduous plant species. Another important factor is the effect of changing spatial scale. In certain tallgrass prairie ecosystems, for instance, intermediate levels of disturbance (annually burned versus unburned or burned once every few years) are linked to lower within-site diversity of vegetation; but the relationship reverses when larger spatial areas are considered.

Other experiments in tallgrass prairies have garnered support for the lesser-explored component of IDH, temporal scale (time elapsed since disturbance), while contradicting the disturbance-diversity predictions of IDH. Scale dependence is also seen in coral reef systems. Additionally, coral diversity may often be high in deeper zones or under greater coral cover despite the fact that deeper reefs and greater cover are usually subject to or reflect lower disturbance.

In most cases, a complex of several factors may interact and collectively influence diversity patterns: disturbance, soil fertility and/or nutrient versus limitation, resource partitioning, native vs. invasive/exotic species assemblages (and their evolutionary/life history characteristics), climate change and seasonality.

SEE ALSO: Disequilibrium; Disturbances; Species.

BIBLIOGRAPHY. J.H. Connell, "Diversity in Tropical Rainforests and Coral Reefs," *Science* (v.199, 1978); E.R. Pianka, "On r and K Selection," *American Naturalist* (v.104, 1970); R.E. Ricklefs and G.L. Miller, *Ecology,* 4th ed. (W.H. Freeman and Company, 2000).

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Internal Combustion Engine

INTERNAL COMBUSTION ENGINES are the family of engines that confine fuel in a chamber, then burn it to convert the expansion of the resulting high temperature gases into work energy through pistons, rotors, turbines or other means. Although the range of fuels for an internal combustion engine (or ICE) is limited only by the need to produce combustion gases, petroleum derivatives are the preferred energy source due to their availability, high energy return, and portability.

Although there are many varieties of ICE, the most common is the Otto Cycle, or four-stroke, engine used in nearly all automobiles and trucks produced today. It is a reciprocating design where one piston drives others through a cam shaft, and the function is as follows: the first stroke of the piston draws in a fuel and air mixture by moving down the combustion chamber; then on the second, upward stroke the piston compresses the aerosolized fuel to the point of combustion (in the case of a diesel engine) or until the mixture is ignited by an electric spark (in a gasoline engine). In both, the expansion of the gases following combustion drives the piston downward, comprising the power stroke of the cycle. A fourth stroke returns the piston upward, and expels the contents of the chamber, preparing the chamber for the next stroke, which commences the cycle again. The two-stroke engine, common in smaller and portable mechanisms, operates using the same principles with the exception that a valve near the bottom of the chamber allows gases to escape at the bottom of the power stroke so that there is no need for a cycle to expel exhaust.

Gasoline engines first found widespread use operating farm machinery and as stationary power sources in factories. A lack of dependable fuel supplies and stations, and some engineering problems, prevented ICEs from out-competing steam and electric power in automobiles until the beginning of the 20th century. The expansion of refinery capacity and improved mechanical efficiency and reliability granted gasoline engines the edge necessary to capture the largest part of the automobile market in the first decade of the century, particularly after the in-

The most common ICE is the Otto Cycle engine used in nearly all automobiles and trucks produced today.

troduction of the Model T in 1908. The basic design of the production gasoline engine has changed very little since it was standardized by the automobile industry in the 1910s, the major structural change being the replacement of carburetors with fuel injector systems. Most changes have instead come in materials, fuel, and peripheral components, often to meet either fuel economy or emissions regulations.

The advantages of petroleum-fueled ICEs in transportation is that they provide significant power using a compact fuel source in a highly reliable format, and allow the consumer to operate within unparalleled economies of scale. However, for almost a century, automobile and oil companies have consistently been among the largest and most profitable, and in the United States they have also been the recipients of large subsidies from the federal government. The disadvantages of widespread ICE use is the unprecedented changes to society and the global climate.

SOCIETY AND ENVIRONMENT IMPACT

Socially, the introduction of the automobile coincided with a major shift in the urbanization of the American population. According to many, the automobile changed the traditional "walking city" with its busy pedestrian streets and close-knit neighborhoods into a noisy and dangerous "machine space" engineered to facilitate the efficient movement of motor traffic to the exclusion of other uses. The automobile is also blamed for the flight of residents from the city to suburbs, atomizing the old neighborhood framework and replacing it with a more insular and less community-oriented society.

On the positive side, the arrival of the ICE signaled the end of the era of animal-powered technology, lowering transportation times and costs, and requiring minimal maintenance when idle. Lower transport costs and portable power have linked ICEs directly to the dramatic decrease in real costs for many consumer goods. Affordable personal transportation is now a key component of the American dream, permitting the majority of the population to forego the high urban densities and high property costs common to the walking city for ownership of a freestanding house and yard. The Los Angeles metropolitan area in particular became an icon of car culture in the decades following World War II, and a model of urban development with land uses dedicated to freeways, drive-through conveniences, and single-family homes. Since the oil crises of the 1970s, concerns have arisen about the hidden social costs of dependence upon ICEs, including sprawl development, growing fears of disruption and exhaustion of petroleum supplies, and a reevaluation of the social impacts of automobile-driven development. Solutions include restructuring society away from dependence upon personal transportation and the current standards of dispersed, single-use zoning that encourages sprawl. The current popularity of form-based codes and New Urbanism reflect many of these concerns by encouraging community spaces that de-emphasize reliance upon automobiles.

ICEs are also central to the debate over air quality and global climate change. Long targeted as the majority of nonpoint source air pollution, most changes to ICE design have targeted reducing emissions and improving fuel efficiency. Early improvements included raising piston compression and preheating the fuel/air mixture to return more power and eliminate the products of incomplete combustion, and the addition of catalytic converters to exhaust systems to capture hydrocarbons that still escape the combustion process. However, improvements in engine compression and quality of combustion created new, unintended products that are less immediately noxious but remain dangerous including nitrous oxide (NO_2), carbon monoxide (CO), and ozone (O_3), which are particularly important causes of urban air pollution and damaging to human health. More recent improvements include computer control of the engine and fuel injection, as well as experiments with hybrid technology that uses the surplus heat energy of the Otto-cycle to generate electricity. These changes were sufficient to drastically reduce the amount of particulate and hydrocarbon emissions produced by ICEs; however, they only partially address the fundamental problem ICEs pose through global warming.

The optimal emissions of a hydrocarbon fueled ICE is a combination of water vapor and carbon dioxide, both of which identified as primary agents of climate change. Improvements to ICE efficiency only forestall the onset of global climate change, but do little to prevent it. This is true also of the alternatives to petroleum fuels, although some attempt to redirect the basis of energy into renewable sources. Because of their relative scarcity, other uses of ICEs have not attracted the same attention as their use in personal transportation, yet pose similar concerns. Commercial aircraft are especially criticized for polluting the upper levels of the atmosphere.

BIBLIOGRAPHY. S. Grayson, *Beautiful Engines: Treasures of the Internal Combustion Century* (Devereux Books, 2001); D.J. Holt, *100 Years of Engine Developments* (Warrendale, PA, Society of Automative Engineers, 2005); M.K.W. Ko et al., "Effects of Engine Emissions from High-Speed Civil Transport Aircraft: A Two-Dimensional Modeling Study" (Atmospheric and Environmental Research Inc, 1991); W. Zuckermann, *End of the road: The World Car Crisis and How We Can Solve It* (Chelsea Green Pub. Co, 1991).

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International Monetary Fund

THE INTERNATIONAL MONETARY Fund (IMF) is an international financial institution created to assist member states to resolve their short-term monetary, exchange, and balance-of-payments problems. It was founded along with the World Bank at the Bretton Woods conference of 1944 by representatives of 44 of the world's core economies, after contentious negotiations chaired by the United States.

PURPOSE AND MAKEUP

The IMF formally came into existence in 1945, when 29 countries signed on to the IMF's six-point Articles of Agreement:

(i) To promote international monetary cooperation.

(ii) To facilitate the expansion and balanced growth of international trade.

(iii) To promote exchange stability.

(iv) To assist in the establishment of a multilateral system of payments.

(v) To give confidence to members by making the general resources of the Fund temporarily available to them under adequate safeguards, thus providing them with opportunity to correct maladjustments in their balance of payments.

(vi) To shorten the duration and lessen the degree of disequilibrium in the international balances of payments of members.

The IMF mandate is thus to safeguard international financial and monetary stability by conducting surveillance, providing technical assistance, and making short-term loans to member countries. The capital for these loans was initially collected, and is periodically enhanced, through payments of quotas by member countries. In 2006, the Fund's total holdings amounted to $60 billion, including $9 billion in gold reserves. The Fund also grows by charging interest on its loans; for instance, in 1987, the IMF received a surplus of $8.6 billion from loan repayments over what it lent out.

Today the IMF is comprised of 184 member countries and employs almost 2,700 staff members, mainly economists based at IMF headquarters in Washington, D.C. The Fund is generally directed by the Board of Governors comprised of one governor from each member country (typically the minister of finance), which gathers once a year. Theoretically, board decisions are made by consensus, but the unequal distribution of voting rights gives disproportionate power to Europe and the United States, which enjoy *de facto* veto power (even small European states hold more votes than India or Brazil). By tradition, the IMF's managing director is always a European.

LENDING ACTIVITIES

These inequalities matter because the IMF is arguably the world's most powerful nonstate economic actor. The Fund's powers stem from its capacity to dispense loans and its annual evaluations of member states' economic policies. The IMF extends loans through contractual arrangements that designate policy measures that must be implemented by the member country before loan disbursement. A country that receives a poor bill of health in its annual IMF evaluation will have a difficult time raising affordable capital on finance markets. In this way, the IMF's surveillance, lending practices, and policy recommendations are tightly linked to the practices of the World Bank, regional development banks (such as the Inter-American Development Bank and the Asian Development Bank), as well as private banks. In 2006, the IMF held $71 billion in outstanding loans to 82 countries, mainly in the Global South (Turkey is presently the IMF's largest debtor). While in an absolute sense, outstanding IMF credit peaked in 2003, in a relative sense—debt measured as a percentage of global trade—the Fund's loan portfolio was greatest in the mid–1980s. With the onset of the debt crisis in 1982, the IMF came to serve as judge of the creditworthiness of most developing economies, dispersing economic policies and advancing loans to those member states that accepted its conditions. After the creation of Structural Adjustment Loans (SALs) at the Belgrade IMF/World Bank annual meeting in 1979, SALs rapidly spread throughout Latin America, Africa, and much of Asia (no core capitalist economies were subjected to structural adjustment). Most SALs were said to be needed to overcome balance-of-payments problems caused by high oil prices and rising interest rates on debt incurred in the 1970s.

SALs come with numerous conditions that became widely practiced during the 1980s as structural adjustment programs (SAPs) became the *de facto* development strategy of the Global South. These typically include: currency devaluation, intended to reduce imports and spur exports; trade liberalization (slashing tariffs and quotas); strict austerity in state spending on social services (e.g., health, education, and environmental programs); and financial liberalization, or the freeing of capital from state discipline. These measures aim at increasing the creditworthiness of the developing economy by suppressing domestic demand and productive investment while freeing up capital to repay external debt on imports and loans. SAP policy conditions tend to cause slower economic growth, a shift of domestic capital investment away from production (into trade and finance), and an increase in socioeconomic inequality.

Rather than leading to a resolution of the import-financing problems that gave rise to SAPs, by the mid-1990s most economies in the Global South were saddled with more debt than before the era of structural adjustment. Many environmentalists have criticized the IMF for the negative effects of SAPs on the environment. The emphasis on increasing exports and repaying loans, coupled with the reduced capacity of the state to discipline capital, often causes unsustainable resource extraction (e.g., deforestation to increase timber exports).

PROPOSED IMF REFORMS

A transnational social movement emerged in the 1990s calling for the fundamental reform, if not the elimination, of the IMF. Reform proposals have ranged widely, but tend to focus on reducing the purview of the IMF and placing it under popular, democratic control. The IMF's status suffered a serious blow from the East Asian and Argentine economic crises of the late 1990s—crises that the IMF antagonized rather than prevented. In the early years of the 2000s, the IMF faced greater scrutiny from all sides, a shift away from economic liberalization across South America, and reduced borrowing by member states (the loan portfolio contracted as states grew wary of relying on the IMF's funds and advice). Thus the influence of the IMF has declined. The IMF has even ceased practicing structural adjustment in name, and schemes for debt rescheduling have been discussed. But the Fund is unlikely to disappear soon. Like the World Bank and the World Trade Organization, it remains one of the few institutions that can be said to regulate capitalism on a global scale.

SEE ALSO: Globalization; World Bank; World Trade Organization.

BIBLIOGRAPHY. Yilmaz Akyüz, *Reforming the IMF: Back to the Drawing Board*. Third World Network Global Economy Series No. 7 (Third World Network, 2006); Dharam Ghai, ed., *The IMF and the South: The Social Impact of Crisis and Adjustment* (Zed Books, 1991); Bahram Ghazi, *The IMF, the World Bank Group, and the Question of Human Rights* (Transnational, 2005); IMF, "What Is the International Monetary Fund?" www.imf.org (cited June 2006); Richard Peet, *Unholy Trinity: The IMF, World Bank and WTO* (Zed Books, 2003); Joseph Stiglitz, *Globalization and Its Discontents* (W.W. Norton, 2002).

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International Tropical Timber Agreement (ITTA)

THE BEGINNINGS OF the ITTA date to 1966, when the United Nations Conference on Trade and Development (UNCTAD) and Food and Agriculture Organization (FAO) proposed the establishment of a tropical timber bureau. By 1973, the emphasis had broadened from market requirements and the availability of tropical timbers to include forest management considerations. Intergovernmental meetings under UNCTAD failed to reach agreement in 1978. A second round of negotiations in Geneva involving 50 countries in 1982 was successful. Here, against the backdrop of two seasons of dramatic fluctuations in supply of tropical timbers on European markets, Japan urged the creation of a commodity agreement to regulate global trade in tropical timber products.

Finally signed in 1983, the ITTA combined commodity trade and nontimber products as well as noncommercial concerns in a single agreement. It was intended to simultaneously serve as an agent of forest conservation by assisting in the creation of a viable forest industry and forest sector, thus restricting the major cause of tropical deforestation—clearance of land for agriculture. The ITTA was serviced by the International Tropical Timber Organization (ITTO), based in Yokohama, Japan.

A new ITTA signed in 1994 came into force in 1997. Membership was extended to include most of the tropical timber producing and importing countries, including Brazil. Now the ITTO broadened its approach to sustainable forestry management to include social forestry and biodiversity considerations. A detailed study was also made of Sarawak. A third ITTA involving 180 countries was signed in January 2006 to be effective for 2008–17.

Environmental groups initially were critical of the ITTA and the ITTO, pointing to insecure funding and slow progress. They also recognized that significant producers and consumers were not members of the ITTA, which detracted from its effectiveness. To some extent this situation no longer applies. Environmentalists regarded the ITTO as Asian dominated even though much of the funding came from grants from the governments of Switzerland, the United States, and Japan. Furthermore, they suggested that many tropical timber-producing countries were not vigorously pressing for sustainable use of tropical forests. Having participated in earlier ITTO council meetings, the World Wildlife Fund withdrew from the 1994 session. Although the ITTO has been quite active in promoting sustainable forest management and developed a number of manuals and protocols, it cannot compel member countries to adopt these at a national level. Even so, the ITTA, by its enduring existence and global reach, may be poised to exert greater influence on the sustainable management of tropical forests, particularly in terms of assisting states to confront illegal harvesting and improve governance.

SEE ALSO: Biodiversity; Deforestation; Forest Management; Forests; Rain Forests; Timber Industry.

BIBLIOGRAPHY. Marcus Colchester, "The International Tropical Timber Organisation: Kill or Cure for the Rain Forests? *Ecologist* (v.20/5, 1991); International Tropical Timber Organization, www.itto.or.jp (cited June 2006); Duncan Poore, *Changing Landscapes: The Development of the International Tropical Timber Organization and Its Influence on Tropical Forest Management* (Earthscan, 2003).

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Inter-Tropical Convergence Zone (ITCZ)

THE INTERTROPICAL CONVERGENCE zone is a trough of low pressure in the tropics that circles the globe in an east-west direction. Its location shifts roughly between 23.5 degrees north and south latitude and tends to follow the subsolar point over the course of the year. The low pressure results from the intense heating of the vertical rays of the sun, which causes the warm air to ascend and causes the northeast and southeast trade winds to converge on the zone of lifting. The warm air is extremely humid, and as it rises along the convergence zone, the air cools and the moisture condenses, forming precipitation. The ITCZ represents the primary engine of the global circulation of the atmosphere, since it is the only global pressure system arising from direct solar heating. Additionally, the ITCZ represents the cyclonic portion of the Hadley Cell circulation system.

The latitudinal displacement of the ITCZ over the course of the year varies according to the variable character of the Earth's surface. Land tends to increase in temperature more rapidly than oceans, so for any given latitude, temperatures tend to be greater over land than the oceans. As a result, the ITCZ tends to shift further toward higher latitudes over land than over oceans. Additionally, warm ocean currents tend to flow poleward along the east coasts of continents and cold ocean currents flow equatorward along west coasts of continents, such that, for any given latitude, temperatures off the east coasts of continents tend to be warmer than the west. The ITCZ thus tends to deflect further toward the higher latitudes along the east coasts.

The shift of ITCZ over the course of the year brings seasonal precipitation. Equatorial regions receive rainfall year-round (152–254 centimeters annually) under the influence of the ITCZ, and is a defining characteristic of the tropics. At the latitudinal extreme of the tropics, the seasonal retreat of the ITCZ corresponds to the advancing influence of the subtropical high pressure system with its characteristic dry, subsiding air. The climates in these regions are characterized by a marked dry season of varying length. The Tropical Monsoon climates of South and East Asia are characterized by heavy rains brought by the ITCZ during the summer months (254–508 centimeters annually) and a short, marked dry season of up to three months. Tropical Savanna climates have a less pronounced wet season (90–180 centimeters) and a dry season of up to six months.

The inundating rains of the ITCZ are important to the developing countries of the tropics, many of which rely on agriculture as a mainstay of the subsistence and market economies. In South and Southeast Asia, the rains from the ITCZ support wet-rice production in irrigated paddies. Additionally, severe seasonal flooding often accompanies the rains. During the summer of 2005, monsoon rains in India killed over 100 people, disrupted transportation networks, and left over 150,000 people stranded. The rains of the ITCZ are important to the livelihoods of the societies that receive them, but the rains constitute a hazard as well.

SEE ALSO: Climate, Tropical; Hadley Cell; Monsoon.

BIBLIOGRAPHY: Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); H. J. de Blij and Peter O. Muller, *Geography: Realms, Regions and Concepts* (John Wiley & Sons, 2000); Tom L. McKnight and Darrel Hess, *Physical Geography* (Pearson Prentice Hall, 2005); National Aeronautics and Space Administration Earth Observatory, "Monsoon Flooding in India," www.earthobservatory.nasa.gov (cited July 2005).

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Invasive Species

DEFINING BIOLOGICAL INVASIONS is challenging due in part to the proliferation of terms, especially among biological disciplines, that usually describe a set of ranging and different concepts. Depending on the author, a species in the invasion might be referred to as: *alien, exotic, invasive, non-indigenous, imported, weedy, introduced, nonnative versus naturalized, endemic* or *indigenous*. Some of the terms employed evoke anthropocentric concepts such as *aggression, assault,* and *attack,* which have normative implications. These implications and the lack of consistent uses of terms contribute to confusion.

Invasive species in general are defined as species that occupy or are in the process of occurring in regions where they have not been present historically. Specifically, invasive species are defined by their origin and distribution. An invasive species might spread into native plant communities and cause environmental harm by developing self-sustaining populations and disrupting the structure and functioning of the system. What characterizes invasive organisms is the ability to take hold of a habitat and become aggressive and dominant. It could be that either invasive species have extraordinarily wide distributions around the world, or that they are distributed locally with very high population densities affecting the endemic biota of specific regions. Invasive species are usually alien species, meaning they are able to reproduce outside their native ecosystems, and whose introduction is more likely to cause environmental harm.

Plants and insects are the most common orders in terms of their invisibility. From a population biology point of view, invasive plants tend to produce reproductive offspring, often in very large numbers (e.g., seeds, spores) and disperse them at considerable distances from parent plants. Invasive species also spread successfully through the use of roots or rhizomes (for example, more than 2 meters/year for taxa spreading), and such strategies enable them to spread over a considerable area. This definition also concerns species that have spread previously but not currently because of competition. These species are still considered invasive species because once local competition disappear, it may lead to re-invasion.

DIFFERENT APPROACHES

Research questions on invasive species range with discipline with extremes in population biology and ecology to economics. Ecological approaches center on how the biological aspects of invasive species related to the biophysical environment. Due to the complexities of such relation, the human linkages are less explicit and only mediated through disturbance processes. Concepts such as competition, disturbance, homogenization of habitats and species capacity are at the core of ecological research. Among social scientists, economists have attempted to understand the linkages between human activities and the spread of invasive species. Economic theory tends to be helpful in diagnosing human sources of invasion problems, to provide information on the risks associated with invasions, and to evaluate the damaging effects of invasions on public goods like biodiversity or common-property lands. Economic analyses are useful to prescribe when, where, and how to control invasions; at estimating the expected benefits of various control programs; and in minimizing the costs of controlling invasions that have already taken place. The links between invasion and effects on ecosystem services is usually descriptive and not normative, and its links with economic activities are through monetary value. Such utilitarian perspective is problematic, especially from a conservation perspective; improvements, however, could be made if nonmarket valuations of the ecological and social processes are included in such analyses.

A cultural and political ecological approach to invasive species considers human aspects to be central to the understanding of the patterns and process of biological invasions. Humans alter habitat conditions where exotic species can succeed, and the mobility that allows larger and faster movement of species across the world. The process of invasion is not only an ecological process, but a social process that needs to consider not only the current cost–benefit analysis or tradeoffs in economic terms, but also recount of the humanized natural history. Under this perspective, invasive species benefit as well as harm societies. Nonnative species are so much part of human livelihoods and traditions that is difficult to picture such societies never experiencing them.

For example, foods like potatoes and tomatoes in Europe are not native to these environments, but from South America; however, they are very much an integral part of certain European cultures. On the other hand, invasive species could create dire political and economic consequences. Classic Ecological Imperialism shows how disease and other species brought from Europe to America factored in destroying native populations and transforming the landscape in dramatic ways. Understanding the biological character of invasions is critical to understanding the political ecology of such process, which involves an understanding of the cultural complexities and the potential uneven impacts of invasion in society.

SEE ALSO: Cane Toads; Insects; Zebra Mussels.

BIBLIOGRAPHY. A.W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (Cambridge University Press, 1986); C.M. D'Antonio and S. Kark, "Impacts and Extent of Biotic Invasions in Terrestrial Ecosystems," *TRENDS in Ecology and Evolution* (v.17, 2002); C.S. Elton, "The Ecology and Invasions by Animals and Plants (Methuen, 1958); D. Pimentel, L. Lach, R. Zuniga, and D. Morrison, "Environmental and Economic Costs Associated with Non-Indigenous Species in the United States," in *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal and Microbe Species* (CRC Press, 2002); D.M. Richardson, P. Psysek, M. Rejmanek, M.G. Barbour, F.D. Panetta, and C.J. West, "Naturalization and Invasions of Alien Plants: Concepts and Definitions," *Diverstity and Distributions* (v.6, 2000); P. Robbins, "Culture and Politics of Invasive Species," *The Geographical Review* (v.94, 2004); L.C. Schneider, "Bracken Fern (Pteridium aquilinum (L.) Kuhn) Invasion in Southern Yucatán Peninsular Region: A Case for Land-Change Science," *The Geographical Review* (v.94, 2004).

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Inversion, Temperature

GENERALLY, THE HIGHER in the atmosphere air is, the cooler it is. However, there are some circumstances in which the opposite process occurs and a band of warmer air overlays cooler air. This is known as temperature inversion. A permanent temperature inversion occurs at the edge of the troposphere, with warmer air above it in the stratosphere after the barrier of a temperature inversion known as the troposphere. However, several other methods of creating a temperature inversion exist, which are temporary phenomena. One result of temperature inversion is that particles in the air are unable to rise up into the sky and instead form a layer following the contours of the inversion. When a temperature inversion occurs above an industrial area, therefore, it can trap atmospheric emissions and create smoke and gloomy weather, which can have negative health outcomes.

Ways in which temperature inversions can form include the differential degree of conduction between ground and air. If the ground cools rapidly, its greater level of conduction means the air closer to it is cooler than that some way above. This is known as ground inversion. Turbulence inversion occurs when a layer of turbulent air becomes cooled by interacting with upper layers of cooler air and therefore loses average levels of height compared with a higher level of calm air. A frontal inversion occurs when two bodies of air of different temperature meet at approximately the same height. Since the warmer air is lighter, it is forced up by the cooler air, which sinks beneath it. Finally, a subsidence inversion occurs when a body of air of the same temperature sinks. The top level of the body passes through a greater range of pressure change and so becomes warmer than the lower levels. All forms of temperature inversion are associated with the creation of clouds, humidity, and precipitation. Without an inversion, particles continue to rise and clouds are not formed.

Temperature inversion can have many different impacts on activities taking place on the ground. Ground temperature inversions can, for example, create frost that can damage or kill sensitive plants and crops. Widespread inversions can create extensive areas of pollution that can affect the health of people, animals, and plants. Since inversions tend to occur in the same places repeatedly, poorly located areas can suffer from persistent and pernicious pollution. Microclimate regions can occur in, for example, upland regions that regularly experience ground inversion.

Researching the presence and nature of inversions involves the use of satellites, thermal imaging, advanced statistical modeling, and physical measurement of atmospheric conditions in a range of different locations. The complexity of weather conditions across the earth means that it has not yet been possible to model inversions accurately in all conditions. However, awareness of their likelihood and effects can be used in planning the locations of industrial, residential, and agricultural activities.

SEE ALSO: Atmospheric Science; Climate Modeling; Climatology.

BIBLIOGRAPHY. Roger Barry and Richard Chorley, eds., *Atmosphere, Weather and Climate* (Routledge, 2003); Edward Bryant, *Climate Process and Change* (Cambridge University Press, 1997); United Kingdom Meteorological Office, www.met-office.gov.uk (cited July 2006).

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Iran

FORMERLY KNOWN AS Persia, the Islamic Republic of Iran has long been the site of political struggle, especially for the control of oil, under the influence of foreign powers. In 1953, for example, after the Anglo-Iranian Oil Company was nationalized by the democratically elected government, a traditional monarchy under a shah was reinstated with support from the United States and the United Kingdom. The country received worldwide attention in 1979 by expelling the ruling shah, a strong ally of the United States, and taking over the American Embassy in Tehran. Between 1980–88, Iran carried on a war with neighboring Iraq, ultimately facing the U.S. Navy in 1987–88. Recent elections have further cemented conservative power in Iran and have produced clashes with international organizations over nuclear capabilities. In February 2006, Iran's Atomic Energy Organization contracted with Russia to develop a joint uranium enrichment project. Two months later, the Iranian government announced that it would not yield to demands of the United Nations (UN) Security Council to halt such activities, but would begin producing nuclear fuel on an industrial scale.

Despite Iran's collecting around $40 billion in foreign exchange oil reserves, 40 percent of the Iranian population of 68,017,800 lives in poverty. With a per capita income of $12,900, Iran is ranked 99th in world incomes. More than 11 percent of the labor force is unemployed, yet Iran is experiencing a shortage of skilled labor. Some 27 percent of females and around 11 percent of males over the age of 15 are illiterate. Almost one-third of the workforce is engaged in agriculture, chiefly at the subsistence level. Seven percent of the population lack sustained access to safe drinking water, and 16 percent lack access to improved sanitation. Even so, the country has a strong and growing middle class and a large and widespread set of opportunities in education for both men and women. The UN Development Program (UNDP) Human Development Reports rank Iran 99th of 232 countries on quality-of-life issues.

Strategically located in the Persian Gulf and bordering the Gulf of Oman and the Caspian Sea, Iran has a coastline of 1,513 miles (2,440 kilometers). Iran shares land borders with Afghanistan, Armenia, Iraq, Pakistan, Turkey, and Turkmenistan as well as Azerbaijan and the Azerbaijan-Naxcivan exclave.

The Persian Royal Road

In the ancient world, the Achaemenid Empire was one of the largest empires, and communications between empires were difficult. To help messengers travel around the empire easily, Darius I of Persia (reigned 522–486 B.C.E.) built a 1,677 mile (2,669 kilometer) road across the empire, making the Greek historian Herodotus claim that "there is nothing in the world that travels faster than a Persian courier."

Unlike many other national highways, the Persian Royal Road linked the major cities of the empire, so it often did not follow the shortest possible route. In the west, the road began at Sardis, in the west of present-day Turkey. It then heads through Phrygia to Gordium, where Alexander the Great cut the famous "Gordium Knot." The road continues eastwards to Comana, then cuts south to Mazaca, to Maras in southeastern Turkey, and then to Gazientepe, going eastwards to Edessa.

From Edessa, the road follows the route of an Assyrian road to the former Assyrian capital of Nineveh, near present-day Mosul, in Iraq, and then continues to Arbil, Kirkup and then through southern Media to Susa in the land of the Elamites, in present-day Iran. From there it continues southeast to the Persian capital at Persepolis.

It seems probable that the road incorporated many previously existing roads, and was largely to help control the Achaemenid Empire as it spread westward. It certainly helped unify the empire, and was not only used by the Persians, but was also used by the men of Alexander the Great's army, and the armies during the Diadochi Wars that followed Alexander's death in 323 B.C.E. The road was still in use during Roman times, and at its easternmost, it joined with the fabled Silk Road to China. Parts of it were later used by Marco Polo.

The terrain varies from rugged mountains to a high, central basin with deserts giving way to small, isolated plains along the coasts of the gulf and the Caspian Sea. Except for the area along the Caspian coast where the climate is subtropical, Iran's climate is either arid or semiarid. In addition to large deposits of petroleum and natural gas, Iran's most valuable natural resources are coal, chromium, copper, iron ore, lead, manganese, zinc, and sulfur.

Iran experiences periodic droughts and floods, and sand and dust storms are common. Earthquakes are a constant threat in Iran, such as the quake registering 7.5 on the Richter scale that hit the southeastern city of Bam in December 2003. The quake caused the deaths of more than 40,000 people and displaced an additional 100,000 individuals, who are still struggling to regain equilibrium. In March 2006, three new earthquakes struck Iran, causing 66 deaths and injuring over 1,000 people.

MASSIVE AIR POLLUTER

The UN has identified Iran as the country with the heaviest air pollution in the world, largely because of emissions from vehicles that have not been designed to limit pollution. Between 1980 and 2002, carbon dioxide emissions rose from 3.0 to 5.3 per capita metric tons. Iran produces 1.4 percent of the world's total of carbon dioxide emissions. At times, the air pollution level is so high that schools and government offices are forced to close. Iranian air is further polluted by refinery operations and the release of industrial effluents into the atmosphere.

Water in Iran has been contaminated by raw sewage and industrial waste products. Pollution is particularly heavy in the Karoon River, the source of almost a third of Iran's surface water resources. According to the World Bank, health problems related to contaminated water are responsible for 90 percent of illnesses in children and are believed to have contributed to 15 percent of deaths among children under the age of five years. In 2003, the World Bank approved $20 million in loans to help the Iranian government reduce air and water pollution.

The Iranian environment has also been damaged by deforestation, overgrazing, and desertification that is common in underdeveloped countries. The Persian Gulf has been heavily polluted by oil spills. Soil degradation has resulted from both human and climatic activity. Wetlands have disappeared following prolonged periods of drought. Like many countries in the area, Iran suffers from a shortage of potable water, particularly in rural areas. In a 2006 study conducted by scientists at Yale University, Iran was ranked 53rd of 132 countries in environmental performance, slightly above the comparable income and geographic groups. Iran's scores were particularly low in the areas of air quality, sustainable energy, and biodiversity and habitat. Varied forms of wildlife are found in the mountains of northwest Iran, in the central plateau, and in the forests near the Caspian Sea. Of 140 endemic mammal species, 22 are endangered, as are 13 of 293 endemic bird species. Some 4.5 percent of the land area of Iran is forested, and 4.8 percent of land area is under government protection.

In order to deal with environmental pollution that has threatened human life as well as Iranian flora and fauna, the government has made pollution reduction a top priority in its current five-year plan. The authority of the Department of Environment to monitor and enforce existing environmental laws and legislation has been strengthened, and nongovernmental organizations (NGOs) have begun pressuring the government for additional change. Educating the public on environmental issues is seen as a key strategy in dealing with environmental problems. Iran's participation in international agreements on the environment is limited to: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Marine Dumping, Ozone Layer Protection, and Wetlands. The government has signed but not ratified agreements on Environmental Modification, the Law of the Sea, and Marine Life Conservation.

SEE ALSO: Desertification; Drinking Water; Earthquakes; Nuclear Power; Nuclear Weapons; Oil Spills; Persian Gulf; Petroleum; Pollution, Air; Pollution, Water; Poverty; Subsistence.

BIBLIOGRAPHY. CIA, "Iran," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa* *and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); One World, "Iran: Environment," www.uk.oneworld.net (cited May 2006); UNDP, "Human Development Report: Iran," www.hdr.undp.org (cited May 2006); World Bank, "Iran," *Little Green Data Book,* www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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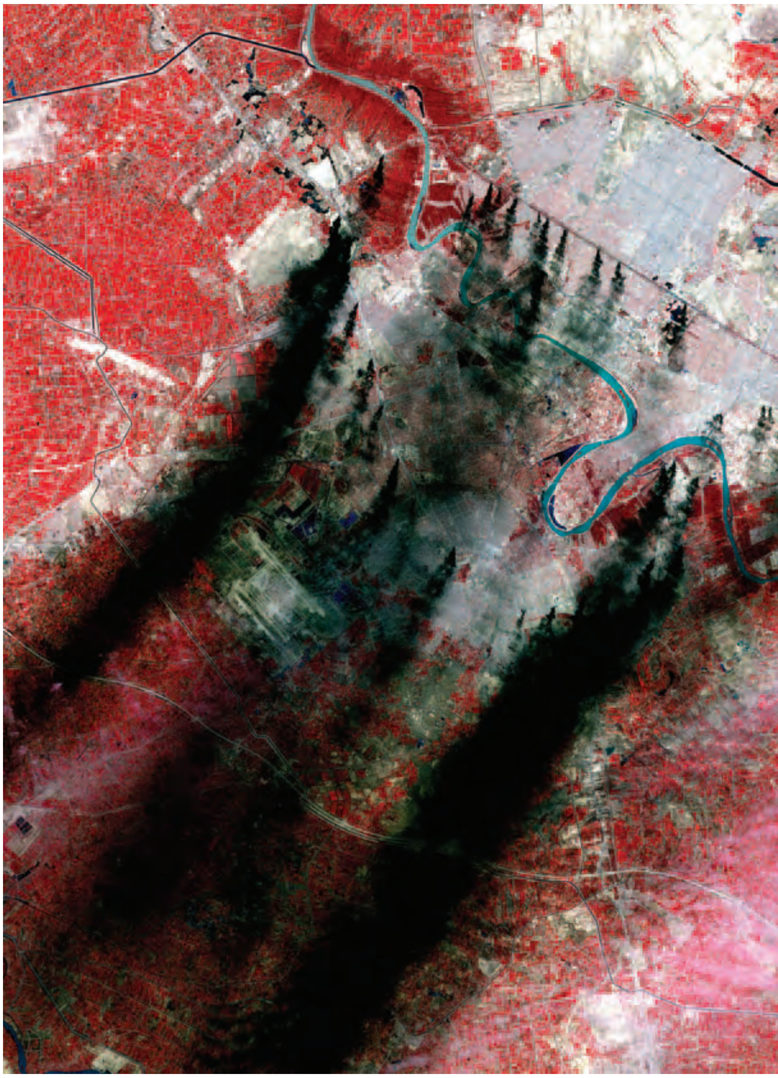
Iraq

HISTORICALLY PART OF the Ottoman Empire, the League of Nations placed Iraq under British administration at the end of World War I, artificially creating the nation's borders by combining multiple regions of Ottoman administration into a single country. After achieving independence in 1932, the Republic of Iraq was ruled by a series of military governments, including the repressive regime of Saddam Hussein, which was unseated by American-led forces in 2003. In April 2006, Hussein was formally charged with genocide and the murder of at least 50,000 Kurds. Iraq and the United States had previously clashed in 1991 after Iraq invaded Kuwait. The United Nations (UN) conducted inspections after the war, despite some resistance from the regime, to try to ensure against the construction of nuclear weapons.

In December 2005, the Iraqi interim government formally transferred power to a elected government. The political situation remained unstable despite the continued presence of United States and coalition forces, as guerrilla warfare continued. Ongoing sectarian violence has resulted in the displacement of at least 100,000 Iraqis. The Bush administration has been harshly criticized for justifying the invasion of Iraq on the grounds that the country was stockpiling nuclear and biological weapons. However, the U.S. 9/11 Commission Report has concluded that no concrete evidence of weapons existed.

In addition to the petroleum and natural gas reserves that give Iraq its strategic importance and provide 10 percent of the world's total, natural re-



Black smoke from burning pipelines plumes over Baghdad in May 2003. Vegetation appear red in thermal imaging.

sources are limited to phosphates and sulfur. The oil industry accounts for 95 percent of foreign exchange earnings. Roughly 13 percent of Iraqi land is arable, but agriculture makes up only 7.3 percent of the Gross Domestic Product (GDP). With a per capita income of $3,400, Iraq is ranked 153rd of 232 nations on world incomes. In 1996, the United Nations instituted an oil-for-food program designed to alleviate human suffering; however, prolonged war has hampered economic recovery.

Although no official poverty level is available, social indicators suggest major threats to human health. Life expectancy is only 68.7 years, and infant mortality is high at 48.64 deaths per 1,000 live births. The high death rate among children is partially responsible for the fertility rate of 4.28 children per female, which further threatens the livelihood of the poorest Iraqis. Between 25 to 30 percent of the population of 26,075,000 is unemployed. Over three-fourths of adult females and 44 percent of adult males are illiterate.

One-fifth of all Iraqis and 48 percent of rural residents have no sustained access to improved sanitation. Half of rural residents and 19 percent of all Iraqis lack access to safe drinking water. The UN Development Program (UNDP) Human Development Reports do not rank Iraq's standard of living because of missing data. In addition to a 36-mile (58-kilometer) border along the Persian Gulf, Iraq shares borders with Iran, Jordan, Kuwait, Saudi Arabia, Syria, and Turkey. Most of Iraq consists of broad plains, but reedy marshes that include large flooded areas are found along the southern border with Iran. The northern sections of Iraq that border Iran and Turkey are mountainous. These areas experience cold winters and may see heavy snows that melt in the spring, producing extensive flooding in central and southern Iraq. Elsewhere, the Iraqi climate is typically desert with mild to cool winters and dry, hot summers. Elevations vary from sea level at the Persian Gulf to 11,844 feet (3,611 meters) at an unnamed peak in the northeastern corner of Iraq. Dust and sand storms are common.

The most serious prewar environmental problem in Iraq was created by the government's draining and diverting feeder streams and rivers away from the inhabited marsh areas near An Nasiriyah. With 85 percent of the Mesopotamian wetlands destroyed, indigenous groups have been displaced and wildlife has been threatened. The shortage of potable water has had enormous health and environmental consequences. Drawing on the resources of the Tigris and Euphrates Rivers requires cooperation with Turkey, and the two countries have had a rocky relationship. Urban areas of Iraq experience extensive air and water pollution. With 67.2 percent of the population urbanized, Iraq produces 0.3 percent of the world's supply of carbon dioxide emissions. Outside urban areas, soil degradation and erosion further threaten the fragile environment, as does the desertification common in the Middle East. The government has not protected any of the land area. Eleven of 81 endemic mammal species are threatened, as are 11 of 140 endemic bird species.

The environmental cost of the current war has not yet been tallied, but it is certain to be extensive because much of the infrastructure has been destroyed. UNEP has identified potential problems with disease-causing pollution, waste management, and unexploded munitions. Insurgents have deliberately set fire to oil wells, producing a thick haze of dark smoke that exacerbates respiratory conditions.

Hanging Gardens of Babylon

The Hanging Gardens of Babylon, and the walls of the city were, according to tradition, constructed by King Nebuchadnezzar II in about 600 B.C.E. They were described by many Greek writers including Strabo and Diodorus Siculus, and were regarded as one of the Seven Wonders of the Ancient World. They remained until about the 1st century B.C.E., when they were destroyed in an earthquake.

Nebuchadnezzar II was said to have ordered the gardens to be built for his wife Amyitis, the daughter of the King of the Medes. She found the relatively dry land around Babylon depressing, so the king began work on lush rooftop gardens and an artificial mountain that would remind Amyitis of her homeland.

There has been some controversy about the gardens with several historians suggesting that they were, in fact, in Nineveh, the Assyrian capital. This comes from mention in cuneiform tablets of gardens at Nineveh, whereas there is no local contemporary account of the gardens at Babylon. It seems likely that there were, in fact, another set of gardens there. Those at Babylon did exist—certainly Strabo describes them in some detail. The term "hanging gardens" comes from the fact that the greenery from the plants "overhung" the buildings on which it was constructed, with the nearby River Euphrates being used to water the plants.

After the Persian Gulf War of 1991, Iraq's electric, transportation, water, and sanitation systems were verging on total collapse.

In the ancient city of Babylon, river reeds have encroached on historical sites such as the Tower of Babel and the Hanging Gardens, and signs of military occupation and fighting are everywhere. Habitats have been destroyed by war activity and human encroachment.

The Environment Protection and Improvement Council is the Iraqi government agency that bears major responsibility for implementing and monitoring environmental laws and regulations. In connection with other government agencies, this ministry has initiated programs designed to promote water conservation; prevent further damage to fragile ecosystems; and check air and water pollution, desertification, and soil degradation and erosion. International agencies continue to work with the Iraqi government in implementing these policies. Because Iraq is not fully integrated into the global community, the government has ratified only the international agreement on the Law of the Sea. The agreement on Environmental Modification has been signed but not ratified.

SEE ALSO: Bush (George W.) Administration; Desertification; Drinking Water; Natural Gas; Nuclear Weapons; Persian Gulf Wars; Petroleum; Pollution, Air; Pollution, Water; War; Weapons of Mass Destruction; Wetlands.

BIBLIOGRAPHY. CIA, "Iraq," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Jeffrey Gettleman, "Ruined Treasures in Babylon Await an Iraq without Fighting," *New York Times,* April 18, 2006, www.select.nytimes.com (cited June 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Human Development Report: Iraq," www.hdr.undp.org (cited May 2006); UNEP, *Desk Study on the Environment in Iraq* (UNEP, 2003); World Bank, "Iraq," *Little Green Data Book,* www.worldbank.org (cited May 2006).

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Ireland

IRELAND IS AN island country, the third largest in Europe, at the edge of the northwestern European continental shelf. It is surrounded on the north, west, and east by the Atlantic Ocean. The Irish Sea separates it from Britain. Four-fifths the size of South Carolina, it has an area of 27,136 square miles (70,238 square kilometers), stretching 290 miles (465 km) north to south and 177 miles (285 km) east to west.

Topographically, Ireland has three main features—coasts, lowlands, and mountains. The Irish coastline surrounding is 1,738 miles long (2,797 kilometers) are cut by numerous inlets and bays, especially on the northern and western sides.

The Shannon River runs through the center of the country into Galway Bay, where the ports of Limrick and Galway are located. Bantry, Clew, Dingle, Donegal, and Sligo Bays are also on the western side of Ireland along with hundreds of islands. The most important of the western islands are Achil Island, Aran Islands, and Valentia Island. Dublin Bay is on the east coast, with Cork and Waterford are on the south coast. The north coast of Ireland has in recent decades become an important vacation center with its long sandy beaches and miles of dramatic chalky cliffs beaten by sea waves.

The Giant's Causeway is located on the north coast in North Antrim. Irish lore says that the basaltic blocks in geometric shapes are the work of the giant Finn McCool. There are 40,000 basalt columns that lead to the sea and beneath it. Most are hexagonal, but some have four, five, seven or eight sides with the tallest extending 40 feet into the air.

The lowlands are mainly in the center of the country, which is cut by the Shannon River. It rises in the northwest and flows 230 miles to the Atlantic at Galway Bay. Numerous peat bogs covering a tenth of Ireland are scattered across the rolling hills of the central lowlands. The area is actively farmed for potatoes, vegetables, and other crops.

The coasts of Ireland are the location of its mountains. In the southwest are the Kerry Mountains. The Donegal Mountains are in the northwest. The Sperrin, Antrim, and Mourne Mountains are in the north. The Mountains of Mayo and the Mountains of Connemara are in the west. The highest elevation in Ireland is Carrautoonhill (3,414 feet, 1,041 meters) in the Connemara Mountains. The Wicklow Mountains in the east are the source of the Liffey River, which empties into the Irish Sea at Dublin.

The Boyne River is in the northeast; the Barrow, Nore, and Suir Rivers are in the southeast; and the Moy flows through the northwest. The rivers are fed by the mild wet ocean winds that bring rain, which is heaviest in the western mountains with flooding a regular problem in the lowlands. The North Atlantic Current, a branch of the Gulf Stream, warms the island, making snow rare along the coast although it does occur in the mountains.

There are no snakes in Ireland, driven out by St. Patrick according to Irish legends, and only three amphibians. Of the mammals on the island, only 31 are native. These include the red fox, Irish hare, red deer, and the hedgehog. Other mammals including rabbits were introduced at one time. There are, however, over 400 species of birds.

BIBLIOGRAPHY. Paddy Dillon, *Connemara (Collins Ramblers Guides)* (HarperCollins, 2001); Wendy Walsh, *Irish Florilegium: Wild and Garden Plants of Ireland* (Thames & Hudson, 1988); Philip S. Watson, *The Giant's Causeway: A Remnant of Chaos* (Hmso, 1996).

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Irrigation

IRRIGATION IS THE artificial application of water to land for the purpose of supplying moisture essential for plant growth. Although irrigation is an old art, its importance has increased in recent times with the increased demand for food to meet the needs of a growing population. Today, irrigation accounts for 70 percent of all water used by humans. Although irrigation works are found almost everywhere, they are most important in arid and semiarid regions, where the quantity and timing of rainfall are not inadequate for crops. For instance, in those parts of Asia where rainfall is seasonal, and most precipitation occurs in three to four months of the year, irrigation is highly critical to agriculture.

The importance of irrigation is evident from the fact that, historically, the development of human civilizations has followed the development of irrigation. For instance, Egypt claims to have had the world's oldest dam, 355 feet long and 40 feet high, built some 5,000 years ago to store water for drinking and irrigation. In fact, basin irrigation introduced in the Nile valley around 3000 B.C.E. still plays an important part in Egyptian agriculture. Similarly, in the valley of the Euphrates and the Tigris (the two rivers which pass through Turkey, Syria, and Iraq, and which defined what was once called Mesopotamia), there are remains of the largest irrigation canals built around 2200 B.C. Historical references to the practice of irrigation from wells, tanks, and canals are also found in countries such as China, India, Iraq, the former U.S.S.R., Mexico, and Peru.

The importance of irrigation has grown further since the 19th century, particularly with the application of modern engineering technology. The 19th century saw the world's irrigated area increase from 8 million hectares to about 40 million hectares, of which the single largest share was that of India (17 million hectares). Considerable irrigation development also took place in the western United States and Italy in the latter half of the 19th century. Irrigation development continued in the 20th century, particularly after World War II, when the use of irrigation technology, along with other inputs, led to the so-called Green Revolution in many parts of Asia. But since the late 1970s, irrigation expansion has slowed markedly due to a number of reasons such as low commodity prices, high energy costs, and economic conditions that discourage agricultural production.

Currently, the Asian continent accounts for nearly 70 percent of the irrigated area in the world, and the Americas for 15 percent. The three countries with the largest areas under irrigation are India, China, and United States, in that order.

According to estimates by the Food and Agriculture Organization, the share of irrigation in world crop production is expected to increase in the next decades, although the rate of increase will slow down. Irrigated land will expand by 45 million hectares to reach a total of about 242 million hectares by 2030, at a projected annual growth rate of 0.6 percent compared with the 1.9 percent observed in the period from 1963–99. The expansion of irrigation is projected to be strongest in south Asia, East Asia, and Near East/North Africa. Rising economic and environmental costs, along with declining public investments in irrigation, means that a significant increase in the rate of addition of irrigated areas is unlikely in the future; therefore, irrigation's contribution to food production will have to come from improving existing systems rather than from expanding them to new lands.

METHODS AND CLASSIFICATION

Irrigation systems can be classified in a number of ways. The most common mode of classification is by the characteristics of the water and power source. The water source can be surface (canals and tanks) or groundwater (wells). In some parts of the world, such as South Asia, most of the recent expansion in irrigated area has been through private investments in wells to exploit groundwater. Wells in turn can be open wells (where water is pumped up by manual or animal labor or motors) and shallow and deep tubewells (which are almost exclusively operated by diesel engines and electric motors). Further, water can be conveyed by gravity flow or lifted via pumps, depending on whether the irrigated area is located downhill or uphill of the source of water.

Other criteria for classifying irrigation systems include capital labor ratio, scale, institutional arrangements (whether water is directly appropriated by the user, acquired via contract, or allocated by a community or a bureaucracy), and degree of farmer control over availability and timing of irrigation.

The method of water application also varies. Irrigation water can be applied to crops by flooding it on the field surface, by means of furrows, applying it beneath the soil surface, spraying under pressure (sprinklers) or applying it in drops (drip irrigation). Of these, drip and sprinkler irrigation are water-saving techniques, but drip irrigation involves high initial investment and sprinkler irrigation involves high level of power. Ultimately, the choice of method is dictated by a number of factors such as the available water supply, type of soil, topography of the land, and the crop to be irrigated. Irrigation can be intensive or extensive. Intensive irrigation is usually used when the motive for irrigation is increasing production per unit area, and extensive irrigation is used when the motive is to protect crops from droughts by expanding the cultivated area.

MULTIDIMENSIONAL

Irrigation is a subject that has a number of dimensions. The science and engineering dimension includes the construction and maintenance of structures and channels for the conveyance of water, as well as the adequate application of water to maintain plant growth. The economic dimension of irrigation arises from the fact that water is a primary input in agriculture, as well as one that increases the benefits from other inputs and makes possible the use of high-yielding varieties of seeds and fertilizers. Another important economic aspect of irrigation is its profitability. The unit cost of irrigation development varies with countries and types of irrigated infrastructures, ranging typically from $1,000 to $10,000 per hectare, with extreme cases reaching $25,000 per hectare. The lowest investment costs are in Asia, which has the bulk of irrigation and where scale economies are possible. The most expensive irrigation is found in sub-Saharan Africa, where irrigation schemes are usually smaller and development of land and water resources is costly.

The social aspect of irrigation stems from the fact that it often necessitates collective action, for which it may draw upon existing institutions and organizations, as well as cultural practices. For example, the Indonesian *subak* is an irrigation institution where there is a strong interrelationship between water and religion. Each *subak* or irrigation group has two temples—one dedicated to the goddess of fertility, the other to the god of water—and there is a complex, albeit synchronized, relationship between rituals in the temple and agricultural activity. Irrigation projects that do not take into account preexisting local social structures, or social and cultural practices, can result in conflict.

There is also a political aspect to irrigation. This is because irrigation is not just an economic resource, but also a source of power and patronage at the local, regional, and national levels. In fact, the relationship between irrigation and general political authority has been the subject of considerable discussion among social scientists. The most well-known theory in this regard is Wittfogel's (1957) theory of Oriental Despotism, which hypothesized that agriculture in arid regions required the building and operation of large-scale irrigation works, the control and management of which gave rise to a highly centralized and elite bureaucracy; this in turn provided the base for the emergence of despotic, "agro-bureaucratic" states in ancient China, India, Egypt, and Mesopotamia. In other words, hydraulic societies have an inherent tendency to become centralized, despotic states. Wittfogel's thesis has been critiqued on a number of grounds, such as the presence of local autonomy in irrigation management in many countries and the lack of systematic correlation between the existence of irrigation and the nature of the overall political authority.

CAUTIONS AND CAVEATS

There is no doubt that irrigation is important not only in food production, but in the multiplier effect of creating employment opportunities and bringing about development via linkages with other economic activities. Further, irrigation can also help to bring about social change because of its linkage with social and political power. But in spite of its importance, irrigation has also resulted in a number of problems. For instance, lack of adequate drainage and lack of knowledge of the appropriate relationship between soil, crop, and irrigation, have given rise to serious problems of waterlogging, salinity, and alkalinity in many irrigated projects in India, Pakistan, China, the United States, and Central Asia. This has resulted in once-fertile land becoming unfit for agriculture. Similarly, overpumping of groundwater in many regions is beginning to make continued irrigation too costly—as well as resulting in drying up of aquifers—thereby forcing land out of agriculture. For instance, about one-fifth of U.S. irrigation is achieved by pumping groundwater at rates that exceed the water's ability to recharge, which means that aquifers like the Ogalla in the Midwest are being rapidly depleted.

Apart from environmental problems, there are also problems of underutilization of existing systems (due to inefficiencies such as leaky pipes and unlined canals) and low rates of cost recovery, as well as social problems (for instance, as a result of displacement due to big dams). There are also pressures on irrigation water due to growing demands for water from other sectors, the most important among these being industry and increasing urban populations. Shifting water from farms to cities is already being done in a number of places such as the western United States, China, Mexico, and India. Water-scarce countries often satisfy the growing needs of cities and industry by diverting water from irrigation, then importing grain to make up for lack of production. This practice has now come to be called trade in "virtual water"; the water used to produce an agricultural commodity.

The multifaceted nature of irrigation means that a wide variety of factors, such as geography, agrarian structure, population pressure, cultural factors, the role of the state, and the vision of development, determine the direction and pace of irrigation development. This, in turn, has led to considerable differences in the way irrigation development has taken place. For instance, in many parts of the world (such as in South Asia), the state has played an important role in undertaking irrigation development. In others (like Australia, Canada, and the United States), governments have encouraged irrigation development by private individuals or groups.

There have been a number of changes in the nature of irrigation development since the 20th century, and particularly in the last two decades. First, irrigation has been extended even to areas of sufficient and abundant water supply. Second, there has been considerable interest in the science of irrigation techniques and works, resulting in changes in the way irrigation is conceived. For instance, the concept of single-purpose irrigation projects first gave way to multipurpose projects (which include water supply, hydroelectric power and flood control), then to river basin planning and to the integrated development of a river basin. Third, there has been greater emphasis on the necessity of learning from traditional water management systems. Fourth, there is a trend toward privatization and user participation in irrigation systems.

SEE ALSO: Arid Lands; Wastewater; Water.

BIBLIOGRAPHY. James K Boyce, "Technolgical and Institutional Alternatives in Asian Rice Irrigation," *Eco-*

nomic and Political Weekly (v.23, 1988); K.K. Framji, B.C. Garg and S.D.L. Luthra, *Irrigation and Drainage in the World: A Global Review* (International Commission on Irrigation & Drainage, 1981); International Commission on Irrigation and Drainage, "Irrigation and Food Production Information from ICID Network Countries," www.icid.org (cited April 2006); A.M. Michael, *Irrigation: Theory and Practice* (Vikas Publishing House, 1978); Sandra Postel, "Water and Agriculture," in *Water in Crisis: A Guide to the World's Fresh Water Resources*, Peter Gleick, ed., (Oxford University Press, 1993); UNESCO–WWAP, *The United Nations World Water Development Report* (UNESCO and Berghahn Books, 2003).

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Israel

FOLLOWING DECADES OF tumultuous political and cartographic struggle, Israel was created as a Jewish state after World War II, setting the stage for decades of bitter divisions between Jews and Muslims in the Middle East. An Israeli victory in a number of separate conflicts and Israel's close ties to the West have exacerbated the ongoing religious and territorial tensions with her Muslim neighbors and with indigenous Palestinians. Bordering on the Mediterranean and Dead Seas, Israel has a coastline of 169 miles (273 kilometers). The terrain is diverse, ranging from the Negev Desert in the south to low coastal plains and central mountains to the Jordan Rift Valley. Israel has a temperate climate, and the southern and eastern desert areas are hot and dry. The country experiences periodic droughts and sandstorms in the spring and summer.

With a per capita income of $22,200, Israel is the 44th richest country in the world. However, 21 percent of the population live below the poverty line. There is a good deal of economic inequity, with the richest 10 percent controlling 28 percent of the country's wealth. Natural resources include timber, potash, copper ore, natural gas, phosphate rock, magnesium bromide, clays, and sand. Even though less than 3 percent of the workforce is engaged in agriculture, forestry, and fishing, the only regular food imports are grains. Israel exports fruits and vegetables to surrounding areas, and diamonds and high-technology equipment are exported around the world. Tourism is also essential to the Israeli economy. The United Nations Development Program (UNDP) Human Development Reports rank Israel 23rd in the world in overall quality-of-life issues.

The Israeli government's commitment to environmentalism began with the creation of the Environmental Protection Service in 1973. In 1988, the Ministry of the Environment was established to implement laws and monitor compliance. The lack of fresh water resources severely taxes Israel's environment. Consequently, the government has developed wastewater treatment facilities that allow 65 percent of generated water to be reused for agricultural purposes. Less than 10 percent of the population live in rural areas, and heavy industrialization and urbanization have led to substantial levels of air pollution. There are 230 cars for every 1,000 people in Israel. Between 1980 and 2002, carbon dioxide emissions per capita metric tons rose from 5.6 to 11.0. Israel produces 0.3 percent of the world's CO_2 emissions.

Israel is home to 2,600 plant species, seven amphibian species, almost 100 reptile species, over 500 bird species, and around 100 mammal species. Of 116 endemic mammal species, 14 are endangered. Likewise, 12 of 116 bird species are threatened. Approximately 6.1 percent of the land area of Israel is forested, and 15.8 percent of the area is protected. These areas include 142 nature reserves and 44 national parks. However, Israeli environmentalists insist that the government has not taken all necessary steps to protect the land, citing the practice of encouraging farmers to sell agricultural land for development by paying them 30 percent of profits.

Other environmental issues involve desertification, groundwater pollution from domestic and industrial waste, and the irresponsible use of chemical fertilizers and pesticides. A study by scientists at Yale University in 2006 ranked Israel 45th of 132 countries on environmental performance, well above the relevant geographic group but well below the relevant income group. The lowest rankings were received in the categories of air and water quality, biodiversity, and natural resource protection. The environment perhaps has suffered most greatly in the Israeli-occupied Palestinian territories where instability and continued transitions of authority and violence have left forests, grazing lands, and water in relatively poor condition.

Extensive ecological damage has also occurred in the Dead Sea, which Israel shares with Jordan. The lowest point in the world, the Dead Sea is in danger of disappearing altogether. The practice of harvesting the minerals that balanced the sea's ecology has led to a drastic decline in the water table, and levels of brine have drastically increased. Massive sinkholes have appeared that engulf land and forests. A number of environmentalists have expressed opposition to proposed plans to build pipelines to transfer water from the Red Sea, which is ecologically different, to the diminishing Dead Sea.

Israel's commitment to the global environment has been demonstrated through participation in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Ozone Layer Protection, Ship Pollution, and Wetlands. The Marine Life Conservation agreement has been signed but not ratified.

SEE ALSO: Desertification; Fertilizers; Groundwater; Pesticides; Pollution, Air; War.

BIBLIOGRAPHY. CIA, "Israel," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Alanna Mitchell, *"Dancing at the Dead Sea": Tracking the World's Environmental Hotspots* (University of Chicago Press, 2005); UNDP, "Human Development Report: Israel," www.hdr.undp.org (cited April 2006); World Bank, "Israel," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale. edu (cited April 2006).

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Great Fire of Rome

The Great Fire of Rome raged for five days in Imperial Rome, destroying about two-thirds of the city, and resulting in it being rebuilt by the Emperor Nero in a grand style. The fire broke out on July 19, 64 C.E., and started in shops selling heating oils near the Circus Maximus, where the chariot races were held. It was a densely populated part of the city, with wooden houses easily catching alight and spreading quickly. The fire raged for nine days, but is only mentioned by three historians. Tacitus, who was nine years old at the time of the fire, wrote that the Emperor Nero watched the fire from the Maecenas Tower; and Suetonius and Pliny the Elder also mention the fire. Other Roman historians who were there at the time make no references, causing some later commentators to doubt the seriousness of it. However, archaeological evidence of the fire in blackened remains found during "digs" in Rome have shown its effects.

The Emperor Nero was said to have "fiddled while Rome burned" but this comes from a reference to him playing the lyre—the fiddle had not yet been invented. Nero provided shelter for many people in his palaces, and when Rome was to be rebuilt, the emperor laid down regulations about the spaces between houses, encouraged building in brick, and wanted wider roads.

Some blamed Nero for the fire, and he seems to have quickly passed the blame onto Christians, large numbers of whom were crucified or thrown to the lions in arenas—the Colosseum had not yet been built. Nero also used the fire as an opportunity to enlarge his palace, building the Domus Aurea ("Golden House"), which had an entrance so large it could accommodate a 120-foot-tall statue of himself.

1913 poster showing Nero playing the lyre while Rome burns.

Italy

ITALY, A STATE of Europe in the south of the continent, has a land area of 116,305 square miles (301,230 square kilometers, including the large islands of Sardinia and Sicily) and an estimated population of 58 million people in 2006. The country can be divided into three main physiographic units. The north, dominated by the Alpine mountain arch; the center, whose main feature is the Po river plain; and the mountainous south, with the Apennines mountains stretching to Calabria. Coastal lowlands are also frequent, especially in the Adriatic sea. In Sardinia and Sicily, high and rugged mountains and volcanoes (in Sicily) alternate with lower elevations and coastal plains. The climate is Mediterranean except for the Alps and the Po river plain, where continental conditions (cold winters and warm summers) prevail.

The most pressing environmental issues faced by Italians concern air and water quality; soil erosion and desertification linked to agricultural abandonment (especially in the south and in the islands); and a wide array of natural hazards (floods, droughts, landslides, earthquakes and volcanic eruptions). Air pollution shows some improving trends, such as the decrease in sulfur dioxide emissions (largely as a result of the reduction in coal burning and the increase in the use of the cleaner natural gas), but a serious deterioration in cities due to traffic. Italy has one of the highest per capita rates of car ownership in the world. Atmospheric pollution remains especially acute in cities where thermal inversions are frequent, and the concentrations of some pollutants in Rome, Milan, and other capitals often exceed the standards of the European Union (EU). Also, air pollution constitutes a serious threat for the rich historical heritage of Italian cities. However, several policy initiatives launched in the 1990s in order to curb pollution have attained some success, such as "car free" Sundays or rotating the use of cars with alternate plates on given days. Moreover, Rome was the first European city to establish a fee for cars willing to access the center.

Water pollution continues to be an important environmental problem, because of agricultural and industrial discharges, especially into the Adriatic. The so-called "yellow" and "red" tides (algae concentrations in highly eutrophied waters) of this sea are less

Mount Vesuvius

The eruption of Mount Vesuvius on the afternoon of August 24, 79 C.E.—coincidentally on the day after Vulcanalia, the festival of the Roman god of fire—engulfed the city of Pompeii. There had been a previous eruption on February 5, 62 C.E., and some of the damage was still being repaired when the second and larger eruption took place.

Although the eruption is described well in two letters by Pliny the Younger—his uncle, Pliny the Elder was commander of the nearby Roman fleet, and died in the eruption—it is best known because of the discovery of the buried city of Pompeii in the 18th century. In 1709 there were some finds at Herculaneum, and in 1748 work started at Pompeii. By the 1990s, two-thirds of the city had been excavated, and relics have been shown in exhibitions around the world. Although these two eruptions are the best-known, Mount Vesuvius has erupted many times. Indeed, it was the rich volcanic soil of Vesuvius that encouraged large settlements such as Pompeii. Formed from a collision between the African and Eurasian tectonic plates, Vesuvius has erupted in 472, when ash was reported to have fallen at Constantinople; and in 512, with Theodoric the Great, King of the Goths, exempting the area from taxation.

There were further eruptions in 787, 968, 991, 999, 1007, and 1036. The eruption in December 1631 resulted in the death of 3,000 people. Mount Vesuvius has continued to erupt at intervals since then, with 18 eruptions between 1660 and 1872. It erupted in 1906, when 100 people were killed; in 1929; and in March 1944, the most recent. In that eruption, some nearby villages were destroyed and the U.S. Army lost a number of aircraft. Since then there have been a few landslides and the occasional appearance of small clouds of ash dust.

common than in the past, and important efforts have been made to reduce marine pollution, for example in the Venice area. During the 1990s, Italian river basin authorities have been plagued by a crisis of underinvestment and mismanagement.

Agricultural land in Italy covers around 27.1 million acres (11 million hectares), or one-third of the total land area of the country, but it is declining fast; more than 20 percent disappeared between 1970 and 2000. Urbanization, on the contrary, is progressing, especially in the coastal areas. In 1996, it was estimated that only about 30 percent of the more than 4,960 miles (8,000 kilometers) of coast were free from development. In 2003, 11.2 percent of Italy was subject to some environmental protection. The country has created a network of 468 natural parks, including 46 Ramsar Sites and 5 biosphere reserves, notably the Ticino Valley in the Alps and the Tuscan islands. In 2004 Italy was the fourth-largest user of energy in Europe. The country disregarded nuclear energy in the 1970s and depends heavily on oil and natural gas. Only 2 percent of the energy generated comes from renewable resources (excluding hydropower).

Between 1991 and 2001, the country experienced some 12,000 flood and landside episodes affecting about 300,000 people and causing damages above 2 billion euros. Between 1980 and 2002, Italy sustained 17 percent of all flooding episodes in Europe but 38 percent of fatalities, including the 147 people killed in the floods and mudslides of Sarno (in the South) in 1998.

SEE ALSO: Automobiles; Biosphere Reserves; Desertification; Floods and Flood Control; Fossil Fuels; Pollution, Air; Pollution, Water; Soil Erosion; Sulfur Dioxide; Urbanization; Wind Power.

BIBLIOGRAPHY. C.A. Brebbia, V. Popov, and D. Fayzieva, *Environmental Health Risk III, Vol. 9* (WIT Press, 2005); John R. Patterson, *Landscapes and Cities: Rural Settlement and Civic Transformation in Early Imperial Italy* (Oxford University Press, 2006); Ronald Edward Zupko and Robert Anthony Laures, *Straws in the Wind: Medieval Urban Evironmental Law—the Case of Northern Italy* (Perseus Publishing, 1996);

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Ivory

IVORY IS THE hard, mellow-colored dentine substance of elephant and walrus tusks (the upper incisors). The teeth of the hippopotamus and the sperm whale resemble tusk ivory and also carry commercial value. Elephant ivory, however, is the most sought-after type, deriving from the African or Indian elephant. Wooly mammoth and mastodon ivory is also popular, the remains of which are found in Canada, America, and Siberia. Connoisseurs note a difference in the quality of "live" and "dead" ivory, the former from recently deceased animals and the latter having lain in the ground for thousands of years. Live ivory is more resilient and resists cracking and is therefore preferred. The high value placed on live ivory, however, is driving the African elephant into extinction. For millennia, people have worked ivory because it is easier to carve than bone, serving therefore as a medium for detailed sculptures and, when cut, emitting an oily substance that is amenable to a high polish. Ivory is also simple to bleach or paint. In addition to its use in the creation of jewelry and sculptures, ivory has also been cut into plates and used for book covers and inlay.

Upper Paleolithic peoples (40,000–12,000 B.C.E.) were the first to carve the tusks of mammoth and mastodon into beads and religious amulets. With access to elephant and hippopotamus ivory from Nubia, the Egyptians used ivory for a wide range of items. It was with the Classical-era Mediterranean (500 B.C.E.–500 C.E.), however, that massive amounts of ivory flooded the consumer market. An increasing demand in ivory corresponded especially with the beginning of the Roman Empire, when it was used to create, for example, musical instruments, statues, furniture, floor coverings, chariots, and birdcages. The Emperor Caius Caligula built a stable of ivory for his horse, and the philosopher Seneca owned 500 tables with ivory legs. By the late 1st century, supplies of African ivory had diminished, but the Indian market maintained steady supplies to Rome. Indian elephant tusks are significantly smaller, more easily breakable, and have a less beautiful natural color than those of African elephants, whose tusks can reach up to 3.5 meters in length with a cross-section of eight inches. The east coast of sub-Saharan Africa, therefore, was the major supplier of the best ivory during the Late

Antique and Medieval periods. Byzantine Christians in particular employed ivory in religious sculptures. In northern Europe and Russia, however, the elites began to make use of a new supply ivory from walrus tusks; albeit inferior, it was accessible.

However great, the impact of the ancient and medieval demand on ivory-producing animals was negligible compared to the devastation wrought in modern times. Ivory was used increasingly for such mundane objects as piano keys and billiard balls. A dramatic decline in African elephant populations coincided especially with the expansion of East Asian markets, notably Japan. From 1979 to 1989, the African elephant population fell from 1.3 million to 750,000. A worldwide ban on the ivory trade in 1989 had mixed results. Illegal poaching continued in all African countries. While the creation of wildlife reserves helped, an estimated 80 percent of African elephants lived in unprotected areas. As elephant populations slowly returned, several African countries urged for a partial lifting of the ivory ban, and dispensation was granted to South Africa and Zimbabwe, to allow the legal hunting of African elephant ivory.

SEE ALSO: Elephants; Endangered Species; Extinction of Species.

BIBLIOGRAPHY. George Frederick Kuntz, *Ivory and the Elephant in Art, in Archaeology, and in Science* (Doubleday, 1916); David Pearce, ed., *Elephants, Economics, and Ivory* (Earthscan Publications Ltd., 2001); Ike Snug and Urs Kreuter, *Elephants and Ivory: Lessons from the Trade Ban* (Coronet Books, 1994).

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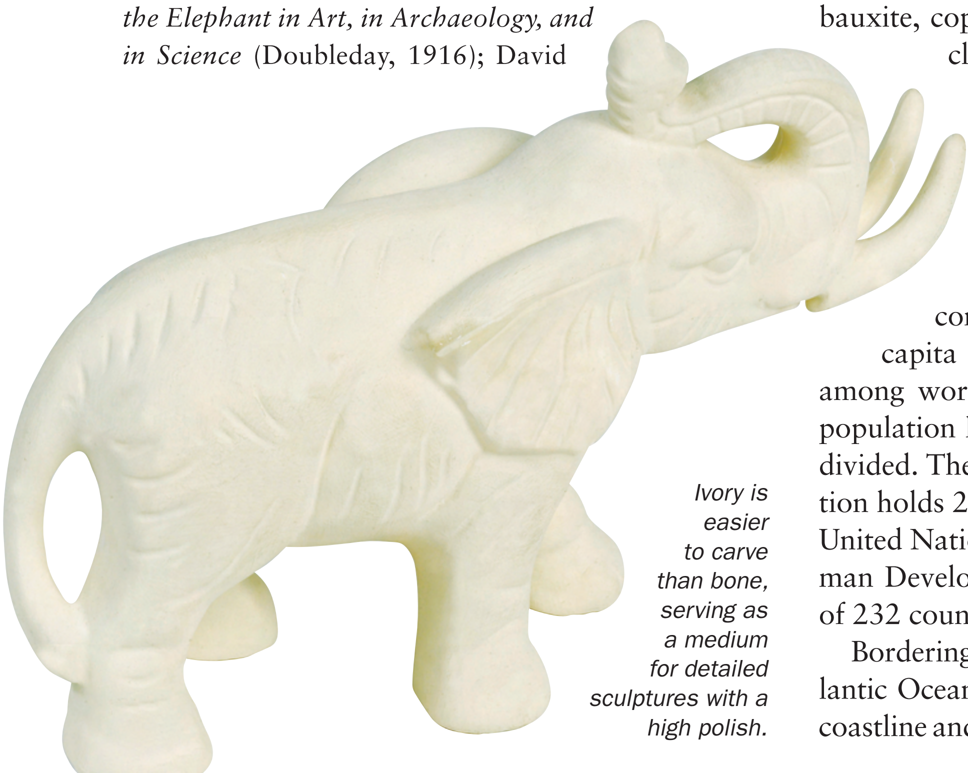

Ivory is easier to carve than bone, serving as a medium for detailed sculptures with a high polish.

Ivory Coast

HIGHLY PRIZED FOR its abundance of natural resources during colonial times, the Cote d'Ivoire, or the Ivory Coast, has continued to be closely tied to France since winning independence in 1960. Controversy developed in the country after a military coup in 1999 established a government elected through rigged results. After this government was overturned by popular protest, fighting continued between government and rebel forces. A ceasefire in 2003 has been enforced by the continued presence of French and West African peacekeeping forces. The Cote d'Ivoire is among the world's major exporters of coffee, cocoa beans, and palm oil, and oil production is expected to reach over 200,000 barrels per day by 2010. Other natural resources include natural gas, diamonds, manganese, iron ore, cobalt, bauxite, copper, gold, nickel, tantalum, silica sand, clay, and hydropower.

Some 68 percent of the workforce is engaged in an agricultural sector that generates less than a third of the gross domestic product. Economic potential has been adversely affected by the political situation and weather conditions. The Cote d'Ivoire has a per capita income of only $1,500, ranking 196th among world incomes. Around 37 percent of the population lives in poverty, and income is unevenly divided. The most affluent 10 percent of the population holds 28.8 percent of the country's wealth. The United Nations Development Program (UNDP) Human Development Reports rank Cote d'Ivoire 163 of 232 countries on overall quality of life issues.

Bordering on the Gulf of Guinea in the North Atlantic Ocean, the Cote d'Ivoire has a 515 kilometer coastline and 4,460 square kilometers of inland water resources. The Cote d'Ivoire shares land borders with Burkina Faso, Ghana, Guinea, Liberia, and Mali. The terrain of the country is generally flat with undulating plains except in the mountains of the northwest. Elevations range from sea level to 1,752 meters at Mont Nimba. Along the coast, the Cote d'Ivoire experiences a tropical climate. However, in the north, the climate is semiarid. The Cote d'Ivoire has three distinct seasons. The period between November and March is warm and dry. Temperatures continue to rise until the end of May. The hot rainy season that begins in June lasts until October, frequently producing torrential flooding. The coast, which is subject to heavy surf, has no natural harbors.

The population of 17,655,000 is beset by both poverty and disease. Due to an HIV/AIDS prevalence rate of 7 percent, some 47,000 people have died and another 570,000 are living with the disease. While 84 percent of the population has sustained access to safe drinking water, only 23 percent of rural residents and 40 percent of all residents have access to improved sanitation. Ivoirians are also susceptible to a very high risk of food and waterborne diseases, as well as malaria and yellow fever. Such high incidences of disease have resulted in low life expectancy (48.82 years) and growth rates (2.03 percent) and high infant mortality (89.11 deaths) and death rates (14.84 deaths per 1,000 population). Ivoirian women give birth to an average of 4.5 children. Literacy rates of 43.6 for females and 57.9 for males make it difficult for the government to educate Ivoirians about disease prevention.

At one time, the rain forest of the Cote d'Ivoire was the largest in West Africa. Today, however, the forest has become overexploited; between 1960 and 1987, forest cover was reduced from 37 million to 8 million acres. Some 71 percent of land area is currently forested, but deforestation is occurring at a rate of 3.1 annually. Most of the population lives along the coast, particularly in the area around Abidjan, which is the commercial and administrative capital of the Cote d'Ivoire. In urban areas, agricultural runoff, the dumping of raw sewage, and industrial effluents have produced severe water pollution. The government has, however, improved air quality by reducing the rate of carbon dioxide emissions per capita metric tons from 0.7 percent in 1980 to 0.4 percent in 2002. The government has also protected 6 percent of land area. Nevertheless, the biodiversity of the entire rain forest is threatened by the expanding population. Of 230 endemic mammal species, 19 are endangered, as are 12 of 252 bird species. In 2006, scientists at Yale University ranked Cote d'Ivoire 86 of 132 countries on environmental performance, slightly above the comparable income and geographic groups. The overall score was greatly reduced by the poor showing in the category of environmental health.

Between the mid-1960s and 2002, the government of the Cote d'Ivoire began passing a body of legislation designed to deal with mounting environmental problems, assigning responsibility for implementing and enforcing laws to the Minister of Environment. New laws dealt with protecting fauna and with revising existing forestry, mining, petrol, environment, rural land management, and water codes. The government also established a national park system and set aside nature reserves. Implementation and enforcement of these laws, however, has been hampered by a lack of funding, personnel, and technology. The Cote d'Ivoire participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: Guinea; Ivory; Liberia; Mali.

BIBLIOGRAPHY. CIA, "Cote d'Ivoire," *World Factbook*, www.cia.gov/cia (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC–CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Cote d'Ivoire," www.hdr.undp.org (cited April 2006); World Bank, "Cote d'Ivoire," www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Jamaica

THE BRITISH SEIZED the Spanish Caribbean island of Santiago in 1655, establishing a slave plantation colony that would not achieve independence until 1962. Despite the optimism associated with Jamaica as a fee-market experiment built on export crops and tourism in its early years, economic downturn in the late 20th century left the country in poor condition, exacerbated by high levels of international debt, leading to further political and social instability. Bordered entirely by the Caribbean, Jamaica has 634 miles (1,022 kilometers) of coastline. The climate is temperate in the interior but tropical elsewhere. The terrain is mountainous with a narrow, discontinuous plain. While hurricanes may occur at any time on the island, they are most likely from July to November. Recovering from hurricanes such as Ivan, which hit Jamaica in September 2004, is difficult both financially and environmentally.

Jamaica's limited natural resources include bauxite, gypsum, and limestone. Around 16 percent of the land area is arable, and 20.1 percent of the workforce is engaged in the agricultural sector. Most Jamaicans are involved in the service sector (61.3 percent). Slightly over half the population live in urban areas. The largest contributors to the Jamaican economy are tourism, remittances from Jamaicans who work abroad, and the bauxite/alumina industry. Unemployment is persistently high (currently 11.5 percent), and the population of 2,732,000 people live on a per capita income of $4,300.

Almost one-fifth of all Jamaicans live below the national poverty line. Some 93 percent of the population has access to safe water, but 20 percent do not have access to improved sanitation. Because land is scarce, squatter settlements have sprung up, leading to vast overcrowding and enormous sanitation problems. Government funding for environmental programs and health programs is hampered by high external debts. The United Nations Development Program (UNDP) Human Development Reports rank Jamaica 98th of 232 countries on general quality-of-life issues.

Less than a quarter of Jamaica's land is forested as a result of a high level of deforestation. In the industrial area of Kingston, air pollution is a major threat. Marine pollution is also extensive. Industrial waste, untreated sewage, and oil spills have been dumped into the Caribbean, and the coral reefs have been damaged.

Poor agricultural practices have led to serious soil erosion. Development, agriculture, mining, and tourism all contributed to the pollution of ground and surface water. A 2006 study by scientists at Yale

University ranked Jamaica 43rd of 132 countries on environmental performance, well above the income group average and slightly above the geographic group average. Jamaica's lowest scores were in the categories of air quality and sustainable energy. The island did particularly well in the field of biodiversity and habitat, in large part because 84.6 percent of Jamaica's land is protected. However, there are problems. Of 25 endemic mammal species, five are endangered. Likewise 12 of 75 endemic bird species are threatened.

The Ministry of Land and Environment, the National Environment and Planning Agency, and the National Resource Conservation Authority are responsible for implementing environmental policy and identifying particular areas of environmental concern. Current government projects include the Biodiversity Strategy and Action Plan, the National Forestry Management and Conservation Plan, the Master Plan for Sustainable Tourism, the Water Sector Strategy and Action Plan, the National Strategic Plan on HIV/AIDS, the Inner City Renewal Program Phase 2, and the Agro-Industrial Development–Neutraceutical Project. Jamaica has also reactivated the Sustainable Development Council, and regional groups are actively involved in environmental issues in Jamaica.

Jamaica has expressed concern for the global environment by signing the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Deforestation; Drugs; Pollution, Air; Pollution, Water; Poverty; Tourism.

BIBLIOGRAPHY. CIA, "Jamaica," *The World Factbook,* www.cia.gov (cited April 2006); Franklin W. Knight and Teresita Martinez-Vergne, eds., *Contemporary Caribbean Cultures and Societies in a Global Context* (University of North Carolina Press, 2005); Mark Kurlansky, *A Continent of Islands: Search for the Caribbean Destiny* (Addison-Wesley, 1992); Ministry of Land and Environment, *Jamaica National Report to the World Summit on Sustainable Development* (Government of Jamaica, 2002); UNDP, "Human Development Reports: Jamaica" www.hdr.undp.org (cited April 2006); World Bank, "Jamaica," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Japan

WITH A population of approximately 127,417,000, Japan is one of the most remarkable success stories in the post–World War II era. Shifting the focus from war-making to economic progress allowed Japan to become the second major industrial power in the world, outranked only by the United States. Unfortunately, along with industrialization and economic growth, Japan has also become a major environmental polluter. To offset this, the country has also become a leader in antipollution technology. In a 2006 study conducted by Yale University, Japan ranked 14th in environmental performance.

The quality of life in Japan is high, and the United Nations Development Program (UNDP) Human Development Reports ranks the country 11th in overall quality of life. All Japanese have access to clean water and proper sanitation, and the amount of malnourishment in the country is negligible.

With only 4.6 percent of its population in agriculture, Japan is a major importer of food products. Despite the fact that they are small in number, Japanese farmers use more pesticides per acre than any other nation in the world. Local governments were assigned the responsibility for monitoring industrial and agricultural pollution until the mid-20th century, when major environmental fiascos called for greater national oversight. However, local governments retained the right to pass supplementary environmental legislation, which is often more rigid than national laws.

Japan is an island chain located between the North Pacific Ocean and the Sea of Japan. The topography is generally rugged and mountainous, and the climate varies from tropical to cool temperate. Japan is also a land of volcanoes, with some 1,500 seismic occurrences each year, along with typhoons and tsunamis that cause major flooding and environmental damage. Japan has suffered both politically and economically from a dearth of natural resources, possessing only fish and a few mineral deposits. Environmentally, Japan's major problems are air pollution from power plants that have caused acid rain and the acidification of lakes and reservoirs that have lowered the quality of drinking water and posed a hazard to marine life. In addition to threatening its own environment, Japan has been called an "eco-outlaw" because it creates major environmental problems in others nations, particularly through the depletion of tropical timber. Japanese industrialists have also set up businesses in countries such as Indonesia, Venezuela, and Brazil, where environmental laws are less strict. As a result, these countries have increased levels of pollution.

Almost 80 percent of the Japanese people live in urban areas. Consequently, Japan is responsible for 5.2 percent of the world's carbon dioxide emissions, which are believed to be the major reason for global warming. In order to cut down on these emissions, the Japanese government has begun using low-emission vehicles for official use and has enacted the NO_x (nitrogen oxides) law of 2001 that tightened pollution standards for diesel vehicles. Other attempts to control pollution include stricter standards for the use of pesticides and tighter control over the emission of nitrate nitrogen, fluorine, boron, and ammonia into water sources.

Japan's long history of organized environmental support began in the late 19th century, when locals discovered that the Ashio Copper Mine, 100 kilometers north of Tokyo, was releasing large clouds of sulfuric acid into the air and polluting the water of the Watarase River used by rice farmers. In addition to health problems, the pollution was destroying nearby forests. The Ashio Riot of 1907 lasted three days, culminating with miners setting fire to the mining complex. Martial law was subsequently declared to restore order. Environmental protests were revived in the 1960s due to high-profile lawsuits involving the cadmium poisoning of residents of Toyama, the mercury poisoning of the inhabitants of Minamata and Niigata, and high incidences of asthma caused by exposure to sulfur dioxide in Yokkaichi.

Other illnesses during this period were traced to high emissions of sulfur dioxide and to industrial and agricultural pollution of water sources due to the lack of adequate treatment facilities. Between 1960 and 1965, the concentration of sulfur dioxide in Japan rose from .015 ppm to .060 ppm, resulting in high incidences of asthma and other respiratory diseases. Between 1960 and 1980, concentrations of nitrogen oxide rose from .005 ppm to .03 ppm. In the Inland Sea, scientists discovered red tides, caused by chemicals in the water that stimulated the growth of algae and destroyed marine life. The incidence of red tides increased from 60 in 1968 to 300 in 1977.

Japan is the second major industrial power in the world, outranked only by the United States.

During the 1970s, some 3,000 Japanese environmentalists groups were formed, and the government responded by passing new environmental laws and establishing stronger enforcement mechanisms. The Japan Environment Corporation, which funded business costs of installing environmental control equipment, was also established. In 1968, Japan passed the Basic Law for Environmental Pollution Control and forced industries to compensate the victims of industrial pollution, even in the absence of overwhelming evidence to link particular pollutants to local health problems. The law has since been revised, with stricter regulations and enforcement. In 1971, Japan created the Environment Agency to monitor environmental compliance and provide aid to victims of environmental pollution.

GOOD ON ITS PLEDGE

When the major industrial nations attending the 1972 United Nations Conference on Human Environment in Stockholm, Sweden, pledged to reduce sulfur dioxide emissions, Japan was the only nation to follow through. However, economic problems in the 1980s and early 1990s led to decreased attention to the environment, despite the fact that physicians and scientists had identified nitrogen oxide in the air as a major cause of respiratory illnesses. Interest in environmentalism was rejuvenated in 1995 and 1997, when Japan experienced nuclear reactor accidents, and a major oil spill in the Sea of Japan in 1997 further aroused public interest. However, 90 percent of Japan's 4,500 environmental groups are locally based, and they have little power at the national level. Japan Tropical Action Network has been the most effective Japanese environmentalist group, successfully promoting a decrease in the amounts of tropical timber imported into the country.

The processes of industrialization and afforestation, and converting open land into forest to supply timber demands, have left Japan with almost no wilderness and with major problems in sustaining the wildlife population. Of Japan's 144,687 square miles (374,744 square kilometers) of land, only 6.8 percent is under national protection. Critics claim that formerly protected land has been given over to recreational areas. Japan is home to 188 species of mammals, and 37 of these species are threatened with extinction. At least 210 species of birds reside in Japan, and approximately 34 of those species are currently threatened. Japan has also been harshly criticized by environmentalists around the world for its continued support of the whaling industry.

Since the 1997 Kyoto Protocol, the Japanese government has remained committed to curbing environmental pollution and is attempting to achieve its goal of reducing greenhouse gases 6 percent by 2012. This is being accomplished in part through the Official Development Assistance (ODA) program that ties development loans to other countries to the purchase of carbon credits, as is permissible under the Kyoto Protocol. The government also requires such countries to purchase Japanese products and services. In 2001, the Japanese created a Ministry of Environment to replace the Environmental Agency. The new ministry was given the responsibility to establish new regulations for air, water, and soil conservation and to protect wildlife and national parks. Recycling has become a major goal of Japan's new environmental policies, as is regulation of chemicals, radioactivity, wastewater treatment, and conservation of all natural resources.

Japan participates in the following international agreements designed to promote improved guardianship of the environment: Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Seals, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Acid Rain; Carbon Dioxide; Carbon Trading; Endangered Species; Floods and Flood Control; Kyoto Protocol; Minimata; Nitrogen Oxides; Pollution, Air; Pollution, Water; Red Tides; Sulfur Dioxide; Whales and Whaling.

BIBLIOGRAPHY. Asia Environmental Review, "Japan," www.environmental-center.com (cited March 2006); Brendan F.D. Barrett and Riki Therirel, *Environmental Policy and Impact Assessment in Japan* (Routledge, 1991); Jeffrey Broadbent, *Environmental Politics in Japan: Networks of Power and Protest* (Cambridge University Press, 1998); CIA, "Japan," *The World Factbook,* www.cia.gov (cited March 2006); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Nimura Kazua, *The Ashio*

Riot of 1907: A Social History of Mining in Japan (Duke University Press, 1997); UNDP, "Japan," www.hdr.undp.org (cited March 2006); David Wallace, *Environmental Policy and Industrial Innovation: Strategies in Europe, the United States, and Japan* (Earthscan, 1995); Anny Wong, *The Roots of Japan's International Environmental Policies* (Garland, 2001); World Bank, "Japan," *Little Green Data Book,* www.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Jet Stream

THE JET STREAM is a relatively narrow band of fast, west-to-east flowing air found above the polar front at an altitude of around 6–7 miles (9–12 kilometers) above the surface. The jet stream is produced by the strong pressure gradient that arises from the contrast between the cold air north of the polar front and the warmer air to the south. Winds in the jet stream average about 75 miles per hour (125 kilometers/hour) in winter, when the temperature contrast across the polar front is greatest, and are slower in summer when the temperature contrast is reduced. Wind speeds are variable, however, especially in winter, when segments of the jet stream will often have wind speeds topping 125 miles per hour (200 kilometers/hour). The location of the polar front, and the jet stream above it, also varies seasonally, retreating northwards into Canada in summer and shifting southwards as far as northern Mexico during the winter.

Upper level winds, including the jet stream, tend to flow in sinuous patterns called Rossby Waves, in which the prevailing west-to-east flow meanders north/south in large arcs known as troughs (curves to the south) and ridges (northward bends). These wave patterns gradually change over a period of days, typically with the ridges and troughs slowly migrating to the east and gradually increasing and decreasing in curvature. Jet stream winds flow through the Rossby Waves like water flowing down a curving river, while the shape of the Rossby Waves continuously varies.

The earliest experience of the jet stream came during World War II, as high-altitude U.S. aircraft such as the B-29 bomber encountered extremely fast headwinds as they attempted to fly westward across the Pacific. Today, aviators rely on accurate knowledge of the jet stream position in planning routes in order to avoid the delays, excessive fuel consumption, and turbulence that result from attempting to overcome these strong headwinds. Although the jet stream would assist an eastward bound flight, the associated turbulence can still be hazardous to aircraft and passengers.

The position of the jet stream also has a significant affect on surface weather. Cold air is found north of the polar front, while warmer air is to the south. Troughs in the jet stream guide cold air southward, while ridges bring unusually warm air to the north. More dramatically, the speed and path of the jet stream helps to determine where storm systems such as midlatitude cyclones are able to form. When a deep trough forms in the jet stream, there is a tendency for upper-level air to diverge or spread out on the downstream (east) side of the trough. This upper-level divergence causes air to be drawn up from the surface, which produces a cyclone (a region of low pressure with winds spinning in a counterclockwise direction). As the cyclone spins, cold air is pushed south, producing a cold front, while warmer air is pushed northward, producing a warm front. The entire system is blown generally eastward in the direction of the upper-level flow. Midlatitude cyclones tend to form in the winter when upper-level flow is strongest, and often are associated severe weather, including thunderstorms, heavy precipitation, and tornadoes.

SEE ALSO: Atmosphere; Precipitation; Weather.

BIBLIOGRAPHY. Jay R. Harman, *Synoptic Climatology of the Westerlies: Process and Patterns* (Association of American Geographers, 1991); Frederick K. Lutgens and Edward J. Tarbuck, *The Atmosphere,* 8th ed. (Prentice-Hall, 2001); Joseph M. Moran and Michael D. Morgan, *Meteorology: The Atmosphere and the Science of Weather,* 5th ed. (Prentice-Hall, 1997).

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Johnson, Lyndon Administration

THE PRESIDENTIAL ADMINISTRATION of Lyndon B. Johnson (1963–69) is most remembered for the sweeping domestic reforms under its Great Society Program and the continual struggle presented by the war in Vietnam. The Great Society initiative was announced by Johnson in a speech given at the University of Michigan in Ann Arbor on May 22, 1964, in which he set out his plan to establish a series of working groups to hold conferences "on the cities, on natural beauty, on the quality of education, and on other emerging challenges." Soon after, task forces were established to study virtually every aspect of the American society and to come up with domestic policy to address problem areas. Among these was the Task Force on Pollution of the Environment.

In the years preceding Johnson's Great Society, environmental programs concentrated primarily on the conservation of natural resources and less on proactive measures to remedy environmental degradation. The environmental programs proposed and created under the Great Society umbrella were precedent setting in their scope. During the Johnson Administration, the environmental programs enacted included the Aircraft Noise Abatement Act (1968), a series of acts and amendments addressing air and water quality, The Endangered Species Preservation Act (1966), The Land and Water Conservation Fund Act (1965), the National Historic Preservation Act (1966), the National Trail System Act (1968), the Solid Waste Disposal Act (1965), the Wild and Scenic Rivers Act (1968), and the Wilderness Act (1964).

Amendments to the Clean Air Act of 1963 included the Motor Vehicle Air Pollution Control Act (1965), which established standards for automobile emissions. The legislation also set up research efforts to determine resulting health damages. In 1966, an amendment to the act expanded local air pollution control initiatives, and the 1967 amendment established Air Quality Control Regions throughout the country to monitor and report emission levels. In addition, the 1967 amendment established one national standard for emissions.

The Solid Waste Disposal Act of 1965 was established, and the Public Health Service was charged with creating and enforcing regulations for the collection, transportation, recycling, and disposal of solid wastes. Prior to this legislation, most solid wastes ended up in unregulated landfills. Subsequent to the new regulations landfills were required to have a liner and an integral collection system to prohibit contaminated water from entering groundwater systems. The Land and Water Conservation Fund Act of 1965 established a fund for federal and state acquisition of land and water bodies for recreational and conservation purposes.

The degree and quality of the environmental legislation created under the Johnson administration was superb and far reaching. For the first time in U.S. history, a collective societal view existed toward environmental protection. This view carried forward to the Richard Nixon administration when the expansive National Environmental Policy Act of 1969 was prepared and signed into law on January 1, 1970.

SEE ALSO: Clean Air Act; Nixon, Richard Administration; Wilderness Act.

BIBLIOGRAPHY. Robert A. Divine, ed., *The Johnson Years, Volume Two: Vietnam, the Environment, and Science* (University of Kansas Press, 1990); Bruce L. Schulman, *Lyndon Johnson and American Liberalism: A Brief Bibliography with Documents* (St. Martin's, 2006); Jeffrey W. Helsing, *Johnson's War/Johnson's Great Society: The Guns and Butter Trap* (Greenwood, 2000).

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Joint and Several Liability

JOINT AND SEVERAL liability is a U.S. legal provision where all parties to a prosecution can be held individually liable for up to the full amount sought by a plaintiff, irrespective of the amount of responsibility the individual defendant may be for the overall cost. For example, a negligent ship's maintenance crew could be held severally responsible for the full cost of an oil spill occurring when the ship suffers a mishap. The very high costs of many forms of environmental degradation greatly exceed the ability of most defendants to pay. Consequently, there has been a tendency for plaintiffs and their legal representation in such cases to "search for deep pockets"—that is, attempt to prosecute those individuals and organizations considered best able to pay for damage allegedly caused, no matter how tenuous their connection to the incidents. This has led to pressure upon individual states to amend their laws, largely because of the pressure that has been brought to bear on medical care providers as well as medical insurance systems.

This process of reform has led to legal changes in 37 U.S. states in the process known as tort reform. This was a central policy of the second Bush candidature in 2004 and received more prominence due to Democratic candidate John Kerry's choice of running mate, John Edwards, since Edwards was a trial lawyer and was characterized, somewhat unfairly, as an "ambulance chaser." The power of the corporate lobby under the Bush administration has led to a tide of tort reform legislation. Many people claim that joint and several liability—an important part of the checks and balances of an advanced democratic state—represents the only meaningful method of holding corporations to account for damages, and that abolishing or compromising it represents a serious impairment of the rights of individual people. Corporate malfeasance, environmental degradation, lack of appropriate health and safety conditions in workplaces, and other questionable practices represent a potent body of evidence to support this viewpoint. Joint and several liability is of particular importance in the area of maintaining effective protection of the environment because of the multifactorial nature of environmental degradation.

SEE ALSO: Bush, George W. Administration; Common Law; Oil Spills.

BIBLIOGRAPHY. American Tort Reform Association, www.atra.org (cited July 2006); Lewis A. Kornhauser and Richard L. Revesz, "Multidefendant Settlements: The Impact of Joint and Several Liability," *Journal of Legal Studies* (v.23/1, 1994); National Association of Mutual Assurance Companies, www.namic.org (cited July 2006); Berkeley Rice, "If You're the Deepest Pocket," *Medical Economics* (v.82/17, 2005).

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Joint Forest Management

THE FOOD AND Agriculture Organization of the United Nations (FAO) defines *Joint Forest Management* as "a forest management strategy under which the government (represented by the Forest Department) and the village community enter into an agreement to jointly protect and manage forestlands adjoining villages and to share responsibilities and benefits."

Taking from the principle of the "Inhabited Forest," Joint Forest Management (JFM) aims to promote a fair way to define and organize the relationships between four elements: the state, forests, forest exploiters, and the local population. Instead of conceiving the local communities as nonexperts or ignorant indigenous who can not exploit forest or take advantage of the woods or would spoil the resources, Joint Forest Management calls for local people's participation with the forest exploiters, keeping in mind that most of the productive forestland (known as "Public Forests," or "Crown land" in Canada) is owned by the state: that is, the whole population. In that sense, Joint Forest Management is conceived as a way to fight poverty or to avoid conflicts with aboriginal groups, wherever forest resources are exploited in a specific region.

In many aspects, Joint Forest Management as a concept emerges from the principles of various, earlier perspectives such as "local community involvement in conservation," social forestry, ecomanagement, and sustainable development. For instance, an early report made for the United States Agency for International Development in Nepal in 1978 already called for "*Community Involvement in Conservation*." Furthermore, sociologist Nandini Sundar even argues that the idea of Joint Forest Management already existed in the 1930's (without using that specific expression), but the strategy did not flourish because it did not have the support of advocacy groups and NGOs.

In many ways, the advent of Joint Forest Management is like a possible answer to the wish of Jack Westoby (1912–88), who was Senior Director of the Department of Forestry at the FAO, when he called for "a truly social forestry," made first for humans. In his posthumus book *Introduction to World Forestry: People and Their Trees*, Westoby argued that

"Forestry is not about trees, it is about people. And it is about trees only insofar as trees can serve the needs of people."

Although many initiatives were experienced in the 1980's, Joint Forest Management officially began in India in 1990, when the Government of India issued its new policy guidelines for the involvement of village communities and voluntary agencies in the regeneration of degraded forest lands. Currently, Joint Forest Management is applied in a few countries, like Nepal, Australia, Canada, India (in the province of Karnataka), and in some African countries.

Since Joint Forest Management is an evolving policy in various contexts, critics and concerns have been raised, for instance by communities who were counting on more stable profits. Sharachchandra Lele, from the Centre for Interdisciplinary Studies in Environment & Development (CISED) in Bangalore has expressed some worries.

That emerging concept has various labels that are much similar. In Canada (and mostly in Québec), Joint Forest Management is refered to as "Aménagement conjoint des forêts." In France, NGOs use a rather different expression: "Gestion forestière conjointe." In India, people sometimes say "Joint Forest Planning and Management," "Participatory Forestry," or "Participatory Forest Management." A group of Canadian scholars have published an online annotated bibliography on Joint Forest Management, which remains the most comprehensive source on that matter.

SEE ALSO: Eco-Management; Environmental Education; Forest; India; Inhabited Forests; Poverty; Public Forests; Social Ecology; Social Forestry; Sustainable Development.

BIBLIOGRAPHY. J.G. Campbell, *Community Involvement in Conservation*. (United States Agency for International Development, 1978); The Energy and Resources Institute, India, Joint Forest Management, www.static.teriin.org; FAO, Forestry Paper 64: *Tree Growing by Rural People*, 1986, www.fao.org; Food and Agriculture Organization of the United Nations (FAO), www.fao.org (cited December 2006); Government of Canada, Natural Resources, *Testing a New Concept: Joint Forest Management,* www.nrcan.gc.ca (cited December 2006); Government of India, Ministry of Environment and Forests, *Joint Forest Management: A Decade of Partnership* (Resource Unit for Participatory Forestry, 2002); Mary Hobley, *Building State-People Relationships in Forestry*, (Overseas Development Institute, 2005); Modern Architects for Rural India, Joint Forest Management, www.ltam.lu (cited December 2006); Kate Schreckenberg, Cecilia Luttrell, and Catherine Moss, *Participatory Forest Management: An Overview*. Forest Policy and Environment Programme (Overseas Development Institute, 2006); Erin Sherry, Gail Fondahl, Berverly Bird, and Regine Halseth, *Joint Forest Management: An Annotated Bibliography of Selected Resources* (University of Northern British Columbia, 2003); Jack Westoby, *Introduction to World Forestry: People and Their Trees* (Blackwell, 1989);

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Jordan

MANAGING TO MAINTAIN an independent stance in the face of enormous international pressure, the Hashemite Kingdom of Jordan under King Hussein (1953–99) evolved in the late 20th century as a parliamentary democracy that promoted liberalization of its economy. After succeeding to the throne upon his father's death, King Abdallah II instituted political reforms aimed at fighting poverty and ending political corruption. With a per capita income of $4,800, Jordan is ranked 139th of 232 countries in world incomes. Official estimates place the poverty rate at 15 percent, but it is likely that the actual rate is at least twice the official count, partly because of the high unemployment rate. There is considerable economic inequity in Jordan, with the richest 10 percent of the population holding nearly 30 percent of all wealth. The United Nations Development Program UNDP Human Development Reports rank Jordan 90th in the world in overall quality-of-life issues.

With only 26 miles (42 kilometers) of coastline along the Gulf of Agaba, Jordan's other significant waterways are the Dead Sea, which is shared with Israel, and the Jordan River, located along the Israeli and Syrian borders. Both Jordan and Israel bear responsibility for the ecological damage done to the

Dead Sea, where the water level has diminished to such an extent that it is in danger of disappearing altogether. Proposals for preventing further damage have led to intense controversy, and some environmentalists fear for the ecological balance of the Dead Sea. Around 90 percent of Jordan's land area is arid desert, but the western section of the country experiences a distinct rainy season from November to April. The Great Rift Valley divides the East and West Banks of the Jordan River. As a result of the arid climate, Jordan experiences frequent droughts and periodic earthquakes.

With an average of only 42,268 gallons (160 cubic meters) of water per individual available for consumption each year, Jordan is among the top ten countries in the world suffering from the lack of a fresh natural water supply. Consequently, the government began developing policies to address this issue in the first quarter of the 20th century. Solutions include the use of water-saving devices and the practice of recycling wastewater for agricultural use. Less than 3 percent of Jordan is arable, and the Jordan River provides the only major source of water for agriculture and industry. The government has purposefully curtailed agriculture because of its intensive drain on scarce water supplies. In 2000, the Ministry of Water and Irrigation in conjunction with the American Academy for Educational Development launched the Water Efficiency and Public Information for Action program designed to promote the installation of water-saving devices in homes and businesses and teach Jordanians of all ages and social classes how to conserve water.

Deforestation in Jordan has reduced forested areas to only 1 percent of total land area. Less than 4 percent of the land is nationally protected. Jordan was once home to some 347,000 species of birds. Currently, of 117 endemic bird species, eight are threatened. Of 71 endemic mammal species, 10 are endangered. For instance, the oryx, a large desert antelope, totally disappeared in Jordan in response to hunting and disease. An international effort to restore the oryx to Jordan has been successful, although the animal's survival remains somewhat precarious. Several species of apes are also endangered in Jordan due to their being killed for bush meat and to loss of habitat.

Agricultural mismanagement in Jordan has led to overgrazing, soil erosion, and desertification. In 2006, scientists at Yale University ranked Jordan 64th of 132 countries in environmental performance, roughly in line with the relevant income and

The Roman City of Jerash

Although the deserted city of Petra is the best-known tourist site in Jordan, Jerash in the north of the country is the best-preserved Roman provincial city in the Middle East.

Curiously, the city of Jerash was not along any important trade routes, but the area was very good for growing corn. It had been inhabited since Neolithic times but it became an important center during the period of Alexander the Great (died 323 B.C.E.). In 64 C.E., the Roman general Pompey conquered the region and Gerasa, as it was then known, became an administrative center for the Romans. By this time iron ore was mined near the city and in the 1st century C.E., the whole city was drawn up again on Roman lines with a colonnaded main street cut across by two side streets. The Temple of Artemis was in the center of the town and there were also two theaters. The Emperor Trajan centered more of the Roman regional administration in the city, and his successor the Emperor Hadrian visited it in 129 C.E. with a Triumphal Arch erected to mark the visit. Much of it still survives at the entrance to the old city. In the 3rd century Gerasa became a colony but then went into slow decline.

By the middle of the 5th century, Christianity was emerging as the major religion, and churches were built, with a few more added under the Emperor Justinian (reigned 527–565 C.E.), including the Church of St. John the Baptist near the remains of the Temple of Artemis. The town was captured by the Sassainian Persians in 614, and by Muslim Arabs in 636. It experienced an earthquake in 747 and massively shrunk in size. During the 12th century it became a Crusader garrison town but remained little known until 1878 when Circassians from Russia started work on the archaeological remains.

geographic groups. The lowest ratings were assigned in the categories of air quality, water resources, and the production of natural resources. Between 1980 and 2002, Jordan's carbon dioxide emissions rose from 2.1 per capita metric tons to 3.2. The country produces 0.1 percent of the world's share of carbon dioxide emissions. While only 7 percent of Jordan's population of 5,760,000 lack access to improved sanitation, the number of people with access to safe drinking water fell from 98 percent in 1990 to 91 percent in 2002. Jordan's natural resources are limited to phosphates, potash, and shale oil.

In 1980, the Jordanian government established the Department of Environment within the Ministry of Municipal, Rural and Environmental Affairs, assigning the department the task of coordinating the implementation and enforcement of Jordan's environmental laws and regulations. In 1986, Jordan adopted the National Environment Action Plan. Over the next five years, the government committed itself to pursuing sustainable development by passing the Law of Environmental Protection, which enhanced the government's ability to monitor compliance with environmental laws through the General Corporation for Environmental Protection. Jordan participates in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, and Wetlands.

SEE ALSO: Conservation; Deforestation; Desertification; Endangered Species; Petroleum; Poverty; Wastewater; Water.

BIBLIOGRAPHY. Francesca De Châtel, "Solving Jordan's Water Problems by the People, for the People," www.islamonline.net (cited May 2006); CIA, "Jordan," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Alanna Mitchell, "Dancing at the Dead Sea: Tracking the World's Environmental Hotspots" (*University of Chicago Press*, 2005); One World, "Jordan: Environment," www.uk.oneworld.net (cited May 2006); UNDP, "Human Development Report: Jordan," www.hdr.undp.org (cited May 2006); World Bank, "Jordan," *Little Green Data Book,* www.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Justice

JUSTICE, LIKE SO many political, legal, and theological terms, has always challenged some of the best minds in the world. It is a key concept that plays a major role in the thinking of ethicists, human rights, natural law, and procedural law. And it is an elusive concept that is very difficult to define precisely. Fundamentally, it is the moral principle that a person should receive the type of treatment that he or she deserves.

Most people can easily recognize numerous actions that can be considered unjust. Injustice evokes anger at unfair treatment of either themselves or of another. However, even here, unfair treatment will evoke different responses depending upon what a person feels to be unfair.

Injustice is seen as a departure from a naturally occurring moral order. In Western civilization, concepts of natural justice or divine justice have been the grounds or inspiration for developing numerous moral concepts. Similar notions of a cosmic moral law expressive of justice are to be found around the world. In all cases they involve ideas of fair treatment. To some are due rewards and to some are due punishments, but in all cases fairly delivered.

As a theory of moral deserts, justice is the foundation of ethical judgments. In short, it is a system of rewards and punishments that are designed to fit the actions of those receiving justice. This should apply to the ethical theory that is the foundation of legal and social systems. It often does not.

In the case of justice and the environment, there are a range of views over what is and what is not justice. And these lie at the heart of what a state should establish in its governing of the relations between people.

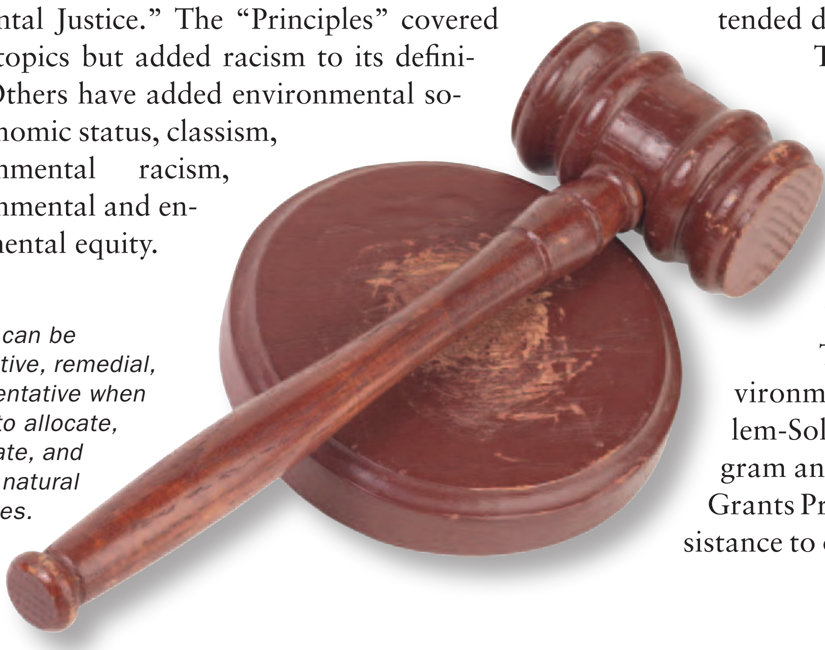
In relations between people, there have always been resource disputes over land, forests, water, minerals, or other aspects of nature or over the right to access. Historically, nature has been conceived as a commodity. However, the advent of the environmental movement has added a new element to the idea of justice, namely environmental justice. The concern is over the right use of nature.

ENVIRONMENTAL JUSTICE

Historically, for many in Western civilization, the creation mandate in the Book of Genesis (Gen.1:28) has been a passage that called for dominion over the earth and it creatures. However, the passage has also been interpreted as a obligation to exercise stewardship as a responsible ethic. This type of ethic has been brought to the public forum by environmental activists who are seeking to establish relationships between modern industrial society and the remnants of unspoiled nature, or demands for the restoration of spoiled nature.

Justice can be distributive when some authority acts to allocate available resources. Justice can also be remedial when it acts to remedy wrongs by restoring what was lost. Justice can also be preventative when it acts as a form of equity to prevent irreparable harms from taking place.

There are a range of definitions for environmental justice that go beyond the mere impact of environmental conditions such as the impact of pollution. In 1991 the People of Color Environmental Leadership Summit adopted "Principles of Environmental Justice." The "Principles" covered many topics but added racism to its definition. Others have added environmental socioeconomic status, classism, environmental racism, environmental and environmental equity.



Justice can be distributive, remedial, or preventative when it acts to allocate, remediate, and protect natural resources.

The National Governors Association uses a definition that focuses on protecting minority and low-income communities from having to bear a disproportionate share of pollution. A different definition has been adopted by the Board of Trustees of Environmental Defense, which operates a "Scorecard." The type of justice sought by environmentalists is preventative and remedial. It has been institutionalized in current American law as the fair treatment and meaningful involvement of all people irrespective of race, color, national origin or other qualification in the development of environmental policies, laws, and regulations.

ENVIRONMENTAL PROTECTION AGENCY

The Environmental Protection Agency (EPA) has set this as its policy goal so that the environment may be protected, health hazards may be prevented, and equal access to both natural resources and to the decision-making process about the environment. In order to implement its policy, the EPA created the Office of Environmental Justice in 1992. Its goal was to integrated environmental justice into EPA's policies, programs, and activities. On September 30, 1993 the EPA established the National Environmental Justice Advisory Council (NEJAC). The council was created as a forum for academics, the community, environmental groups, industry, and indigenous peoples, and also for the state, local, and tribal governments, who are all stakeholders in the environment. NEJAC exists to find solutions to environmental justice problems through extended dialog about specific topics.

The business of NEJAC is conducted under the leadership of a Designated Federal Officer (DFO). It is bound by the requirements of the Federal Advisory Committee Act (FACA) of 1972. The findings of subcommittees of the NEJAC make recommendations.

The EPA also supervised the Environmental Justice Collaborative Problem-Solving Cooperative Agreement Program and the Environmental Justice Small Grants Program. Both provides financial assistance to organizations to achieve a number of objectives including identifying local environmental or public health issues, and for developing solutions that will empower the community through education, training, and outreach.

On February 11, 1994, President Bill Clinton issued Executive Order 12898 on Environmental Justice. This executive order made each federal agency responsible for making environmental justice a part of its mission. This was to be accomplished by identifying and addressing ways in which health and environmental effects of the respective federal agencies impacted people, especially minority and low-income populations in the United States and its territories: the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Marian islands.

It also applied to Native American Programs operated by the Department of the Interior in consultation with tribal leaders. The whole cost was to be borne by the federal government. Each agency was ordered to form working groups that would formulate strategies for implementing environmental justice into it regulations and practices. Among the specifics of the executive order were directions for collecting data and for identifying consumption patterns of fish and wildlife. The federal agencies are responsible for publicizing the risks posed by the currently polluted environment of eating fish, fowl, and wildlife.

Ultimately, proponents of environmental justice believe that the environment is where people live, work, and play, and seek to overcome the institutionalize forces that they believe work against a clean environment. The variations in definitions, goals, practices, and contradictory theories of environmental justice reflect the many local conditions and groups of people from which the movement arose.

SEE ALSO: Clinton, William Administration; Environmental Protection Agency (EPA); Environmental Racism.

BIBLIOGRAPHY. Robert D. Bullard, ed, *The Quest for Environmental Justice: Human Rights and the Politics of Pollution* (Sierra Club Books, 2005); Sue Cutter, *Hazards, Vulnerability and Environmental Justice* (Earthscan, 2006); Jonathan Harr, *A Civil Action* (Vintage Books, 1996); J.Timmons Roberts and Melissa M. Toffolon-Weiss, *Chronicles from the Environmental Justice Frontier* (Cambridge University Press, 2001); Peter S. Wenz, *Environmental Justice* (State University Press of New York Press, 1988).

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Kalahari Desert

THE KALAHARI DESERT is an arid region of sand and dry lakebeds in southern Africa extending into parts of Botswana, South Africa, and Namibia. The region is an interior plateau covering an area of approximately 100,000 square miles and lies between the Orange and Zambezi Rivers. The name Kalahari derives from the Tswana word *keir*, which means "the great thirst." Rainfall in the region averages eight inches annually, identifying it as a true desert. However, annual rainfall is extremely variable and ranges from a high of 15 inches to a low of three inches.

The Boteti River flows northward into a marshland at the northern edge of the desert, and carries excess water in years of high precipitation into Lake Xau. During the late 20th century and early 21st century, this volume of water significantly diminished. During periods of low precipitation, animals in the Kalahari are are forced to wander in search of water. A number of smaller, temporary streams and rivers will carry water, depending on the amount of precipitation. Vegetation in the Kalahari Desert is typical for an arid region and includes acacia woodland, savanna grasslands, and some palm trees. Animal life is abundant: springbok, giraffe, hartebeest, hyena, and warthog predominate.

The Kalahari is relatively sparsely populated. The main culture groups include the San people, Tswana, Herero, and Kgalagadi. In 2002 the Botswana government moved into permanent encampments all the San, who have lived in the region an estimated 30,000 years by traditionally hunting, gathering, herding, and raising crops. The governmental effort to settle the Bushmen was justified by a concern for environmental conservation, specifically to save diminishing water supplies. Experts on the region suggest that the government will increase the number of encampments in the future in order to more easily expand diamond-mining activity and formal ranching by majority populations.

There is considerable mineral wealth in the Kalahari. Coal, nickel, copper, and uranium deposits add to the economic inventory of the region. In addition, The Kalahari is home to diamond mines and one of the worlds largest is located at Orapa in the northeastern area of the region. There are a number of important game reserves within the Kalahari Desert. The Central Kalahari Game Reserve ranks as the second largest in the world. Also notable are the Khutse Game Reserve and the Kgalagadi Transfrontier Park.

SEE ALSO: Botswana; Desert; Namibia; South Africa; Water Quality.

The Gods Must Be Crazy

In 1980 the film *The Gods Must Be Crazy* was released. Directed by Jamie Uys and set in Botswana and South Africa, it was about the bushmen of the Kalahari presenting them as the "noble savages" leading a simple and utopian life style, which changed dramatically when a pilot in a passing aircraft drops an empty glass Coca-Cola bottle.

The bushmen recover the bottle, and soon start using it for a variety of purposes. The film pursues the concept of the discovery of something new, which everyone has survived for centuries without having, becoming so vital to the existence of many people in the tribe that they cannot do without it. The bottle is used in agriculture, craft work, and cooking. However, with only one bottle to share around all the members of the tribe, it soon leads to arguments over its use, hatred, and eventually even violence. For this reason, the bushmen decide that the bottle should be taken away and thrown off the edge of the world, with one of the bushmen, Xi, being delegated the task. The film is about his journey.

Although a comedy and a contrast between the new "civilized" world and life in primitive societies, *The Gods Must Be Crazy* reinforces problematic stereotypes about the society in which the bushmen lived. Drawing on ideas typical of colonial writing and so frequently invoked in the writings of Laurens Van der Post, romantic representations of hunter-gatherer societies like these produce a skewed vision of the "noble savage," where one modern invention leads to the upsetting of an otherwise perfectly adjusted society.

There has been a sequel, *The Gods Must Be Crazy II,* which was filmed in 1985 and released four years later. There have also been three unauthorized Chinese sequels that were intended to be pure comedies, and have only a vague connection with the authentic *The Gods Must Be Crazy* films.

BIBLIOGRAPHY. Nigel Dennis, *Survival in the Thirstland Wilderness* (Struik New Holland Publishers, 1997); *Global Deserts Outlook* (United Nations Environmental Programme, 2006); Rupert Isaacson, *The Healing Land: The Bushmen and the Kalahari* (Grove Press, 2003); Mark Owens and Delia Owens, *Cry of the Kalahari* (Mariner Books, 1992).

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Karst Topography

KARST TOPOGRAPHY RESULTS from the dissolution of subsurface carbonate rock (calcite and dolomite) through the percolation of slightly acidic moisture in the form of carbonic acid, which is formed from rainwater picking up carbon dioxide in both the atmosphere and the soil. Once within the carbonate rock layers, the acidic liquid begins to dissolve the rock, leading to landscapes with numerous cave features. A common outcome is also the development of sinkholes, where the dissolved subsurface rock layer can no longer support soil and rock above it and collapses. Karst landscapes can develop from fluvial formations (surface water) and underground drainage. The term *Karst* is rooted in the German place name, Kras, designating a region in Slovenia extending into Italy, where the first research on Karst topography was conducted.

Sinkholes can appear suddenly and with no warning, resulting in the loss of farm machinery, buildings, and cattle. In 1981, a sinkhole in Winter Park, Florida, opened up to a diameter of nearly 1,000 feet, swallowing several cars, a home, and half of a swimming pool. It is estimated that more than 25 percent of the world's population lives in an area of Karst landscape or relies on areas of this composition for its water supply. Because Karst regions are particularly susceptible to water pollution, sources of drinking water can be at risk. The flooding of caves in the Bowling Green, Kentucky, area in the mid–1980s caused industrial waste to enter wells in the region.

The conterminous United States, with 20 percent of its land surface on Karst topography and nearly 40 percent of groundwater deriving from Karst underground sources, is particularly vulnerable to water pollution. The presence of landfills, cattle gazing areas, and septic tanks on Karst landscapes provide additional hazards to water supplies when disruptions occur. Agriculture within Karst regions can also be problematic. Normally fertile soils can become leached of nutrients when rapid drainage occurs, preceding periods of drought. Millions of dollars are spent in the United States alone to repair fields and roads disrupted by Karst dissolutions and resulting sinkhole formation.

Karst regions are found throughout the world. A considerable number of Karst landscapes are found in Asia (China, Laos, Malaysia, Thailand, and Vietnam), a number of countries in Europe, the island of Madagascar, and throughout North America and Central America. Kentucky and Florida lead all states in the number of Karst regions. Karst topography can also become a tourist attraction. The famous Carlsbad Caverns in New Mexico is a case in point. Thousands of tourists visit the expansive caverns annually to view its dramatic stalactite and stalagmite formations.

SEE ALSO: Geography; United States, Central South; United States, Gulf Coast South.

BIBLIOGRAPHY. Robert W. Christopherson, *Geosystems: An Introduction to Physical Geography* (Prentice Hall, 1997); Alan H. Strahler and Arthur N. Strahler, *Introducing Physical Geography* (John Wiley & Sons, 2003); Edward J. Tarbuck and Frederick K. Lutgens, *Earth, An Introduction to Physical Geology* (Prentice Hall, 2002); William B. White, *Geomorphology and Hydrology of Karst Terrains* (Oxford University Press, 1988).

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Kazakhstan

DOMINATED BY RUSSIA during much of its history, the Republic of Kazakhstan has struggled to develop a national identity after the exodus of large numbers of Russian immigrants following independence in 1991. Today, Kazakhs make up 53.4 percent of the ethnic mix in Kazakhstan, while remaining Russians and Ukrainians constitute one-third of the population. The Kazakh economy has traditionally been dependent on oil, gas, and mining. In 2001, the Caspian Consortium pipeline stretching from Tengiz, Kazakhstan, to the Black Sea, provided a means of substantially increasing Kazakh oil exports. The government is currently negotiating with China to build an additional pipeline.

The government is now attempting to diversify the economy, in which one-fifth the workforce is involved in agriculture. Extensive natural resources include iron ore, manganese, chrome ore, nickel, cobalt, copper, molybdenum, lead, zinc, bauxite, gold, and uranium. With a per capita income of $8,800, Kazakhstan ranks 81st of 232 nations in world incomes. Some 19 percent of the people live below the national poverty line. The United Nations Development Program (UNDP) Human Development Reports rank Kazakhstan 80th in the world in overall quality-of-life issues.

Kazakhstan borders two sections of the Aral Sea (663 miles) and the Caspian Sea (1,174 miles). With a total area of 1,049,150 square miles, the country supports a population of 15,186,000. The continental climate in some areas leads to cold winters and hot summers. Elsewhere, the climate is arid and semiarid. Kazakhstan extends from the Volga to the Altai Mountains, with the plains in western Siberia giving way to oases and desert in Central Asia. Elevations vary from 433 to 22,949 feet. Southern Kazakhstan is subject to earthquakes, and mudslides are common in the Almaty area.

Kazakhstan's main river, the Syr Darya, was diverted from its course during the Soviet era to irrigate the desert. This river, along with the Amu Darya in Uzbekistan, flows toward the Aral Sea bordering the country in the south, leaving this historically vast freshwater body with almost no inflow. As a result, the Aral Sea is drying up, and is now half its original size, leaving large deposits of chemical pesticides and natural salts that turn into noxious dust storms when they are picked up by the wind. Coupled with chemical and biological warfare waste deposits, the area represents an ecological disaster on an enormous scale. Conversely, the sea level at the Caspian Sea on Kazakhstan's western border, which is also heavily polluted, is steadily rising.

As in many former Soviet republics, Kazakhstan was left with a legacy of toxic chemical sites created by the defense industry. Radiation residue from test ranges places all life forms at great health risk. Fourteen percent of Kazakhs lack access to safe drinking water, and 28 percent lack access to improved sanitation. In urban areas, where 55.9 percent of the population reside, industrial pollution is widespread. The country produces 0.5 percent of the world's carbon dioxide emissions. Kazakhstan's two main rivers, which were diverted from their course toward the Aral Sea, are also drying up. Conversely, the sea level at the Caspian Sea, which is also heavily polluted, is steadily rising.

Agricultural mismanagement, including overuse of poisonous chemicals, has polluted the soil; and poor infrastructure and improper irrigation have produced salination. In 2006, a study by scientists at Yale University ranked Kazakhstan 70th out of 132 countries in environmental performance, slightly above the relevant geographic group and below the relevant income group. The lowest score was received in the category of biodiversity and habitat. With 4.5 percent of the country forested, only 2.7 percent of Kazakhstan's land area is protected. Sixteen of 178 endemic mammal species are endangered, and 15 of 379 endemic bird species are likewise threatened.

A large grassroots environmental movement has surfaced in Kazakhstan. The largest group is the Nevada-Semipalatinsk, which gathered more than two million signatures within a week in 1989 to force a ban on nuclear testing. Operating under the National Environmental Action Plan for Sustainable Development, the Ministry of Natural Resources and Environmental Protection has the responsibility for policy planning and implementation of environmental laws and legislation in Kazakhstan.

The U.S. Environmental Protection Agency and international agencies such as the World Bank and the International Monetary Fund are also heavily involved with cleanup activities in Kazakhstan. The government has signed the following international agreements: Air Pollution, Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection, and Ship Pollution. The Kyoto Protocol has been signed but not ratified.

SEE ALSO: Aral Sea; Drinking Water; Petroleum; Pesticides; Pollution, Water; Radiation.

BIBLIOGRAPHY. CIA, "Kazakhstan," *The World Factbook,* www.cia.gov/cia (cited April 2006); Country Studies, "Kazakhstan: Environment," www.country-studies.com (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); Robert C. Paehlke, *Democracy's Dilemma: Environment, Social Equity, and the Global Economy* (MIT Press, 2003); UNDP, "Kazakhstan," www.hdr.undp.org (cited April 2006); World Bank, "Kazakhstan," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Kennedy, John F. Administration

JOHN F. KENNEDY (1917–63), a Democrat, was the 35th president of the United States. Elected in 1960 and assassinated three years later, Kennedy was succeeded by his vice president, Lyndon B. Johnson. Kennedy was a glamorous and charismatic figure from a large and influential family in Boston, Massachusetts.

Kennedy narrowly won the 1960 presidential race, having defeated the Republican candidate, Richard M. Nixon. Kennedy's 1,000-day presidency was dominated by the threat of the Cold War and Communism. Kennedy was determined to advance the American national interest by combating Communism around the world. This led to an escalation of support for the government of South Vietnam and, ultimately, to the full-scale American war in Vietnam.

Kennedy presided during a period when environmental policy and issues were largely state and local level regulatory affairs and pollution controls were managed primarily through nuisance law. As a result, his administration has no direct environmental legacy in policy innovation. Nevertheless, the Gemini and Apollo programs, designed to put a man on the moon in less than a decade, radically reconfigured not only the relationship of science and engineering in the government but resulted in some of the most important transformations of human relationships with the planet.

The development of the National Aeronautics and Space Administration (NASA), an interdisciplinary science and engineering effort, linked military flight engineering and experimentation. This innovative conglomeration of expertise, funded heavily from federal sources, not only propelled attention to the moon, but also resulted in countless ancillary benefits of innovation in environmental management, materials engineering, and computing. The legacy of the Apollo program in directing science and engineering research and inspiring young people to pursue education in physical and environmental sciences fundamentally changed America.

Less instrumentally, the Gemini and Apollo programs resulted in startling images of the earth as seen from space, images that would help to transform the imagination of people around the world towards seeing the planet not as a boundless and differentiated place, but as a unified and fragile one. This image and others that followed over the next decades are fundamental to the global imaginations of contemporary environmentalism, and are essential even to the founding of "Earth Day," with its ubiquitous picture of the globe.

SEE ALSO: Johnson, Lyndon, Administration; Nixon, Richard, Administration; Nuclear Weapons; Space Program (U.S.); Vietnam.

BIBLIOGRAPHY. The John F. Kennedy Presidential Library and Museum, www.jfklibrary.org (cited November 2006); Michael O'Brien, *John F. Kennedy: A Biography* (Thomas Dunne Books, 2005); Richard Reeves, *President Kennedy: Profile of Power* (Simon and Schuster, 1994). Biography of John F. Kennedy, www.whitehouse.gov (cited November 2006).

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Kenya

THE REPUBLIC OF Kenya is a relatively young geopolitical entity, having gained independence from British rule in 1963. Yet, the area that comprises present-day Kenya and its East African neighbors has been called the cradle of humankind, due to fossil evidence that suggests the region has been a hub of hominine activity for over 4 million years. While Kenya's landscapes are renown for their wildlife, nature reserves, and national parks, continuous human and prehuman presence means they are entirely anthropogenic.

Kenya is bordered by the Indian Ocean and Somalia to the east, Ethiopia to the north, Sudan to the northwest, Uganda and Lake Victoria to the west, and Tanzania to the south. The country is bisected by the equator. With an area of approximately 225,000 square miles (about twice the size of Arizona), Kenya has great geographic diversity. It includes wide, sandy beaches and coral reefs along the coastal belt; the Eastern African plateau with its semiarid plains; the Rift Valley, its series of lakes, and its surrounding fertile uplands; northern deserts; and Mt. Kenya's snow-capped peaks at 5,199 meters above sea level, making it Africa's second tallest mountain, the tallest being neighboring Tanzania's Mt. Kilimanjaro.

The few millennia prior to colonization saw population increases and subsistence practice shifts due to in-migrations of Cushitic, Nilotic, and Bantu speakers. Although Arab traders had settled the East African coast a millennium beforehand and established a string of thriving Swahili city–states, the Berlin Conference (1884–85) marked the beginning of colonial demarcation of African land, through which Britain claimed an area including today's Kenya. The Imperial British East Africa Company (IBEAC) received a royal charter in 1888 to "prepare" the colony and promote its commercial interests, and to some degree it did. However, the IBEAC went bankrupt by 1895, after which the British government assumed direct control over Kenya.

By the mid–1890s, the British had relocated, recruited, and imported enough people to begin work on the Kenya–Uganda railway. With its railhead in Nairobi, the railway stretched from coastal Mombasa to Lake Victoria by 1901, thus further opening the interior of Kenya to British and Asian settlers, farmers, and traders. British colonists restricted access to land and animals, relocated Africans (Maasai and Gikuyu) into reserves, and established means by which they could act upon the Dual Mandate: the notion that the colonial enterprise was not only meant to benefit resource-challenged, industrial and expansionist Britain, but also to enable the "development" of Africans. A British crown colony by 1920, Kenya Colony attracted increasing numbers of white settlers, whose social and economic investments in Kenya severely disrupted the ideals of indirect rule established by the British crown. Settlers and colonial administrators relied on the labor of colonized peoples to build the infrastructure for transporting cash crops and other raw materials to Europe. Colonial rule imposed systems of taxation, compulsory labor, cash-based markets, and limited, skills-based education on Africans.

Kenya's expansive game reserves were meant to serve colonists and elites from abroad. The game reserves of the late 1890s and early 1900s were eventually replaced by national parks and reserves (1946 onward), as well as a conservationism that led to a thriving tourist industry and a post-colonial ban on sport hunting in the 1970s.

Kenya's independence from British colonialism in 1963 followed a period of bloody conflict called the Mau Mau, or the Emergency, which lasted from 1952–60. The Gikuyu-dominated Land and Freedom Army (LFA) rose against the British colonial government to fight for fair representation and access to the lands from which they had been alienated.

Post-independence Kenya has been described as simultaneously stable and corrupt. Jomo Kenyatta, president from 1963–78 and known as Baba wa nchi (Father of the State), established a patrimonial, patronage system of government. Kenyatta and his successors, including current president Mwai Kibaki, have embraced pro-capitalist, modernization theory and its attendant emphases on large-scale, export-oriented agriculture and industrialization.

Although only an estimated 8 percent of Kenya's land is arable, nearly three-fourths of Kenya's labor force engages in agriculture. Chief cash crop exports include cut flowers, tea, coffee, and horticultural products. Much of the expanding industrial sector of Nairobi take advantage of Kenya's export processing zone and the country's status as

Kenya is renown for its wildlife, nature reserves, and national parks; its landscape has great geographic diversity.

the regional center for trade and finance. Tourism and ecotourism remains among the most significant foreign revenue earners in Kenya.

Today's Kenya has a population of nearly 35 million, half of whom are listed as living at or below the international poverty line; the median age is 18 years. Unemployment estimates range between 25–40 percent in Nairobi.

Although Kenya is renown for its biodiversity, it is also beset by multiple environmental issues that have coevolved with the rapidly growing population—which has more than doubled since independence—as well as through the diffusion of people, technologies, ideologies, and introduced species. Current environmental problems include deforestation; soil erosion; desertification; water pollution from urban, suburban, and industrial wastes; diminished water quality from increased use of pesticides, herbicides, and fertilizers; water hyacinth infestation in Lake Victoria; wildlife poaching; recurring drought; and flooding in some regions during rainy seasons. Other significant large-scale concerns include malaria and HIV/AIDS.

The 2004 Nobel Peace Prize was awarded to Kenya's *Mama Miti*—mother of the trees—Wangari Maathai. Maathai has been a prominent figure in Kenya for decades because of her commitment to environmental issues, democracy, and human rights. The first Kenyan woman to earn a Ph.D., she founded the world-renowned Greenbelt Movement in 1977, served as a leader of Kenyan Debt Relief Network and its partnership with Jubilee 2000, and has received numerous international awards for her work. In 1989, Maathai received international attention for her historic opposition to then-President Moi's attempt to erect a skyscraper in Nairobi's Uhuru Park. Maathai charged Moi's government with grabbing public land and intensifying Kenya's debt crisis when Kenyan citizens faced starvation, land insecurity, and diminished access to health care and education. Maathai's arguments convinced foreign investors to pull out of the project. Elected in December 2002 as a member of parliament (MP), Maathai now serves as Kenya's Assistant Minister for the Environment, Natural Resources and Wildlife. Maathai's receipt of the Nobel Prize is significant for the link it makes between environmental issues and peaceful governance.

SEE ALSO: Indian Ocean; Maathai, Wangari; Victoria, Lake.

BIBLIOGRAPHY. David Anderson, *Histories of the Hanged: The Dirty War in Kenya and the End of Empire* (W.W. Norton & Company, 2005); John MacKenzie, *The Empire of Nature: Hunting, Conservation, and British Imperialism* (Manchester University Press, 1988); Norman Miller and Rodger Yeager, *Kenya: The Quest for Prosperity* (Westview Press, 1994); Transparency International, www.transparency.org (cited April 2006).

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Keystone Species

THE TERM *KEYSTONE* was introduced to the fields of ecology and conservation biology in 1969 by Robert T. Paine, a professor of zoology at the University of Washington. A keystone denotes one stone at the top center of an arch or vault that provides critical structural support. Due to the keystone's strategic location, if removed, the entire arch will collapse to the ground. This in essence explains the role of keystone plant and animal species—they are the central critical piece holding other associated species together.

Similarly, in the natural world there are *keystone resources* (natural resources like food, water, mineral deposits, shelter, mineral deposits, among others) on which a variety of species depend. When a keystone resource is threatened, lost or become unavailable, it needs to be supplemented by artificial means such as the setting up of wildlife feeding stations, artificial waterholes, salt licks, and the creation of wildlife refuges to arrest the loss of important wildlife habitat.

Keystone species have become an important concept in conservation biology because of the disproportionate influence they have in relation to their abundance in the environment. In a biological community, they can hold power over other species by determining which species propagate and which do not. This has led to the prioritization of keystone species for conservation.

Ironically, the keystone function of a plant or animal is usually recognized when the species is removed or lost from an ecosystem. As a result of Robert Paine's groundbreaking research on the ecology of the sea otter and the biodiversity of marine communities in the Pacific Northwest, we know that sea otters play a keystone role by consuming and regulating sea urchins. Sea urchins feed on forests of giant kelp and bull kelp, and an explosion in sea urchin populations can destroy kelp forests. This helps maintain marine biodiversity, allowing California sea lions, harbor seals, sea otters, and many other species to feed and shelter in the kelp.

Top carnivores are some of the most visible keystone species. Wolves are threatened around the world for different reasons; they can seriously affect rural milk and dairy economies by destroying livestock, and in parts of Asia, wolves are hunted in the belief that they are child-lifters. In areas from where the endangered gray wolf was exterminated, populations of deer have increased, resulting in overgrazed habitats that cannot support other herbivores and insects.

Examples of other keystone species include pollinators and seed dispersers in tropical forests such as bats essential to the reproduction of many trees; species called *ecosystem engineers* (e.g., beavers) because the new wetland habitats they create are used by other species; elephants, which help maintain grasslands by browsing on and removing trees and bushes that would otherwise shade out grasses; and disease-causing organisms that multiply and regulate excessive animal populations.

Animals are not the only keystone species. Fig trees comprise a small proportion of all trees in a forest but produce a copious and continuous supply of fruits critical to many birds and small animals, especially during a drought. Adding new information to the knowledge base on keystone species is an ongoing activity that helps continuously improve wildlife and forest management. For example, fig trees and keystone resources, like den trees and fallen trees that shelter many animals and provide unique humid environments for plant regeneration, are now often retained during forest logging operations.

SEE ALSO: Biodiversity; Conservation; Ecosystems.

BIBLIOGRAPHY. William J. Bond, E.D. Shultze, and H.A. Mooney, eds., *Biodiversity and Ecosystem Function* (Springer-Verlag, 1993); James A. Estes and John F. Palmisano, “Sea Otters: Their Role in Structuring Nearshore Communities,” *Science* (v.185, 1974); L. Scott Mills, Michael E. Soule, and Daniel F. Doak, “The Keystone-Species Concept in Ecology and Conservation,” *BioScience* (v.43, 1993); Mary E. Power et. al., “Challenges in the Quest for Keystones,” *BioScience* (v.46, 1996); Richard B. Primack, *A Primer of Conservation Biology* (Sinauer Associates,, 2004); Kent H. Redford, “The Empty Forest,” *BioScience* (v.42, 1992); John Terborgh and M.E. Soule, ed., *Conservation Biology: The Science of Scarcity and Diversity* (Sinauer Associates, 1986).

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Kilimanjaro, Mount

MOUNT KILIMANJARO IS a mountain in the African country of Tanzania near the border with Kenya. Kilimanjaro is actually a massif, a mountainous complex with a number of peaks, the highest being Uhuru Peak at 5,895 meters, the highest point of land on the continent of Africa. The massif is considered a strato-volcano containing magma 400 meters below the surface. No eruptions have taken place in the modern era.

Mount Kilimanjaro came into prominence in 2000 when researchers reported that its glaciers and ice fields were fast disappearing. The most prominent explanation for this phenomenon was global warming, which has also been blamed for the loss of comparable ice accumulations on a number of other mountain ranges in the equatorial regions. Studies in the early 2000s by researchers from Ohio State University indicated that the Kilimanjaro ice field began forming over 11,000 years ago and that three extensive droughts occurred before the drought during the 21st century. However, none of these resulted in the complete loss of ice cover. Other factors also contribute to loss of ice cover. Forest cover on Kilimanjaro’s slopes has been severely reduced for agricultural expansion and from forest fires caused from the smoking out of bees from their hives for honey collection. Forest reduction brings about a loss of moisture entering the atmosphere, lower precipitation levels, increased short wave radiation, and hastened glacial evaporation.

The demise of the Kilimanjaro ice sheet is damaging the Tanzanian economy in a number of ways. Tanzania is already one of the poorest counties in the world; 90 percent of its population lives below the established poverty level of $2 per day. The country relies heavily on income from agriculture, which employs more than three-quarters of the workforce. Loss of the ice fields will greatly reduce the amount of runoff for downslope settlements during the dry seasons. Loss of the ice cover also results in the diminishment of hydroelectric generating potential and a curtailment in the supply of water for irrigation. If hydroelectric generation declines, the shortfall in power production will most likely be made up with an increase in the burning of fossil fuels, an increase in greenhouse gasses, and more global warming. Tanzania and other African countries were already under severe development pressure before the demise of the Kilimanjaro ice sheets. Studies have been initiated by the United Nations to find ways in which science, technology, and innovation can be brought to bear on the socioeconomic difficulties in African countries.

SEE ALSO: Global Warming; Mountains; Tanzania.

BIBLIOGRAPHY. Samuel Aryeetey-Attoh, ed., *Geography of Sub-Saharan Africa* (Prentice Hall, 1996); Eija Soini, "Changing Livelihoods on the Slopes of Mt. Kilimanjaro, Tanzania: Challenges and Opportunities in the Chagga Homegarden System," *Agroforestry Systems* (v.2, 2005); Robert Stock, *Africa South of the Sahara: A Geographical Interpretation* (Guilford Press, 2004).

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Klamath Basin

THE KLAMATH BASIN is a watery wildlife refuge area shared by California and Oregon, and drains the Kalmath River. It is located in Klamath, Lake, and Jackson Counties in Oregon and areas of DelNorte, Humbolt, Modoc, Sisiyou, and Trinity Counties in California.

The watershed of the Klamath Basin includes in Oregon the Sprague River, Williamson River, Sycan River, Link River, and Lost River, which is shared by both California and Oregon. It also includes Agency Lake and Upper Klamath Lake in Oregon. In California it includes the Shasta River, Scott River, Salmon River and Trinity River. California also holds Tule Lake, Lower Klamath Lake, and Butte Creek.

Much of the Klamath Basis is protected by the federal government. The Klamath Basin National Wildlife Refuges Complex is run by the U.S. Fish and Wildlife Service (USFWS). The refuge was started in 1908 as the first waterfowl refuge in America. Eventually, six wildlife refuges were established for both local and the millions of migrating birds on the Pacific Flyway that come every year. The six wildlife refuges were eventually united under the USFWS.

The ecology of the Klamath Basin Refuges varies widely over its area. It includes freshwater marshes, rock cliffs, grassy meadows, coniferous forests, juniper grasslands, hills, and other features. It supports many fish, bird, and predator species.

In a conflicting move, the U.S. Bureau of Reclamation began the Klamath Reclamation Project in 1905. The goal was to drain areas of the Klamath Basin so that agricultural fields could be created. In other areas of the upper Klamath Basin, dams were created to provide water to farmers. Thousands of acres of sage land were converted into cropland. The success of the Bureau left only 25 percent of the historic wetlands in the Basin by the end of the 20th century.

The Klamath is a study in Western water politics. Conflict has existed for decades over fishing and the water needed to preserve the health of the fish, as well as the health of the wildlife of the area versus the demand for water farming makes.

SEE ALSO: Dams; Fish and Wildlife Service (U.S.); Rivers.

BIBLIOGRAPHY. Tupper Ansel Blake, William Kittredge, and Madeleine Graham Blake, *Balancing Water: Restoring the Klamath Basin* (University of California Press, 2000); Stephen Most, *River of Renewal: Myth and History in the Klamath Basin* (University of Washington Press, 2006); National Research Council, *Endangered and Threatened Fishes in the Klamath River Basin: Causes of Decline and Strategies for Recovery* (National Academies Press. 2004).

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Knowledge

FEW ASPECTS OF human adaptation are as instrumental, and at the same time as difficult to define, as indigenous knowledge. The concept is knowledge with a technical and/or environmental component, which has been labeled by the overlapping terms *traditional environmental knowledge, indigenous technical knowledge, ethnoecology, folk science,* and *local knowledge*. These terms all refer to locally constituted understandings, innovative capacities, and environmental practices utilized by indigenous groups. These terms recognize a category of knowledge apart from that generated and disseminated by professional researchers, policy makers, marketers, or development personnel. It generally excludes the use of information delivered from formal institutions of knowledge. Day-to-day interaction of people with their environment shapes problem-solving strategies for indigenous populations and guides practices as varied as agriculture, resource management, health care, and environmental conservation.

The concern for indigenous knowledge arose largely as a reaction to the ignorance, misunderstanding, and dismismissal of indigenous practices. One reason was simple ignorance: explorers, missionaries, colonial officials, and even development experts consistently misunderstood the logic of indigenous practices and hence dismissed them. A classic recurrent example is swidden (slash and burn) cultivation, widely believed to an indigenous practice ignorant of its environmental effects (deforestation). While swidden cultivation can sometimes lead to deforestation, it is now known that it was practiced productively for millennia in many places, guided by indigenous knowledge of fallow land management.

Interaction with the environment shapes strategies for indigenous populations in areas such as as agriculture.

Corporations selling inputs such as hybrid seeds, pesticide and fertilizer, and development projects benefit from the image of hapless producers lacking knowledge. It is also convenient for commercial ventures and even local governments to neglect indigenous claims to the genetic resources they manage for commercial gain or funding.

SOCIAL SCIENCE RESEARCH

Early studies of indigenous knowledge were conducted primarily by anthropologists and other social scientists, and were aimed at documenting and understanding the nature, structure, and value of non-Western knowledge systems. It revealed an often surprising depth of knowledge and cohesiveness of the resource management strategies and world-views of indigenous groups. In the 1960s and 1970s, key works in cultural ecology lauded the knowledge underlying indigenous production systems; they also showed how ecological knowledge became culturally institutionalized. For instance, Kofyar cultivators in Nigeria knew how to maintain high levels of fertility on annually cropped infields, while their institutions of household formation and festive work parties “knew” how to mobilize labor to exquisitely match the demands of local ecology. By the 1980s, indigenous knowledge emerged as a major topic in its own right, and since then, there has been an outpouring of research on indigenous knowledge.

Several salient themes have emerged from this work. One is that there is a vital social component to indigenous knowledge. Within many indigenous populations, knowledge is widely shared among members of the group, and a tendency for relatively high agreement on, for instance, ethnobotanical knowledge. Indigenous knowledge is also closely linked to social institutions. The household tends to assume center stage in intensive smallholder cultivation systems, in large part because it is well suited to the knowledge-intensive techniques required by this form of cultivation. Indigenous knowledge may even be embedded in cultural institutions that individuals themselves do not fully understand. For instance, in Alpine Switzerland, researchers documented a complex mountain-wide system for managing irrigation schedules that no individual irrigator could describe.

Indigenous knowledge tends to be more holistic and experiential than the professionalized knowledge to which it is often contrasted. However, some criticize this view on the grounds that it constructs a false dichotomy between Western/scientific and indigenous epistemologies. Such a dichotomy holds Western science as the standard of comparison, while ignoring that all systems of knowledge are culture-bound. Furthermore, attempts to define the boundary of knowledge systems typically fail because knowledge and its reproduction are dynamic and cannot be fixed. There is also considerable diversity among indigenous knowledge systems, and just as many similarities as differences between indigenous and Western/scientific epistemologies.

It has become increasingly clear that indigenous knowledge systems tend to be hybrid, incorporating elements of Western/scientific knowledge. This hybridity is not, in general, a recent phenomenon. Some of the most insightful work on indigenous knowledge in recent years has provided historical analyses of how indigenous production systems have selected, altered, and adopted elements from Western scientific knowledge. Examples are work on Kenyan intensive terrace-farmers and Indonesian rubber cultivators.

POLITICS OF INDIGENOUS KNOWLEDGE

Several factors have led to a surge of interest back towards treating indigenous knowledge as a distinct, and even ownable, entity, and encompass and intersect theories of rural development, bioprospecting, and changes in intellectual property regimes.

Bioprospecting

The move to capitalize on indigenous knowledge contributed to a rise in "bioprospecting" ventures, in which scientists from industrialized countries collected and analyzed plants from tropical areas in search of medically valuable compounds. Bioprospecting endeavors frequently culled the potential value of indigenous knowledge of local plants and animals by working directly with indigenous farmers and herbal healers. Indigenous groups were rarely provided financial compensation for their contribution to these ventures. In response to this development, The United Nations Convention on Biological Diversity (1992) promoted equitable sharing of the economic and commercial benefits associated with the use of indigenous knowledge and genetic resources.

These developments coincided with an international movement towards strengthening intellectual property rights, at the center of which was the 1995 emergence of the World Trade Organization with its stipulation that all member nations provide patent (or comparable) protection for plant varieties. This nexus of rural development, bioprospecting, and intellectual property rights engendered a forceful international response that labeled this enterprise as "biopiracy" and intellectual property theft. This left indigenous knowledge at the center of a complex and hotly contested battle of globalization, with a range of disparate but important effects.

One effect was a trend by writers and nongovernmental organizations (NGOs) to reify and romanticize indigenous knowledge. Environmental campaigns have widely touted indigenous peoples as living in pristine harmony with their land. Such idealized depictions obscures the complex realities of people–environment interactions and belies the critical role indigenous knowledge plays in the survival of many minority groups. Romanticized images also undermine the economic and political interests indigenous groups may have in the use and regeneration of their knowledge.

Theories of rural development have changed considerably over time. From the 1960s until the 1990s, development initiatives were primarily oriented towards technology transfer and "top-down" approaches. Characteristically, these approaches saw practices based on indigenous knowledge as an impediment to development, or at best, "festive and folkloric dimension of cultural performance for tourist development." For instance, Green Revolution development programs undermined the temple-based rice fallowing system in Bali. However, the early 1990s saw the advent of the International Cooperative Biodiversity Group (ICBG), a grants program supported by the U.S. National Institutes of Health, National Science Foundation, and Agency for International Development. One of the program's goals was to foster development that capitalized on indigenous knowledge, especially of biodiversity.

DESKILLING AND DEMISE

Indigenous knowledge may be threatened, and in some cases severely disrupted. Environmental destruction and the cultural pressures of modern nation-states threaten the lifestyles and knowledge systems of indigenous peoples. The introduction of poorly understood technologies to indigenous cultivation systems may also prove destructive.

For example, researchers examining the effects of the spread of hybrid maize in the United States have suggested that this development led to "deskilling" of farmers, or an interruption of knowledge regeneration processes. Recent ethnographic studies among Telugu farmers in Andhra Pradesh, India, shows that agricultural deskilling is quite different from the natural replacement of one body of indigenous knowledge by another. Farmers need to be constantly acquiring and revising their knowledge to inform their decision making, and several key factors can disrupt this process. In the Andhra Pradesh case, the disruption occurred in cotton cultivation, and the culprits were reliance on hybrid seeds (which normally have to be repurchased each year) coupled with an anarchic cotton seed market. As farmers found themselves planting seeds of questionable identity and unpredictable performance, they found it increasingly difficult to acquire the requisite knowledge. Eventually, farmers turned to more or less indiscriminate mimicry of each other's cultivation practices, regardless of their efficacy.

Researchers probing the relationships between environmental and cultural change among indigenous groups advocate allowing indigenous peoples to preserve and regenerate knowledge *in situ* in their local environments, rather than documenting knowledge *ex situ* in computerized databases. Reflecting the considerable diversity of indigenous groups and cultural practices worldwide, indigenous peoples range widely in their views regarding how best to regenerate their knowledge systems, and moreover, how the ownership rights of knowledge and the genetic resources it manages should be determined.

Documenting Knowlege

There has been a surge in efforts to document and preserve indigenous knowledge. Discovery of the usefulness of indigenous knowledge, and the recognition that indigenous cultures are rapidly disappearing, have prompted governments, NGOs, commercial researchers, and indigenous groups to lead campaigns to document indigenous knowledge, particularly ecological knowledge, in computerized databases. These organizations offer competing views on their purpose and method of documentation, including codifying and documenting knowledge for general use, preserving it for future generations of indigenes, or to stake claim to patent rights on genetic resources for indigenous groups.

One critique is that this form of data preservation effectively divorces indigenous knowledge from the very context in which it has been useful for indigenous groups. The codification of knowledge into databases also suggests the existence of a definable body of knowledge that is timeless and unchanging. Other controversies have arisen from attempts by local groups to exert political and economic control over indigenous knowledge in the face of bioprospecting projects.

BIBLIOGRAPHY. Arun Argawal, "Indigenous and Scientific Knowledge: Some Critical Comments," *Indigenous Knowledge and Development Monitor* (3(3), 1995); Stephen B. Brush, "Indigenous Knowledge of Biological Resources and Intellectual Property Rights: The Role of Anthropology," *American Anthropologist* (95(3), 1993); Roy Ellen, Peter Parkes, and Alan Bicker, eds., *Indigenous Environmental Knowledge and Its Transformations: Critical Anthropological Perspectives* (Harwood Academic, 2000); Sarah A. Laird, ed., *Biodiversity and Traditional Knowledge: Equitable Partnerships in Practice* (Earthscan, 2002); Paul Richards and Mark Hobart, eds., *Cultivation: Knowledge or Performance? An Anthropological Critique of Development: The Growth of Ignorance* (London: Routledge, 1993); Ellen Roy, and Katsuyoshi Fukui, eds., *Redefining Nature: Ecology, Culture and Domestication* (Berg, 1960); Ladislaus M. Semali, and Joe L. Kincheloe, eds., *What Is Indigenous Knowledge? Voices from the Academy* (Falmer Press, 1999); Vandana Shiva, *Biopiracy: The Plunder of Nature and Knowledge* (South End Press, 1997); Glenn Davis Stone, "Biotechnology and the Political Ecology of Information in India," *Human Organization* (63, 2004).

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Korea, North

JAPAN ANNEXED THE independent kingdom of Korea in 1910, continuing to occupy the country until the end of World War II when the country was split into North and South Korea. Although allied with the Soviet Union, the communist dictator of the Democratic People's Republic of Korea (North Korea) managed to resist total domination by either the Soviets or the Chinese. At the same time, South Korea maintained a close alliance with Western powers. Despite enormous international pressure, North Korea has refused to suspend a suspected nuclear weapons program. Significant economic resources in North Korea go toward maintaining the one-million-strong army and the development of weapons, which leads the population of 22,912,000 to depend heavily on international aid for survival.

With a per capita income of $1,800, the country is the 46th poorest country in the world. Although 36 percent of the workforce in the centrally planned economy is engaged in agriculture, a series of natural disasters and systemic problems have led to major food shortages since the 1990s. With a growth rate of only 1 percent, North Korea is experiencing severe economic hardship. South Korea has provided fertilizer assistance, and international agencies have provided food. However, at least 36 percent of the population is undernourished, and one-fifth of all children under the age of five are underweight. Because information on many social indicators is not released, the United Nations Development Program does not rank North Korea's standard of living.

ENVIRONMENTAL CONDITIONS

Located in the northern half of the Korean Peninsula and bordering on the Korea Bay and the Sea of Japan, North Korea has a coastline of 1,547 miles. The climate is temperate, and rainfall usually occurs only in the summer. In the late spring, droughts may be followed by severe flooding. Occasional typhoons are possible in the early fall. The terrain is generally comprised of hills and mountains interspersed with deep, narrow valleys, but wide plains fill the landscape along the coast.

Specific information on environmental problems in North Korea is sketchy because of the closed society. In August 2003, the North Korean government published its first State of the Environment report, written by the National Coordinating Council for the Environment, which was made up of 20 government and academic agencies who worked with UN officials to assess North Korea's environment. The report revealed that the major environmental problems include water pollution, deforestation, and soil erosion and land degradation.

With almost three-fourths of land area covered by forests, deforestation has accelerated in response to commercial logging, fuelwood, agricultural clearing, and insects and fires in times of drought. Only 2.6 percent of the land is protected by the government, and biological diversity has diminished with at least 13 endemic mammal species and 19 endemic bird species in danger of extinction. Over 60 percent of the people live in urban areas. Consequently, waste

North Korea's Pyongyang

The city of Pyongyang, located on the Taedong River, was founded, according to tradition, in 1122 B.C.E. on the site of the legendary capital of the founder of Korea, Tangun, who reigned in 2333 B.C.E. In 108 B.C.E. There was a Chinese trading center at Pyongyang, which was subsequently fortified and was the capital of the Koguryo kingdom from 427 until 668 C.E., when it was captured by the Chinese. It was then the secondary capital of the Koryo dynasty who ruled from 918 until 1392, Kaesong being their seat of government.

In 1392 the new Yi dynasty moved the capital of the country to Seoul, with Pyongyang going through a short period of decline. In July 1592 the city was sacked by the Japanese, and retaken by the Chinese in the following year. In 1627 the Manchus captured the city, which they left in ruins. With the opening up of Korea from the 1880s, Christian missionaries established as many as 100 churches in the city. However during the Sino-Japanese War of 1894–95, the city was again sacked, and then devastated by plague. It was rebuilt as an industrial center by the Japanese, who renamed it Heijo. In 1945 it became the capital of communist North Korea.

During the Korean War, the city was heavily bombed with most of it destroyed. It was fought over in 1950 when United Nations forces captured it, but it was retaken by the Chinese communists in the following year. After 1953 it was rebuilt on a grandiose scale. Massive monuments, vast sports and cultural complexes, and large statuary dominate the skyline. A few parts of the original city walls survive, but many of these have been moved to new locations.

During the 1970s, Pyongyang, the capital of North Korea, remodeled itself as a "Garden City." Officially it has more greenbelt than any other capital city in the world. it is also a major textile and food-processing center for the rest of the country with a thriving silk industry, and many factories. It has a population of 2,811,500.

management and energy consumption are of major concern. Untreated water and sewage is discharged directly into rivers. Soil deterioration has been a direct response to natural disasters, deforestation, and the use of chemicals in industry and agriculture. Although the entire population technically has access to safe drinking water, there is a shortage of potable water. Forty-one percent of the population does not have access to improved sanitation, and food and waterborne diseases are common.

North Korea's commitment to global environment is limited to ratification of the following agreements: Antarctic Treaty, Biodiversity, Climate Change, Environmental Modification, Ozone Layer Protection, and Ship Pollution. The government has signed the Law of the Sea agreement, but it has not been ratified.

SEE ALSO: Deforestation; Malnutrition; Nuclear Weapons; Pollution, Water; Poverty; Soil Erosion.

BIBLIOGRAPHY. CIA, "North Korea," *The World Factbook*, www.cia.gov/cia (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); UNDP, "North Korea," www.hdr.undp.org (cited April 2006); World Bank, "North Korea," *Little Green Data Book*, www.worldbank. org (cited April 2006).

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Korea, South

AT THE END of World War II, the Allied victors released Korea from Japanese occupation. With Soviet troops in the northern half of the peninsula, and U.S. troops occupying the south, the onset of the Cold War resulted in the division of the country into two separate states, North Korea and South Korea. After an invasion by the north, thwarted with U.S. and United Nation (UN) forces, the armistice of 1953 established the Republic of Korea (South Korea) with a northern border along the 38th parallel. Through close government and business cooperation and strategic planning, over the last several decades, South Korea has transformed itself from one of the poorest economies in the world to a trillion-dollar economy. With a per capita income of $20,400, South Korea is now the 51st richest country in the world. The UN Development Program (UNDP) Human Development Reports rank South Korea 28th in the world in overall quality-of-life issues.

South Korea is located in the southern half of the Korean Peninsula. Bordering on the Sea of Japan and the Yellow Sea, the country has a coastline of 1,496 miles. The climate is temperate. Rain tends to be heavier in winter months. The terrain is mostly hilly and mountainous except in the west and south, which is composed of wide coastal plains. South Korea is subject to occasional typhoons with accompanying winds and floods, and there is low-level seismic activity in the southwest.

A period of environmental degradation accompanied South Korea's rapid economic growth, and over 80 percent of the population of 48,423,000 live in urban areas. With 205 cars per 1,000 people, South Korea produces 1.9 percent of the world's share of carbon dioxide emissions. The discharge of untreated or improperly treated sewage and industrial effluents into water resources have resulted in extensive water pollution, which has adversely affected rice farming. Skin diseases have surfaced in a number of areas in response to contact with polluted water. Drift net fishing is likewise creating hazards. Eight percent of the population lack access to safe drinking water.

More than 60 percent of the land in South Korea is forested, but acid rain has damaged many areas. The government has protected 6.9 percent of the land area. Of 49 mammal species endemic to South Korea, 13 are endangered. Of 138 endemic bird species, 25 are likewise threatened with extinction. In 2006, scientists at Yale University ranked South Korea 42nd of 132 nations on environmental performance, below the relevant income group but well above the relevant geographic group. The lowest rankings were received in the categories of air quality, the production of natural resources, and biodiversity and habitat.

The Minister of Environment is responsible for oversight and implementation of a body of environmental laws and regulations that were passed from the late 1960s through the 1990s. The Asian financial crises of 1997 and 1998 created a setback in South Korean environmentalism, forcing the government to postpone its Long-Term Development Plan and di-

Siberian Tiger in the DMZ

The Amur, or Siberian tiger, has a particularly important symbolic role in Korean history and was revered by many people as being sacred. An Amur tiger called Hodori was chosen to represent the 1988 Summer Olympic Games held in Seoul, South Korea.

Although the tigers did roam in the forests, and were always rare, it was during the Japanese occupation of Korea from 1910–45 that hunting of the tiger is thought to have driven them to extinction in Korea, although a few exist in some parts of China. North Korea claims that there are tigers in the areas around Mount Paekdu, the official birthplace of North Korean leader Kim Jong Il, and also around Wagalbong Mountain and Chuae Mountain. None exist in the wild in South Korea, although there have been claims that a few might have survived in the demilitarized zone (DMZ) which divides the two Koreas.

The South Korean naturalist Lim Sun Nam has devoted his life to trying to prove the existence of tigers in the DMZ. He resigned from his job, sold his house and along with his family and older brother, spent many years in Siberia learning how to track tigers and spot the signs of their presence. In his unprecedented work in the DMZ he has found footprints and fur, as well as eyewitness testimony, but detractors argue that the footprints could be from wild dogs, and the eyewitness accounts are vague or exaggerated. Nevertheless, Lim Sun Nam, nicknamed the "Tigerman," spends all his time in the DMZ on his so-far elusive quest.

vert funds intended for the environment to economic recovery. However, existing environmental laws and regulations combined with strict enforcement have led to a decrease in emissions of sulfur dioxide and other air pollutants. Unfortunately, high levels of carbon dioxide emissions have somewhat offset this gain. As a result, government incentives have been instituted to deal with this problem. It has been predicted that over the coming decades, increasing levels of coal consumption used to generate electricity will substantially increase air pollution in South Korea.

Efforts to address environmental problems have led South Korea to build more than 50 nuclear power plants, thereby reducing reliance on traditional methods of energy. The National Vision for Environmental Policies in the 21st Century was established and charged with planning environmental policy that will promote environmental responsibility while maintaining economic growth. Industries such as the Dusan industrial plant, which released 30 tons of phenol-contaminated wastewater into the Nakdong River during a chemical leak in 1991, are now strictly controlled.

South Korea's commitment to the global environment is expressed through participation in the following international agreements: Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Acid Rain; Carbon Dioxide; Coal; Nuclear Power; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. CIA, "South Korea," *The World Factbook,* www.cia.gov/cia (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Energy Information Administration, "South Korea: Environmental Issues," www.eia.doe.gov (cited April 2006); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993); UNDP, "South Korea," www.hdr.undp.org (cited April 2006); World Bank, "South Korea," *Little Green Data Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Kropotkin, Peter (1842– 1921)

PETER KROPOTKIN [PYOTR Alekseievich], anarchist and geographer, was born in Moscow into a princely family. He was educated at the Corps of Pages (1857–62), an elite military school in St. Petersburg, and served as an officer in the Far East where he undertook important work in exploration, glaciation, and orography with the support of the Imperial Geographical Society, whose gold medal he was awarded. He resigned his army commission in 1867 to study mathematics at St. Petersburg University (1867–68) and then continued his geographical work on the Far East, extending his glacial studies to Finland and Sweden. He had already repudiated his title of prince, and on a visit to western Europe in 1872 he turned to anarchism, returning to Russia to join the revolutionary Tchaikovsky circle in St Petersburg. He was arrested in 1874 and held without trial, but escaped in 1876 and went into exile in the West. In 1878 he married Sofiya Grigoryevna Ananyeva-Rabinovich.

Under Kropotkin's influence, the international anarchist movement developed an ideology known as *anarchist communism*. Kropotkin was imprisoned in France in 1883, but was granted amnesty in 1886 and came to England where he stayed until 1917. He continued the work as a scientific journalist that he had begun on an earlier visit to England (1876–77) with the support of the geographer John Scott Keltie. He also continued to develop his social and political thought, which was influenced by geographical ideas of the interdependence of nature and society. His stress on the cooperation and mutuality evident in nature and in human history made his arguments attractive to many contemporaries, though some later commentators deprecated his lack of emphasis on class antagonism. Conversely, such commentators approved his argument that the final stages of his historical schema would come through popular revolution. He was influenced by his friend and fellow geographer and anarchist Elisée Reclus, to whose *Nouvelle Géographie Universelle* (1875–94) he contributed. Some of Kropotkin's numerous articles were collected in books, of which *The Conquest of Bread* (1892) and *Mutual Aid: A Factor of Evolution* (1902) were the most influential. His books and articles were published in many European languages and commanded a wide audience. He contributed scientific articles to the *Geographical Journal* and *Encyclopaedia Britannica,* the 11th edition of which also contained his important article on anarchism (1910).

Kropotkin returned to Russia in 1917, the year of the revolution for whose success he had long worked. He settled in Moscow but moved to Dmitrov, where he died on February 8, 1921. His funeral in Moscow on February 13 brought together fellow anarchists in demonstration of their support of ideas for which the prevailing Bolshevik regime had no sympathy. Kropotkin was remembered in geographical circles for his work on glaciology, desiccation, and orography, where his discoveries and hypotheses, even where wrong, stimulated important subsequent research. His wider impact, however, was due to his work on anarchism which, under his influence, became an attractive ideology, though one that went unrealized after developments in his homeland took a very different ideological turn.

SEE ALSO: Desertification; Glaciers; Mountains.

BIBLIOGRAPHY. Olga Alexandrovskaya, "Pyotr Alexeivich Kropotkin," in T.W. Freeman, ed., *Geographers: Biobibliographical Studies* (v.7, 1983); Peter Kropotkin, *Memoirs of a Revolutionist,* edited with introduction and notes by Nicolas Walter (Constable, 1988); S.R. Potter, "Peter Alexeivich Kropotkin," in T.W. Freeman, ed., *Geographers: Biobibliographical Studies* (v.7, 1983); Nicolas Walter, "Peter Kropotkin," in *Oxford Dictionary of National Biography,* H.C.G. Matthew and Brian Harrison, eds. (Oxford University Press, 2004).

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Kudzu

KUDZU IS A woody or semiwoody, perennial, deciduous, and leguminous vine. Kudzu grows in a wide range of conditions and soil types, and thrives in areas with abundant sunlight and rainfall, and warm summers and mild winters. Kudzu vines can reach 100 feet in length, and will grow up and over trees, buildings, hillsides, and across flat ground. Kudzu's relatively high rates of energy expended in photosynthesis, ability to fix nitrogen, and tendency to root rapidly contributes to its rapid spread. Once established, kudzu can grow up to 12 inches per day in peak conditions, with tap roots averaging 4–8 inches in diameter and up to 6 feet in length. Such a large root mass may weight up to 400 pounds and can store water, enabling the plant to survive occasional droughts.

The genus *Pueraria* includes 17 species spanning its native range from China and portions of India to Korea, Japan, Malaysia, and Indonesia. The vine has been integrated into medicines, cuisines, textile production, livestock fodder, and more for over two millennia. From China, kudzu and its uses easily spread to Asian neighbors long ago. The vine is not considered a pest in that region because its growth is limited by climatic conditions, certain insects, and its multiple uses for humans.

Kudzu's uses inspired many introductions into different climes around the world. It has reputedly taken hold without negative consequence in parts of South America, Switzerland, and Australia's eastern territories, but its growth rate in the United States beats all. There, kudzu shifted from an exotic species introduced for environmental benefit to being re-characterized as an invasive species and a biopollutant.

Kudzu seems an inherent part of the U.S. South, but it is a relatively recent import to the continent. Kudzu made its debut in the United States in 1876 at the Philadelphia Centennial Exposition, where Japanese participants had planted it to shade and decorate their pavilion. With a followup appearance at the New Orleans Exposition of 1883, kudzu became an aesthetic must. A booming mail-order business for kudzu hastened this process, as the vine was touted to grow where nothing else would.

From 1910 until the mid–1930s, kudzu was largely promoted for the production of livestock fodder, starch, cloth, and paper. By the 1930s, the Soil Conservation Service implemented numerous schemes through which the rapidly growing, nitrogen-fixing kudzu would rejuvenate depleted agricultural lands as well as reverse the effects of erosion along highways, byways, railways, and dam projects. Although some farmers had become leery of its aggressive growth, kudzu was declared "the miracle vine," and 20,000 card-carrying members were recruited to the Kudzu Club of America by the mid-1940s. Amidst the parades, rallies, and even Kudzu Queens, kudzu grew across 500,000 southeastern acres.

INTRODUCED SPECIES GONE WRONG

A mere decade later, attitudes shifted dramatically as kudzu notably overgrew its intended boundaries. In 1953, concerns about kudzu overtaking native trees and shrubs, as well as built structures, led the U.S. Department of Agriculture to remove it from the list of permissible cover crops. By 1970, kudzu became a weed, and by 1997, the U.S. Congress declared it a Federal Noxious Weed.

Today, kudzu covers approximately 7.5 million acres in the United States, most extensively in Alabama, Georgia, and Mississippi, with an estimated growth rate of 120,000 acres per year. There is a high degree of genetic diversity in current kudzu populations. Kudzu's emissions of isoprene (a photochemically reactive hydrocarbon), its ability to fix atmospheric nitrogen, and its tendency to overwhelm forest trees may substantially impact not only biodiversity, but also forest nitrogen cycles, watershed nitrogen saturation and freshwater eutrophication, and air quality. Kudzu exhibits markedly increased growth rates in response to high levels of carbon dioxide, which could in turn further increase kudzu's competitive dominance in an era of global warming.

Efforts to eliminate or reduce kudzu are difficult and expensive. Herbicides can be applied repeatedly for up to 10 years to kill an established population of kudzu, but the larger ecosystem consequences of such applications must also be considered. Experiments in natural and introduced biocontrols are ongoing, although critics note previous examples of the cane toad in Australia and that kudzu itself is an introduced species gone wrong.

Kudzu was brought to the U.S. as a "miracle vine," but now overtakes trees at a rate of 120,000 acres per year.

Larger-scale efforts to harvest the protein-rich, fibrous kudzu powder from its roots are ongoing, as are attempts to convert kudzu into biofuel. Naturopaths continue to investigate the myriad uses of kudzu in Asia and to adopt those healing techniques in the United States.

SEE ALSO: United States, Southeast (Georgia, North Carolina, South Carolina, Virginia).

BIBLIOGRAPHY. Derek Alderman, "Channing Cope and the Making of a Miracle Vine," *Geographical Review* (v.94, 2004); Irwin N. Forseth, Jr., and Anne F. Innis, "Kudzu (Pueraria Montana): History, Physiology, and Ecology Combine to Make a Major Ecosystem Threat," *Critical Reviews in Plant Sciences* (v.23, 2004); William Shurtleff and Akikyo Aoyagi, *The Book of Kudzu: A Culinary and Healing Guide* (Autumn Press, 1977); L.J.G. van der Maesen, "Revision of the Genus Pueraria DC with Some Notes on Teyleria Backer," *Wageningen Papers* (v.85, Agricultural University, 1985); L.J.G. van der Maesen and S.M. Almeida, "Two Corrections to the Nomenclature in Revision of Pueraria," *Journal of the Bombay Natural History Society* (v.85, 1988).

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Kuwait

LOCATED IN THE strategically important oil region of the Persian Gulf, Kuwait achieved its independence in 1961. In August 1990, Iraqi forces invaded Kuwait, but were forced to withdraw after the United States and the United Nations (UN) launched a retaliatory strike in February 1991. While retreating, the Iraqi military intentionally set fire to 60 oil wells and dumped 4 million barrels of oil directly into the Persian Gulf. The Kuwaiti government was subsequently forced to spend $5 billion to renovate its oil infrastructure, and the environmental impact will continue for decades.

Kuwait's natural resources include petroleum, fish, shrimp, and natural gas. Accounting for close to half of the Gross Domestic Product, 95 percent of export revenues, and 80 percent of overall government revenue, the petroleum industry is Kuwait's most valuable resource, representing 10 percent of world reserves. Kuwait has a per capita income of $22,100, making it the 43rd richest nation in the world. However, approximately 80 percent of the workforce of 1.67 million are non-Kuwaitis, whose income is a small fraction of that of native Kuwaitis. The UN Development Program (UNDP) Human Development Reports rank Kuwait 44th of 232 nations on overall quality-of-life issues.

Along the Persian Gulf, Kuwait's coastline runs for roughly 310 miles. The terrain is generally flat with desert plains that undulate slightly. Kuwait's dry desert climate produces intensely hot summers and short, cool winters. From October to April, sudden damaging cloudbursts and heavy rain are frequent, and sand and dust storms are most likely to take place between March and August.

ENVIRONMENTAL CHANGES

Because of limited access to freshwater resources, the Kuwaiti government has installed sophisticated desalination facilities. Three-fourths of all potable water used in Kuwait is either imported or distilled. Less that 1 percent of the land is arable. Because the government limits agricultural development, most of the food supply is imported. Other environmental problems include air and water pollution and desertification. With 96.2 percent of the population residing in urban areas, Kuwait's carbon dioxide emissions rose from 19.7 per capita metric tons in 1980 to 24.6 in 2002. Kuwait produces 0.2 percent of the world's supply of carbon dioxide emissions. The government has converted to unleaded fuel and implemented modern technologies designed to reduce emissions of sulfur and toxic gases. Forested land in Kuwait amounts to only 0.3 percent of the total land area, and these forests are generally part of the plantation system where exotic tree species are grown. Only 1.5 percent of Kuwaiti land has been brought under national protection. Of 21 endemic mammal species, one species is threatened. Seven of 35 endemic bird species are endangered.

Kuwait passed its first environmental legislation in 1964 to check the spread of oil pollution in navigable waters. In 1986, the government began monitoring the quality of air and sea water. Over the next four years, the National Ecological Network was established to promote biodiversity. The Kuwaiti government has expressed commitment to the global environment by participating in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, and Ozone Layer Protection. The agreement on Marine Dumping has been signed but not ratified.

SEE ALSO: Desertification; Natural Gas; Oil Spills; Petroleum; Pollution, Air; Pollution, Water; Urbanization.

BIBLIOGRAPHY. CIA, "Kuwait," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Human Development Report: Kuwait," www.hdr.undp.org (cited May 2006); World Bank, "Kuwait," *Little Green Data Book,* www.worldbank.org (cited May 2006).

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Kyoto Protocol

THE KYOTO PROTOCOL was signed in December of 1997 and entered into force as international law in February of 2005. More than 160 countries are parties to the treaty, which is the cornerstone of the global climate change regime. Its main purpose is to impose binding commitments on industrialized nations to reduce their emissions of greenhouse gases, the major cause of global warming, within a specified time frame. The treaty also requires all signatory governments to submit national reports on their efforts to reduce emissions, thereby promoting transparency and compliance.

UNITED NATIONS AND CLIMATE CHANGE

The global climate change regime, centered around the United Nations (UN), represents one of the most ambitious projects in the history of international environmental law. In 1988, responding to concerns from scientists and environmental groups, the World Meteorological Organization and the UN Environmental Program (UNEP) established the Intergovernmental Panel on Climate Change (IPCC), a multinational group of scientists and other experts, to survey existing studies on global warming and to present their findings to governments. In 1990, the IPCC reported that global warming did pose a threat and was likely the result of human activities.

Thus, in the context of the 1992 UN Conference on Environment and Development (commonly known as the Earth Summit) in Rio de Janeiro, UN member states negotiated the Framework Convention on Climate Change (FCCC), the first international treaty to address the issue. The FCCC sets the objective of stabilizing greenhouse gas concentrations in the atmosphere and requires industrialized countries to inventory their emissions. The FCCC promotes the "precautionary principle," the idea that lack of full scientific certainty should not be used as an excuse for inaction. It also recognizes the notion of "common but differentiated responsibility"; while all countries have a responsibility to tackle climate change, the industrialized nations, given their historical responsibility and greater means, should bear a greater share of the burden than their developing country counterparts.

However, the FCCC was vague and imposed no binding commitments on states. In 1995, parties to the FCCC embarked on negotiations to create an additional agreement with specific limits on greenhouse gas emissions. Years of intense negotiations resulted in a new treaty, adopted in Kyoto, Japan, on December 11, 1997. The Kyoto Protocol sets targets for 39 industrialized countries to reduce their greenhouse gas emissions by 2012, with an average reduction of just over 5 percent below the established baseline levels of 1990. Many of the details on how to implement the protocol were left to future negotiations, which were completed in 2001 with the signing of the Marrakech Accords.

In order for the protocol to enter into force—to become binding international law—two criteria were established. First, at least 55 states would have to ratify. Ratification is the domestic legal process by which countries formally accept their treaty commitments. Second, these ratifications would have to constitute at least 55 percent of industrial nations' total emissions of greenhouse gasses. While the first threshold was crossed early on, several large emitters, including the United States (36 percent of industrial emissions), Japan (8.5 percent), Russia (17 percent), and Canada (3.3 percent) faced substantial domestic political obstacles to ratification. In March of 2001, U.S. President George W. Bush pronounced the treaty "fatally flawed," and withdrew his government from the Kyoto process. With strong European Union (EU) leadership and Russia's ratification in late 2004, enough emissions were covered to achieve the second threshold for entry into force, which went into effect shortly thereafter.

FEATURES OF THE PROTOCOL

The Kyoto Protocol outlines several different policy options in order to meet emissions reduction targets. Governments may employ a variety of "policies and measures" in the form of industrial, agricultural, and transportation regulation and incentives, as well as investment into improved energy efficiency and alternatives to fossil fuels, to reduce emissions of greenhouse gases. The protocol also allows governments to enhance carbon "sinks," which are natural mechanisms that draw carbon dioxide out of the atmosphere. Most sinks are in the form of forests, although land use techniques can also store carbon in the ground.

In addition to these domestic measures, the treaty also provides for three international policy options, commonly referred to as the "Kyoto mechanisms." First, the Clean Development Mechanism (CDM) allows industrialized countries (with binding emissions targets) to sponsor projects that reduce emission in developing countries (without binding targets). The former can earn credits toward their own targets through such practices, while the latter benefit from investment and infusions of cleaner technology.

Second, similar to the CDM, Joint Implementation allows industrialized countries to earn emission reduction credits by paying for projects in other industrialized countries. Third, government may meet their targets by engaging in "emissions trading." Those governments that exceed their required targets accrue credits, which can then be sold to governments that have not met their targets. This "carbon market" allows governments additional options of buying their way into compliance.

The principle behind these international mechanisms is that net emissions reductions are equally helpful wherever they occur since the atmosphere is a global commons. Without geographical constraints, investments into emissions reductions will flow to where they can be applied in the most cost-effective manner, providing both flexibility and efficiency.

Two additional features of the treaty are notable: the employment of successive five-year "commitment periods" and substantial reporting requirements. The first commitment period is from 2008 to 2012; the targets established in the protocol must be met by the end of that time. New targets will be negotiated for each subsequent five-year commitment period, and countries that are not bound by targets can assume commitments for future periods. To monitor compliance, all parties must submit national reports on implementation at regular intervals, and industrialized countries must provide additional information on greenhouse gas emissions and removals, including any activities under the international mechanisms.

SEE ALSO: Carbon Dioxide; Carbon Trading; Framework Convention on Climate Change; Global Warming; Greenhouse Gases; Intergovernmental Panel on Climate Change; Precautionary Principle; United Nations Conference on Environment and Development.

BIBLIOGRAPHY. Michael Grubb, ed., *The Kyoto Protocol: A Guide and Assessment* (Royal Institute of International Affairs, 1999); Jon Hovi, Tora Skodvin, and Steinar Andresen, "The Persistence of the Kyoto Protocol: Why Other Annex 1 Countries Move on without the United States," *Global Environmental Politics* (November 2003); Intergovernmental Panel on Climate Change, *Climate Change 2001: Synthesis Report* (Cambridge University Press, 2001); Sebastian Oberthur and Hermann E. Ott, *The Kyoto Protocol: International Climate Policy for the 21st Century* (Springer, 1999); Sharon Spray and Karen McGlothlin, eds., *Global Climate Change* (Rowman and Littlefield, 2002); UN FCCC, *Caring for Climate: A Guide to the Climate Change Convention and the Kyoto Protocol* (Climate Change Secretariat, 2005).

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Kyrgyzstan

THE KYRGYZ REPUBLIC attained its independence in 1991 after over a century of Russian/Soviet domination. Still in the process of defining itself as a nation, Kyrgyzstan is attempting to expand democracy and political freedoms while reining in government corruption, easing ethnic tensions, and combating terrorism. Some 55 percent of the population is involved in cotton, tobacco, wool, and livestock agriculture. Kyrgyzstan also exports gold, mercury, uranium, natural gas, and electricity. Kyrgyzstan remains poor with a per capita income of $1,800, and is ranked 186th in world incomes. Eighteen percent of Kyrgyzstanis are unemployed, and 40 percent of the people live below the national poverty line. The United Nations Development Program (UNDP) Human Development Reports rank Kyrgyzstan 109th of 232 countries in overall quality of life.

The landlocked, central-Asian nation has 2,780 square miles of inland water. The climate ranges from dry continental to polar in the higher elevations of the Tien Shan Mountain Range. The subtropical climate of the Fergana Valley in the southwest gives way to a temperate climate in the northern foothill zone. The land area alternates between the peaks of the Tien Shan, and its valleys and basins.

Kyrgyzstan has abundant hydropower and significant deposits of gold and rare earth minerals, but coal deposits and oil and natural gas reserves are suitable only for local exploitation. Less than 10 percent of the land area is arable, but Kyrgyzstan has the largest natural-growth walnut forest in the entire world.

Kyrgyzstan has signed a water-sharing agreement with four other Central Asian republics that limits domestic use to one-fourth of the water supply, most of which goes for irrigation. Consequently, almost a fourth of the population of 5,146,000 lack access to safe drinking water. A weak infrastructure and lack of funding has forced the government to rely on obsolete water purification systems; waterborne diseases are easily contracted from contaminated streams and wells. In mining areas, water supplies may be contaminated with heavy metal such as mercury, antimony, and uranium and with oils and sanitary wastes. Agricultural and livestock waste contaminates water in other areas. The Aral Sea has also been heavily contaminated with municipal, agricultural, and industrial waste.

Kyrgyzstan's status as a largely agricultural nation makes it environmentally vulnerable. Poor irrigation practices and management have led to salinity and depletion of the soil. Some 40 percent of the population have no access to improved sanitation. A chronic land shortage has been made worse by flooding agricultural lands for hydroelectric projects, several of which are located in seismically active areas.

Another major environmental concern is the Soviet legacy of uranium dump sites. About 230 mining facilities in Kyrgyzstan produce over 600 million cubic meters of toxic waste each year. Approximately 15 percent of land in Kyrgyzstan is protected. Of 83 endemic mammal species, seven are endangered, as are four of 168 endemic bird species. In 2006, scientists at Yale University ranked Kyrgyzstan 80th of 132 countries in environmental performance, slightly below the relevant geographic group but well above the relevant income group. The lowest scores were received in the areas of sustainable energy and air quality.

International agencies such as the World Bank, the Asian Development Bank, and nongovernmental agencies are providing funding and technical knowledge to Kyrgyzstan, and work with the State Committee of Environmental Protection and the Hydrometeorological Administration to implement and monitor environmental policy. In 1991, the government passed new legislation to update Soviet-era environmental regulations. Kyrgyzstan participates in the following international agreements: Air Pollution, Biodiversity, Climate Change, Desertification, Hazardous Wastes, Kyoto Protocol, and Ozone Layer Protection.

SEE ALSO: Drinking Water; Hydropower; Pollution, Water; Poverty; Uranium.

BIBLIOGRAPHY. CIA, "Kyrgyzstan," *The World Factbook,* www.cia.gov; Country Studies, "Kyrgyzstan: Environmental Problems," www.country-studies.com (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); UNDP, "Kyrgyzstan," www.hdr.undp.org (cited April 2006); World Bank, "Kyrgyzstan," *Little Green Book,* www.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited April 2006).

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Lab Animals

INVERTEBRATE and vertebrate animals are vivisected for a wide range of laboratory research, testing, and teaching purposes. Vertebrates, however, serve as the primary experimental lab subjects for toxicity testing, as well as for pure and applied research by universities, corporate pharmaceutical testing labs, governmental health agencies, and the military. The number of vertebrates used annually as laboratory animals is estimated at approximately 100 million. Mice and rats are the most frequently used lab animals, but any animal may be bred, captured from the wild, or procured from pounds and specialized dealers for use in experimentation. While most lab animals are purposely bred, previously many wild animals were used in laboratories and this resulted in the depopulation of some species. For instance, population estimates for Indian rhesus macaques neared 10 million monkeys in the 1930s but, after a vivisection trade erupted for the animal due to its use in producing a polio vaccine and other experiments, their number was reduced to fewer than 200,000 by the late 1970s and India was forced to enact conservationist protections.

Vivisection of nonhuman animals has a long history dating back to early Greek manuscripts from the 5th century B.C.E. The Roman physician Galen first conducted experiments on dogs, monkeys, and pigs during the 2nd century C.E., utilizing vivisection to test biomedical hypotheses and study biological anatomical structures. Experimental surgery on animals in the context of modern science dates back to the work of Vesalius in the 17th century, but it was not until the 19th century that modern lab experimentation on animals became truly systematic and widespread through the work of scientists such as Claude Bernard, Louis Pasteur, and Robert Koch. Bernard, who is regarded as the founder of modern experimental medicine, held that laboratory experimentation on animals was essential for biomedical advances and he disparaged clinically based studies made by practicing physicians. By the late 1800s, scientists such as Pasteur and Koch made highly popularized advances in immunology and microbiology based on their own lab animal studies.

Anesthetics for animal experimentations were unknown until well into the 1800s and are not always used on animals even today. As a result, vivisected animals have often suffered greatly from experiments and therefore there has always been controversy surrounding the practice. During the 19th century, a strong anti-vivisection movement arose alongside animal research and its legacy

Animal Tests

The most common toxicity test is the LD 50, in which lab animals are administered an increasing amount of a substance until it proves fatal to 50 percent of them. This test remains widely instituted despite the fact that it has proven to be only relatively effective at determining human toxicity over the last few decades. Another common test, the Draize test, in which substances are dripped into lab animals' eyes to determine their capacity for irritation to humans has also been at the center of vigorous debate for its methods and clinical effectiveness.

An estimated 100 million vertebrates are used as laboratory animals every year.

currently lives on in animal welfare and rights organizations, humane societies, and more radical animal liberation groups. Largely because of their political action, laws governing the code and conduct of animal research now exist, but activists continue to argue that they are frequently not enforced and need to be broadened.

Alternatives to animal tests such as in vitro testing of cell and tissue cultures, epidemiology, and computer modeling exist; but many researchers insist that while they are useful, lab animal studies are also required to effectively monitor the thousands of drugs and tens of thousands of synthetic chemicals now on the market.

Researchers are promoting new forms of animal experimentation such as genetic modification of animals and xenotransplantation as necessary for achieving a new age of scientific breakthroughs. Many fear that these experiments unethically threaten society and the environment and should be regulated as a precaution. Yet, some genetic experiments on animals could result in improved animal and environmental welfare. For instance, Australian scientists have attempted to produce genetically modified sheep that would be resistant to flies and parasites. If successful, the inhumane act of mulesing sheep—surgically removing strips of skin from near the tail—and the heavy use of pesticides by the sheep industry would become unnecessary in the future. Therefore, while alternatives to laboratory animal science exist and should be increasingly utilized, some forms of lab animal experimentation could lead to environmental and societal improvements.

SEE ALSO: Animal Rights; Animals; Genetically Modified Organisms (GMOs); Genetics and Genetic Engineering.

BIBLIOGRAPHY. Pietro Croce, *Vivisection or Science?: An Investigation into Testing Drugs and Safeguarding Health* (Zed Books, 2000); Anita Guerrini, *Experimenting with Humans and Animals: From Galen to Animal Rights* (Johns Hopkins University Press, 2003); Hugh LaFollette and Niall Shanks, *Brute Science: Dilemmas of Animal Experimentation* (Routledge, 1996).

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Lakes

LAKES ARE BODIES of water surrounded by land. They cover about one percent of the surface of the earth and contain about 0.02 percent of the water of the earth. Lakes are relatively new from a geological point of view. They are very transitory because they are continually being formed or destroyed. Some are destroyed because they are dried up by declines in their water source(s), or by silting, or by earthquakes, or by other geologic actions. Humans have also played a major role in the destruction of lakes. Excessive drawing down of the water levels of lakes by humans can easily destroy their unique ecosystems. For example, Lake Huleh on the Jordan River above the Sea of Galilee (Lake Tiberius) has been drained nearly dry in the last 50 years to supply human consumption.

Lakes vary widely in their biological, chemical, and physical features. Each lake has its own origin, occurrence, size, shape, sedimentation attributes, circulation patterns, water chemistry, water depth, and life forms. The water chemistry of lakes varies widely. In Croatia, the Plitvice Lakes have unique limestone water chemistries. The dissolution of the limestone rock has created mildly acidic water. The lakes are in the karst region where there are few other surface sources of water. In contrast, many other lakes have high acid concentrations or in other cases have a basic pH number. Some lakes are shallow; others such as Lake Superior and Lake Baikal in Siberia are thousands of feet deep. Some cover only small areas and others are vast seas.

The sedimentation patterns (lacustrine deposits) in lakes are very important to geologists. Lacustrine deposits in lakes that have not been subjected to the actions of glaciers are stable because they remain at the bottom of the lake forming undisturbed layers of sediment. The sediment characteristics of modern lakes are used to interpret the sedimentary records of ancient lakes. From these sediments in ancient lakes, conclusions can be inferred about the earth's climate and life forms in earlier geologic times.

Limnologists have classified lakes into 76 types. The major categories are tectonic, glacial, volcanic, dissolution, landslide-influenced, fluvial-influenced, wind-formed, coastal, and meteorite impacts.

TECTONIC LAKES

Great movements of the earth's crust have formed tectonic lakes. Lake Tanganyika, Lake Malawi, and Lake Victoria are African rift valley lakes. They are located in the Great Rift Valley, which also includes the Dead Sea and the Sea of Galilee (Lake Tiberius). Other tectonic lakes are Lake Baikal in Russia, which is in the Baikal Rift Zone of the Siberian Platform. In the United States, Lake Tahoe and Pyramid Lake in Nevada are in the Basin and Range Province of the west. There are other smaller lakes in the region that are also the result of great

Lakes cover about one percent of the earth's surface and contain about 0.02 percent of the water of the earth.

shifts in the earth's crust including Lake Bonneville and the Great Salt Lake. Some tectonic lakes are shallow. Reelfoot Lake in northwestern Tennessee was one of several lakes created by the New Madrid Earthquake (1811–12). Centered near New Madrid, Missouri, the quake is believed to have been of a magnitude of 8.0 on the Richter scale.

GLACIAL LAKES

When the glaciers retreated after the last ice age, they created numerous periglacial lakes. These were lakes formed by the ice sheet or glacier, and the ice created obstructions that blocked the flow of water. Many lakes in Scandinavia are glacial. The Great Lakes—Lakes Ontario, Erie, Huron, Michigan, and Superior—are glacial lakes. In addition, many lakes in Canada, including the Great Slave Lake and the Great Bear Lake, are glacial lakes. In North America, the retreat of the glaciers left depressions in the ground that have since filled with water. These potholes or kettle lakes are very important ecologically for the breeding of ducks, geese, and other waterfowl. In Europe, glacial lakes formed by glacial sediment creating natural dams include Lakes Geneva, Lucerne, Zurich, Constance, and many others in Austria and Slovenia. In New York, the Finger Lakes were formed from glacial action. Subglacial lakes are in liquid form even though they are covered with ice. Lake Vostok in Antarctica is the world's largest. The ice acts as a thermal insulator so that energy is retained in the water. In other subglacial lakes, pressure from the mass of the ice sheet keeps the water liquid. In some cases, geothermal heating causes the water under the ice to melt or to remain liquid.

VOLCANIC LAKES

Volcanic holes left by volcanic explosions or by collapse of a volcano provide collection points for volcanic lakes. Crater Lake in Crater Lake National Park, Oregon, was formed in a volcanic pipe or caldera created when the 12,000 ft. (3,660 m.) high Mount Mazama collapsed 7,700 years ago following a large eruption. Caldera or volcanic lakes are found around the world. Many volcanic lakes are very beautiful such as the Caldera de Taburiente on the island of La Palma in the Canary Islands.

DISSOLUTION LAKES

The erosion of bedrock forms dissolution lakes. Usually the rock is limestone. As it dissolves a cave is formed, and if the cave's roof eventually collapses, a sinkhole is created. Many lakes in Florida were formed as sinkholes. Silver Springs is one of the best known. Lake Skadar is a dissolution lake located at the southern end of the Dinaric Alps on the border of Yugoslavia and Albania.

OTHER LAKES

Eudorheic lakes are terminal or closed lakes with insignificant amounts of water flowing in or out. The primary method for water to leave is by evaporation. These lakes are usually located in desert areas. Lake Eyre in central Australia and the Aral Sea are examples. The Hueco Tanks in western Texas are natural rock basins containing trapped rainwater. The water leaves by evaporation or is removed by travelers. Meromictic lakes have a water chemistry that is unique. The various layers of water in the lake remain stationary and unmoved so that they do not mix. As a result, the bottom of the lake has not dissolved oxygen. It is often saline as well. These kinds of lakes will have bacteria that feed on sulfur compounds. Earthquakes can disturb the equilibrium in the layers of water and cause a limnic eruption. When this happens, the water in the lake overturns. There may be sudden triggering of carbon dioxide. In 1984, Lake Monoun in Cameroon overturned and caused the death of 37 people. In 1986, nearby Lake Nyos overturned killing 1,800 people.

Coastal lakes include those formed by water trapped behind sand dunes, such as the Okefenokee Swamp in Georgia. In northern Poland on the Baltic Coast, Lakes Lebsko, Gardno, Dolgie Wielkie, and Dolgie Male are coastal lakes formed by the isolation of part of a bay on the Baltic.

Meteorites, asteroids, and comets striking the earth are also a source of lake formation. Mistastin Lake in Newfoundland and Labrador, Canada, are thought to be impact crater lakes as is Lake Lappajarvi in central Finland.

Wind forms lakes, especially in hot or cold desert regions. Some lakes on the north slope of Alaska may be forming in this way. In hot desert areas playa lakes are standing bodies of water left after rare periods of rainfall. These lakes are soon dried by evaporation and leave precipitated salts on their shores to resemble a beach. The meandering of rivers can form lakes. Many ox bow–shaped lakes that are the remnants of the old riverbed parallel the lower Mississippi River.

SEE ALSO: Baikal, Lake; Erie, Lake; Tanganyika, Lake; Titicaca, Lake; Victoria, Lake; Water.

BIBLIOGRAPHY. D.D. Alt, *Glacial Lake Missoula and Its Humongous Floods* (Mountain Press Publishing Company, 2001); P.M. Bethke and R.L. Hay, *Ancient Lake Creede: Its Volcano-Tectonic Setting, History of Sedimentation and Relation to Mineralization in the Creede Mining District* (Geological Society of America, 2000); Jerry Dennis, *The Living Great Lakes: Searching for the Heart of the Inland Sea* (St. Martin's Press, 2004); Richard Wold and W.J. Hinze, *Geology and Tectonics of the Lake Superior Basin* (Geological Society of America, 1988).

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By 2006 the Land and Water Conservation Act had resulted in the funding of some 40,000 projects.

Land and Water Conservation Act (1965)

THE LAND AND WATER Conservation Act of 1965, which was subsequently amended, was U.S. legislation designed to regulate access to and acquisition of land for the use of American citizens and the betterment of their health. During the late 1950s and early 1960s, there was concern that leaving the provision of public spaces and recreation opportunities to the private sector would lead to inadequate facilities and the enclosure of too much land for private use.

As the cold war intensified, the U.S. government also wanted to keep sufficient numbers of young Americans fit enough to fight in the army if required. As a consequence, a number of government agencies were empowered during the early years of the Kennedy administration so that national and state-level plans to implement enhanced land access were put into practice. Agencies and plans were supported by the creation of a Land and Water Conservation Fund that would use federal funds to purchase and maintain land areas for public use that were likely otherwise to have been used for housing or industrial development. Priority was given to areas with very high levels of population density, and the principle was adopted that land set-aside for public recreational use must be done so in perpetuity, unless it should be replaced by land of equivalent utility.

The act received bipartisan support and was signed on September 3, 1964. Funds were provided initially by such measures as charges for using national recreation areas, a tax on motorboat fuel, and the proceeds of sales of existing publicly held real estate properties. However, there was continual pressure on the fund to gather sufficient levels of money, not least because of the rising price of land where it became apparent that the government was willing to purchase it. Additional sources of funding were authorized and from 1971–89, an annual levy of $300 million was also provided. The vision of the act was modified to include more recreational land use within urban and residential areas, as well as within driving distance. This was important in helping poor people to partake of recreational areas despite lacking resources for transportation. Such use of shared public space also had a measurable beneficial impact upon urban living.

One of the most innovative components of the law was its Section 2, which established that the fund would be funded by federal revenues, especially including a proportion of receipts from oil and gas leasing on the Outer Continental Shelf. This lucrative source of capital, property of the people of the United States, has been utilized successfully to maintain the fund for decades, though not always to the degree intended by the original act.

By 2006 approximately $7.2 billion had been disbursed on some 40,000 projects in just about every part of the United States and overseas territories. The funds were provided equally from state and federal treasuries. State-level agencies have become increasingly innovative and imaginative in planning and managing outdoor resources in the interests of their residents.

After 1994 Congress also permitted the disbursement of funds from this program to reduce crime. The act has stimulated improvements in public management generally, and is an important symbol of the importance of the public sector providing common goods for all people that would be unavailable in a purely market-based system or with an insufficiently powerful government sector. The administration of George W. Bush proposed to end the scheme.

SEE ALSO: Land Use; Land Use Policy and Planning; Public Land Management.

BIBLIOGRAPHY. Peter E. Black and Brian L. Fisher, *Conservation of Water and Related Land Resources* (CRC, 2000); Richard J. Dolesh, "Fighting for Funding: NRPA Needs All Members to Act Now and Save the Land and Water Conservation Fund State Assistance Program," *Parks and Recreation* (v.40/6, 2005); U.S. National Park Service, www.nps.gov (cited October 2006).

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Land Cover

LAND COVER REFERS to the actual covering of the surface of the earth at any of its points. This includes plant life such as grasses, trees and forest cover, the sand of the desert, or the concrete and asphalt of developed areas. It is defined by the Food and Agriculture Organization (FAO) of the United Nations as "the observed (bio)physical cover on the earth's surface." It should be distinguished from *land use*, which explains what commercial or agricultural purpose to which a part of the earth's surface is being put, but the two may coincide in many cases.

It is estimated that of approximately 13,400 million hectares of dry land in the world, 3,325 million are suitable for cultivation and a further 156 million are used for urban infrastructure. Meanwhile, 774 million hectares are still under forest. These numbers are dwarfed in terms of raw size by water cover, which is approximately 70 percent of the total global land cover.

Many systems exist to classify different types of land cover, with two principal areas of difference being hierarchical versus nonhierarchical systems and a priori versus a posteriori systems. Hierarchical systems allow for subdivisions within broader categories while nonhierarchical systems tend to treat each separate type of land cover as a unique phenomenon. A priori systems posit a finite number of possible land cover types and then maps the ground to determine the extent to which each of these occurs, if necessary fitting observations into an existing scheme; a posteriori schemes, on the other hand, conduct mapping activities first and then seek to identify separable types of land cover, irrespective of whether they were anticipated or not.

Determining which scheme is most useful in any particular situation depends on balancing the need for inclusiveness with avoiding unnecessary complexity. The enormous expansion of computing power and computer memory available to scientists means that new and more sophisticated land cover mapping schemes are consistently being introduced.

Land cover is determined by mapping and, in the modern world, sophisticated satellite-based mapping systems that can be used for transmitting scanned data into computers directly through digital means. Since the time taken to complete full mapping activities can be extensive, completely up-to-date figures can be difficult to obtain, especially considering the rapidity with which land cover can change.

Many aspects of the classification of land cover are controversial in that they impact zoning regulations and the ability to develop land commercially. The extent to which commercial development is permitted to vary land cover is generally regulated by state-level controls but there may be some unregulated and unpoliced changes as well.

The form of existing land cover and the degree to which it is permissible to change this has considerable importance for opportunities to obtain commercial gain from the land. Hence, zoning controls and supervision are highly contested issues in most countries.

SEE ALSO: Development; Landscape Ecology; Land Use; Land Use and Cover Change.

BIBLIOGRAPHY. Food and Agriculture Organization (FAO), *Land Cover Classification System (LCCS): Classification Concepts and User Manual* (FAO, 2000); The Land Cover Institute of the U.S. Geological Survey, landcover.usgs.gov (cited December 2006); U.S. Geological Survey, www.usgs.gov (cited December 2006).

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Land Degradation

GEOGRAPHERS Douglas Johnson and Laurence Lewis define land degradation as a significant decrease in either the biological productivity or the usefulness of a region for humankind. This definition initially appears quite straightforward, but since land degradation has both biophysical and social components, characterizing land degradation soon becomes much more complicated. The biophysical components are wide-ranging, including: soil erosion, soil fertility, vegetation diversity and coverage, and hydrological functions. The social components draw attention to the notion that "usefulness" has multiple definitions. *Land degradation* is a perceptual term that has different meanings to different people at various times and places.

Conventional definitions of land degradation classify land as degraded only when the decreased productivity is the result of human activities rather than natural events. Natural catastrophes—such as earthquakes or floods—often result in the decreased productivity of a region, and fall outside the conventional definition of land degradation unless they are exacerbated by human activities.

Additionally there is the growing awareness that the term *land degradation* has become part of a dominant environmental and resource governance discourse that often points to the most marginal peoples as the drivers of land degradation rather than seeking to understand the external political and economic factors that influence the land use practices of marginalized people. These multiple layers of complexity associated with land degradation make it a difficult concept to assess and measure. It is even more complex to design appropriate policies that reach even the most marginal farmers and that can mitigate the degradation.

Biophysically, a decline in the productivity of land cannot be determined by any single ecological measure. Therefore, when trying to address land degradation, land managers usually use soil, water, and vegetation as the primary indicators of overall land productivity.

Soil degradation includes erosion from wind and water and a decline in soil fertility. There are many elements to consider in assessing soil fertility, including a loss of organic matter; degradation of soil properties (such as structure, aeration, and water-holding properties); changes in key soil nutrients; and the build up of toxic substances such as pesticides, salts, and heavy metals.

The most frequently cited causes of land degradation as the result of human activity include: overcultivation of agricultural lands, overgrazing of pastures, desertification, deforestation, water logging—or salinization—of irrigated land, and pollution or industrial causes.

Associated with the biophysical definition of degradation is the assumption that land degradation is an undesirable and avoidable process that can be mitigated with appropriate land management techniques.

THE AMERICAN DUST BOWL

The creation of the Dust Bowl in the 1930s in the American Great Plains is a dramatic example of land degradation resulting from inadequate land management practices. The semiarid areas of the Great Plains are known to experience cyclic droughts. Normally, if the sod cover is undisturbed, vegetation protects the soils from wind and water erosion. This relatively undisturbed prairie ecosystem was radically impacted when thousands of farmers were lured to the southern Great Plains by the promise of rich and plentiful soil.

Using farming techniques that had been successful in the northeastern United States, farmers plowed millions of acres of grassland. By breaking up the sod cover for agriculture, they exposed the underlying soil to severe desiccation during the droughts in the 1930s. As a result great windstorms swept up the dusty soil, blowing it as far as Washington, D.C., and out over the Atlantic Ocean. While the average soil erosion rates in the region are estimated to be around a few centimeters per thousand years, during the 1930s wind erosion removed up to one meter of soil in certain areas.

Given examples like the American Dust Bowl, where local farming practices were completely at odds with the environmental conditions, it is not surprising that land degradation is often perceived as the result of ignorant farmers implementing inappropriate management practices on fragile landscapes.

PLACING THE BLAME

The belief that land degradation is the result of land management decisions by irrational, wasteful, or lazy farmers living in marginal ecosystems gained a great deal of momentum in the 20th century. Growing concerns over the perceived crisis surrounding population growth and environmental change resulted in a burgeoning neo-Malthusian conviction that people in the developing world were destroying ecosystems out of ignorance, selfishness, and out-of-control population growth. The general thrust of this argument is that growing population pressure will result in exhausting the soil as people strive to produce more food, causing yields to decline and leading to hunger or starvation.

A globalized discourse emerged that placed the blame for land degradation on smallholders throughout the developing world. Despite a scarcity of scientific evidence to support these conclusions, economists and technocrats introduced environmental policies based on this orthodoxy, taking for granted certain stereotyped narratives about irrational and wasteful smallholders. For instance, shifting cultivators throughout the developing world are often labeled as "voracious forest eaters" since they cut a section of forest for their rice gardens, and then after a few years leave the field to fallow, moving on to clear a new section of forest. Ideally after 10–15 years they can return to the original plot of land, beginning the process anew.

Policies implemented throughout the developing world have made shifting cultivation illegal and placed the blame for environmental degradation on these socially, politically, and economically marginalized peoples. Yet when a similar-sized plot of land is cleared for timber, oil palm or soy bean plantations—all much more intensive land use practices—similar concerns over land degradation are rarely expressed. In this case, the factors driving the assessment of land use strategies are not the ecological outcomes, but rather economic concerns. Following this logic the profits realized from large-scale land use justify environmental degradation while subsistence farming does not, making it easy to shift the criticism away from economically profitable (and ecologically unsustainable) land use practices onto the backs of the smallholders.

To an agriculturalist, the conversion of the forest to agricultural land would not be considered degradation.

NEW DEFINITIONS

In the 1980s, several social scientists began to challenge the conventional wisdom that blamed smallholders for land degradation. Human geographers Piers Blaikie and Harold Brookfield developed a more inclusive definition of land degradation than the one provided earlier by Johnson and Lewis. Their definition of land degradation considers both natural and human effects on a landscape in order to develop an equation that captures "net gradation." To Blaikie and Brookfield, net degradation equals (natural degrading processes plus human interferences) minus (natural reproduction plus restorative management practices).

This definition places more emphasis on the viewpoint of the land manager whose management practices include both natural and human influences on the landscape. This type of land manager makes appropriate management decisions based in a holistic approach, integrating the multiple social, economic, and ecological factors.

Blaikie and Brookfield were at the forefront of a significant wave of scholars who sought to break apart the neo-Malthusian discourse regarding marginalized farmers and land degradation by emphasizing the ways in which their land use decisions are influenced by prevailing social, political, and economic conditions often outside of their control. In later works, Blaikie develops a strategy of inquiry urging researchers to follow "chains of explanation" in order to identify the range of variables that influence land degradation. According to Blaikie, studies of land degradation should begin with the landholder examining the "place-based" factors that influence land use. From there the researcher should seek to combine an understanding of these "place-based" factors that influence land use with "nonplace-based" factors that originate in the political and economic relations between land users and in regional landscape. Some of these factors include access to key resources such as land, labor, and capital, as well as technological and informational resources.

Other scholars, such as James Fairhead and Melissa Leach, have also broken down the myths that point to the supposedly ignorant natives as the perpetrators of land degradation. In their seminal book, *Misreading the African Landscape,* they challenge the contention long held by colonial and postcolonial scientists that the African savanna-rangeland is a region where extensive climax forest has been reduced to savanna as a result of human mismanagement.

Fairhead and Leach demonstrate that current islands of forest were in fact created by human settlement in a once vast savanna. Their analysis reverses the traditional understanding of the direction of environmental change in the African savanna and challenges long-held orthodoxies about the role of local farmers in the processes of land degradation. Fairhead and Leach show that colonial science, and years of subsequent forest and agricultural policies, were based on assumptions that could not be supported by existing evidence.

During this same period in environmental studies scholarship, many environmental historians, geographers, and anthropologists have drawn attention to the fact that all understanding of landscape is constructed through social systems of meaning and dominant categories of knowledge. They raised important questions such as: Who controls the language and normative assumptions of how a landscape should look? Who determines which landscape should be preserved and which ones are degraded?

Human geographer Paul Robbins describes walking through an orderly German forest engineered by some of the first commercial foresters. The even-aged, single-species plantings enhanced harvesting and improved the forest from the utilitarian perspective of the greatest (economic) benefit for the greatest number. But to Robbins, this forest also represents a degraded landscape where commercial interests have arrested natural processes and created a sterile environment in pursuit of the maximum economic potential. To many, this landscape could never be considered degraded given its huge potential for economic "usefulness." To others, this landscape is the height of misguided state schemes aimed at systematically ordering the environment.

This discrepancy draws attention to the perceptual issues surrounding "usefulness." What is considered useful to one person may not be useful to another. To an agriculturalist, the conversion of the forest to agricultural land would not be considered land degradation. Yet to a hunter, who relies on finding game in the forest, croplands might represent significant degradation of the landscape. Therefore, it is worthwhile to consider that economic value is not the only measure of land's usefulness. Furthermore, even under the rubric of economics, productivity can be measured in a variety of ways.

While full-time, large-scale farmers with exclusive control over their land might measure usefulness based on an economic cost-benefit analysis, for subsistence farmers it is seldom a field-based cost-benefit analysis that influences their understanding of usefulness. Instead subsistence farmers need to balance risk associated with market-orientated crop production with the security of sufficient food production.

Land-management decisions that have the potential for high financial gain in the markets may be considered too risky given past experiences with boom and bust market economies. Instead of taking such a risk, a subsistence farmer may choose to stay with a more reliable food crop with little market value, defying rational-actor–based theories. Factors such as: insecure land tenure, inefficient access to markets, limited or no access to capital for land improvements, and an inability to hire a labor force influence the range of alternative calculations of the "usefulness" of land.

POLICY IMPLICATIONS

The policy implications of this line of thinking are tremendously powerful. In his book, *The Political Economy of Soil Erosion in Developing Counties*, Blaikie poses the question, "What level of soil erosion need occur before appropriate legislation is implemented and appropriate agricultural and pastoral technologies are induced?" Using the Green Revolution as an example, Blaikie argues that since farmers in developing countries have a limited ability to access the inputs needed for agricultural intensification, the diffusion of the Green Revolution technology was ultimately based on meeting the interests of large multinational companies.

To Blaikie, the political and economic centers have been blind to the signals from ecologically marginal areas and the farmers who depend on them, and as a result appropriate innovations for these areas are rarely a priority. But since agricultural policies and science are generally believed to be apolitical and an uncontested reality, the blame for land degradation is repeatedly placed on smallholders who refuse (or are unable) to adopt modern technologies that conform with the existing policies.

Improvements are being made in scientific techniques to accurately assess the biophysical characteristics of land degradation. The broader view, however, which includes the multiple dimensions of degradation based on the interactions between people, cultures, political-economic institutions, and a range of biophysical factors, is rarely adopted in the policy-making arena.

Social scientists agree that generic technological solutions to land degradation based on ecological conditions will rarely be successful. Continued research at a range of scales that can synthesize biophysical characteristics with historical transformations and existing social, political, and economic institutions is necessary for successful policies aimed at alleviating land degradation.

SEE ALSO: Deforestation; Desertification; Dust Bowl (U.S.); Grazing; Soil Erosion.

BIBLIOGRAPHY. Simon Batterbury, Timothy Forsyth, and Koy Thompson, "Environmental Transformations in Developing Countries: Hybrid Research and Democratic Policy," *The Geographical Journal* (v.163, 1997); Piers Blaikie, *The Political Economy of Soil Erosion* (Lonman Scientific and Technical, 1985); Piers Blaikie and Harold Brookfield, *Land Degradation and Society* (Routledge, 1987); James Fairhead and Melissa Leach, *Misreading the African Landscape* (Cambridge University Press, 1996); Douglas Johnson and Laurence Lewis, *Land Degradation: Creation and Destruction* (Blackwell, 1995); Paul Robbins, *Political Ecology* (Blackwell Publishing, 2004); Donald Worster, *The Dust Bowl: The Southern Plains in the 1930s* (Oxford University Press, 1982).

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Land Ethic

THE EMERGENCE OF the specific ethical relationship to the earth known as the land ethic is attributed to Aldo Leopold, a forester and natural resource manager who lived and worked in the first half of the 20th century. The land ethic moves beyond economic valuation of natural resources to incorporate intrinsic values such as "love, respect, and admiration for land."

Prior to Leopold's construction of his land ethic, American conservation ethics had undergone two major iterations. J. Baird Callicott, a prominent environmental ethicist, describes the two preceding philosophies as, first, a Romantic-Transcendental Preservation Ethic, put forth by Ralph Waldo Emerson and Henry David Thoreau and expanded upon by John Muir in the early 1900s, and second, a Progressive-Utilitarian Resource Conservation Ethic, largely attributed to Gifford Pinchot and the U.S. Forest Service's philosophy of a "best" or "highest" use of the natural resources possessed by humanity. Leopold's Evolutionary-Ecological Land Ethic, Callicott states, was the third important ethical construction for describing man's relationship with nature.

Leopold was trained as a forester in the tradition of Pinchot and initially adhered to Pinchot's resource conservation ethic, but later in his career he diverged from this anthropocentric focus to develop his own ethic. His book, *A Sand County Almanac and Sketches Here and There,* published in 1949, outlines his developing philosophy in an essay called "The Land Ethic." Leopold states, "There is as yet no ethic dealing with man's relation to land and to the animals and plants which grow upon it." This unification of land with animals and plants indicates Leopold's burgeoning biocentrism: a focus on a respect for life itself. As Leopold put it: "the land ethic simply enlarges the boundaries of the community to include soils, waters, plants, animals, or collectively: the land."

Leopold's land ethic philosophy, proposed in the first half of the 20th century, was far ahead of his time and was not acknowledged for its applications to the field of environmental ethics and ecological thought until the 1970s and 1980s, when environmental ethics emerged as a discipline and the science of ecology shifted from viewing ecological systems as "climax equilibriums" to a more flexible model of dynamic stability.

A simplistic reading of the land ethic may place Leopold in an earlier ecological tradition that believed in ecological equilibriums and therefore proposed a respect for the land based on the astounding climactic balance ecosystems achieved. However, upon closer reading, it becomes apparent that Leopold was in fact rejecting the "balance of nature" paradigm for a "tangle of chains so complex as to seem disorderly, yet the stability of the system proves it to be a highly organized structure."

THE LAND ETHIC AND CONSERVATION

Leopold's land ethic, while contributing to conservation philosophy, does overlook many considerations relevant to the practice of modern conservation. The environmental ethicist Holmes Rolston III cites a few of these omissions in an essay on the land ethic, mentioning movements such as environmental justice, population growth in third world countries, the rights of indigenous peoples, and other human-environment concerns brought to light in current conservation and development debates.

The land ethic can be applied to many of the problems faced by modern-day conservation, which has been criticized for overly subscribing to a romantic construction of man's relationship to land. The modern conservation practice of trying to preserve "wilderness" by constructing unnatural barriers between human populations and the natural systems that support them ultimately results in conservation failure in many parts of the world. The land ethic includes people as citizens of a biological community.

Leopold fully acknowledges and supports the necessity of human alteration of ecological systems. His approach is both anthropocentric and biocentric; his ethic proposes an approach to land management that treats land use decisions and ecological alterations as actions that must be informed by ecological knowledge and a consideration for the long-term needs of both humans and the land upon which they depend.

Conservation has undergone many critiques for its treatment of marginalized peoples in the past few years. Proponents of the land ethic in the conservation movement argue that the land ethic empowers local populations. As Amy O'Neal writes, the land ethic "demonstrates a respect for biodiversity and the experience and knowledge of local peoples." Employing the land ethic could help the conservation movement become more sustainable in the long run. Globalization of the land ethic via conservation organizations and land managers around the world may be the next step in the expansion of Leopold's original philosophy.

SEE ALSO: Anthropocentrism; Biocentrism; Conservation; Ethics; Indigenous Peoples; Justice; Leopold, Aldo; Muir, John; Pinchot, Gifford; Thoreau, Henry David.

BIBLIOGRAPHY. J. Baird Callicott, "Whither Conservation Ethics?" *Conservation Biology* (v.4/1, 1990); Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (Oxford University Press, 1949); Carolyn Merchant, ed., *Major Problems in American Environmental History,* 2nd ed. (Houghton Mifflin, 2005); Bryan Norton, "The Constancy of Leopold's Land Ethic," *Conservation Biology* (v.2/1, 1988); Amy O'Neal et al., "Human Economies, the Land Ethic and Sustainable Conservation," *Conservation Biology* (v.9/1, 1995); Holmes Rolston III, "The Land Ethic at the Turn of the Millennium," *Biodiversity and Conservation* (v.9, 2000).

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Landfills

A LANDFILL IS any low area to be filled in for road building or for storing waste. More commonly, a landfill is a waste disposal site designed and constructed to accommodate municipal solid waste and hazardous waste while protecting against environmental and public health hazards.

One of the earliest forms of waste management was reported in 5th century B.C.E. in Greece where individuals were responsible for collecting garbage and transporting it to a dump site. Standard waste practices for centuries included land and water dumping of ashes, rubbish, and garbage, and household organic waste was often consumed by hogs. Such practices drew increased criticism in the late 19th and early 20th centuries, generating a new class of waste engineers and sanitarians that looked to a variety of alternatives to dispose of municipal solid wastes.

Efficient trash management in controlled landfills did not arise until the 1930s. The Fresno Municipal Sanitary Landfill, located three miles southwest of the City of Fresno, California, and which opened in 1937, is considered to have been the first modern, sanitary landfill. New techniques of trenching, compacting, and the daily covering of trash with soil were used on the Fresno site.

Daily coverings of soil layers reduce environmental and health problems, such as at this landfill in the UK.

Cities with populations of more than 100,000 adopted some form of organized refuse collection and disposal in the United States during the 1930s. Still, even into the 1970s, open and uncontrolled dumps were used to dispose of solid wastes, which increasingly consisted of discarded packaging materials associated with disposable household and industrial items. Often wastes of all types were burned on site. Open dumping caused a variety of environmental impacts, mainly through noxious odors, noise, birds, and smoke, and occasionally uncontrolled combustion occurred.

Most landfills today are regulated by environmental agencies to protect public health during waste disposal activities. Landfills are carefully designed and built into the ground to isolate trash from the surrounding environment. The purpose is to avoid any water-related connection between the waste and the surrounding environment, particularly groundwater. Landfills generally require at least one containment liner, generally made of compacted clay or a synthetic flexible membrane, to avoid leachate seepages into the surrounding soils and groundwater. Daily coverings of soil layers reduce environmental and health problems. Capping systems also avoid precipitation into the landfill and gas emissions into the atmosphere. A landfill siting plan and on-site environmental monitoring systems provide additional safeguards.

Continued problems with landfills include groundwater contamination from leakages, high operative and transport costs, and greenhouse gas emissions. Recent years have seen a shift from smaller to much bigger landfill sites, or mega-fills, some of which have disposal capacity equivalent to 1,000 football fields. Not only has urban waste amplified, its composition has changed from dense and almost completely organic to bulky and increasingly nonbiodegradable.

Changes in lifestyle patterns play a major role in waste generation, which is significantly higher in more affluent regions. Today's trash or garbage consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. Besides household waste, landfills can also receive nonhazardous sludge, industrial solid waste, and construction and demolition debris. Even computers are being dumped in landfills.

On the positive side, the number of landfills in the United States has decreased from 8,000 in 1988 to about 1,767 in 2002. Increased knowledge of the biological, chemical, and physical processes in landfills has also led to improved technologies and more efficient waste utilization. For instance, over 25 megatons of carbon dioxide equivalent are being generated annually from Canadian landfills, which is equivalent to approximately 5.5 million cars on the road. By 2001, 41 landfills in Canada captured this harmful emission, resulting in an annual reduction of over seven megatons per year of carbon dioxide emissions. Such practices also generate green power, offsetting the need to consume fossil fuels to provide an equivalent amount of energy.

Disposal of solid wastes is still by far the most common method in use today to contain generated waste. Still, alternative solutions that focus on the 3Rs (reduce, reuse, recycle) are currently promoting waste diversion from landfills. For example, recycling diverted over 72 million tons of material away from landfills and incinerators in 2003, up from 34 million tons in 1990—doubling in just 10 years. Cities and municipalities all over the world are aiming for high waste diversion rates from landfills.

The focus of traditional landfill activities is also shifting. A landfill can no longer be seen as a "dry tomb" where strict liner systems ensure that emissions will occur for decades or centuries. The idea of not leaving behind a landfill body to subsequent generations has led to technologies that stabilize waste in a shorter period of time while concentrating on landfill gas collection and utilization. Separation of waste at the source (consumer) and separate collection activities have made it possible to treat the organic portion of generated waste for soil fertilizer and to generate biogas, which then can be turned into electrical and thermal energy. Where landfill space is extremely limited—for example, in Sweden, Norway, and Germany—thermal treatment of waste is key.

Humans will likely always produce waste, but only time will tell whether landfills will be needed in the future. Waste is increasingly becoming a viable source of energy.

SEE ALSO: Greenhouse Gases; Groundwater; Recycling; Waste, Solid; Waste Incineration.

BIBLIOGRAPHY. Environment Canada, "Landfill Gas," www.ec.gc.ca (cited June 2006); Edward A. McBean, Frank A. Rovers, and Grahame J. Farquhar, *Solid Waste Landfill Engineering and Design* (Prentice Hall, 1995); Heather Rogers, *Gone Tomorrow: The Hidden Life of Garbage* (New Press, 2005); George Tchobanoglous, Hilary Theisen, and Rolf Eliassen, *Solid Wastes: Engineering Principles and Management Issues* (McGraw-Hill, 1977); United Nations Environment Programme, "Solid Waste," *GEO: Global Environment Outlook 3—Past, Present and Future Perspectives,* www.grid.unep.ch (cited June 2006); U.S. Environmental Protection Agency, "Municipal Solid Waste," www.epa.gov (cited February 2006).

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Landrace

A LANDRACE IS a race of plants or animals that are ideally suited for the environment in which they are grown, or sometimes work. They are ecologically distinct populations with obvious genetic diversity. Landrace animals or plants usually grow well and need little, if any, assistance from people. Landraces are usually older stocks that have not been exposed to modern breeding methods. They are an important part of traditional agrodiversity, sometimes called "folk varieties" or "heirloom" seeds. Local farmers have produced landraces for centuries.

Landrace breeds of sheep have flourished in a number of localities for generations. The Pomeranian coarsewool is also known as the Rauhwolliges Pommersches Landschaf, or as the Pommernschaf. Fishermen favor its wool in winter. It has been bred in small flocks along the Baltic Sea in Pomerania and Mecklenburg since the 19th century, and its preservation is due to the poverty of the small farmers who were unable to switch to the more lucrative fine wool breeds of sheep.

Dogs that are landrace breeds occur in many different localities. Some were developed for hunting, others for herding, guarding, or just to show. The salukis of the Middle East are a landrace breed developed purely for desert hunting in wide open spaces. In contrast, Scottish border collies often show a number of variations, but are still recognizable, especially when they work a flock of sheep.

Beginning in 1895 Danish landrace hogs were developed from the native Danish hog and the large white hog imported from England. The crossing of the two kinds of hogs has enabled Denmark to become a great bacon exporting country with England as a major market. In 1934, the U.S. Department of Agriculture received a shipment of the Danish landrace and began to crossbreed them at various agricultural experiment stations. The Danish landrace contributed to the development of the American landrace. However, other strains of hog, including small strains of Poland China, and larger strains of Swedish landrace and Norwegian landrace played a role in increasing the breed's gene pool. There are a number of swine landrace associations (Poland China Record Association, American Berkshire Association, Gute Sheep Society of Sweden, and the American Landrace Association).

In many places, such as the Andes Mountains, local farmers have developed landrace seeds. Using traditional techniques they select, store, and propagate their specialty seeds. Other areas such as Nepal are rich in landrace diversity.

SEE ALSO: Animals; Dogs; Pets; Seeds, Agrodiversity and.

BIBLIOGRAPHY. R.F. Ellen and Katsuyoshi Fukui, *Redefining Nature: Ecology, Culture, and Domestication* (Oxford, 1996); Peter Walstra, *Growth and Carcass Composition from Birth to Maturity in Relation to Feeding Level and Sex in Dutch Landrace Pigs* (Wageningen, 1980).

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Land Reclamation

LAND RECLAMATION IS both the creation of solid land from swamps and other watery areas and the restoring of polluted land to either a natural or usable state. The practice of land reclamation has been a human activity from early in human history.

The creation of new solid land from watery areas has usually been accomplished by filling in swamps or wetlands. Many famous cities are the products of at least some land reclamation. For example parts of New York City, Rio de Janeiro, Singapore, Hong Kong, Macau, the Chicago shoreline, and the Back Bay area of Boston are all larger in area than they would be if some areas of marsh or wetlands had not been filled to produce solid land for building.

FARMLAND

Often areas that have been reclaimed have first been drained or filled to create farmland. Areas of Florida, some of the Dismal Swamp in Virginia, and some of the wetlands in Louisiana have been drained or filled in order to make them suitable for farming.

Louisiana and eastern Arkansas are major rice growing areas in what were originally swampy areas. The broad flat lands in the rice growing areas are amenable to the use of machinery, which has substantially lowered the cost of rice production making it profitable to sell in the international market.

These rice production areas replace the older rice growing area in South Carolina, which was worked by hand by slaves until emancipation took effect in 1865. The area was eliminated as a rice growing area because the labor cost to work the area was too high. Some areas have been allowed to revert to their natural wetlands state.

The draining of swampy areas for conversion to farmland also destroys areas of wildlife habitat. Often the affected wildlife can relocate to areas near the farmed or inhabited areas. In some cases wildlife adapts to the human presence without significant harm.

Sometimes the destruction of wildlife habitats is the specific purpose of the land reclamation; areas are drained to eliminate health hazards, such as in the exercise of mosquito control. Without this destruction of the wet mosquito breeding grounds, many human populations would be destroyed by malaria, yellow fever, West Nile fever, or other diseases transmitted by mosquitoes.

THE MARSH ARABS

Historically land reclamation has been accomplished in river deltas. The famous deltas of the Nile and the Rhine are places where reclamation has turned marshes and swamps into working farms. For example, the Marsh Arabs, who live in the swampy delta area of the Tigris and Euphrates Rivers in the Tigris-Euphrates alluvial salt marsh, which is surrounded by desert, use the area for producing crops. Sometimes they create islands upon which to build their houses and livestock sheds. Unlike some other delta regions, they have not sought to completely drain their swamp because it has provided them protection from enemies. Invasion of an enormous swamp by people who are accustomed to desert warfare is a technical challenge that historically most potential enemies have avoided. In another example, the Seminole Native Americans in Florida have utilized their swampy regions in ways similar to the Marsh Arabs. They have reclaimed small areas, but otherwise have generally used their wetlands as a natural defense barrier and as a source of livelihood.

ARTIFICIAL ISLANDS

In some areas of the world, land reclamation has taken the form of the creation of artificial islands. Artificial island creation was practiced by the Aztecs before the arrival of the Spanish Conquistadors. In modern times, artificial islands have been created in areas where the scarcity of land makes it necessary to create them for use as airports and other building projects. For example, Kansai International Airport in Osaka, Japan, and the Hong Kong International Airport are built upon artificial islands.

The high-rise Burj al-Arab—known for being shaped like a billowing sail—stands on an artificial island reclaimed from the sea just off of the coast of Dubai in the United Arab Emirates. One of the most amazing modern artificial island creations is also currently under development in Dubai. The Palms is a virtual archipelago of residential islands that have been created by pumping sand into containers that are then fixed as islands. Together the islands form the shape of a palm tree.

Even more ambitious are the nearby World Islands off of Dubai; this collection of artificial islands will be shaped like the continents of the world. When finished, the 300 small, private islands will feature private homes, offices, and other dwellings that will cover an area 5.4 miles by 3.6 miles in length. A seawall will surround the oval island group.

THE NETHERLANDS

In the Netherlands more than a quarter of the country is below sea level and over 60 percent of the Dutch people live in flood prone areas. Historically, the country has been plagued by flooding rivers or incursions by the sea. In an ongoing struggle against the sea, the Dutch have created the Zuyder Zee and Delta Projects. The Zuyder Zee Project began in 1930 with the enclosure of a vast area by the Afsluitdijk (closure-dike). Eventually the area changed from an inland sea into a freshwater lake.

By the 1950s, these areas were drained and the land reclaimed for farming, housing, and other uses. The Delta Project was instituted after great sea storms broke open the dykes in 1953, causing great flooding. Through this project, some of the area has been preserved as a shellfish habitat by the building of gates that control the entry of seawater into the southwestern Netherlands.

RESTRICTIONS

Because the work of land reclamation from wetlands has been so persistent in recent centuries, many countries have restricted the practice. The destruction of wildlife habitat and of the breeding marshlands along coasts has threatened wildlife as well as the survival of many parts of the oceanic food chain. A growing number of countries are adopting environmental protection laws to prevent more land reclamation by wetland recovery.

LAND RESTORATION

Land reclamation is more than the recovery of wetlands. It can also be the restoration of land damaged by environmental degradation. Environmental degradation is caused in a number of ways such as mining, chemical dumping, urban development, logging, flooding, housing development, and other human activities. The goal of this form of land reclamation is to restore the area to a pristine natural state.

One of the culprits of environmental degradation, mining, removes great quantities of material by tunneling or stripping surface layers. Mine overburden may erode into streams and cause flooding. The pollution caused by water seeping into old mine tunnels or pits, which then leaches out chemicals that can pollute streams, rivers, and lakes, killing fish and damaging human health, is even more significant.

Coal mining is the leading cause of land disturbance in the United States and restoration of lands disturbed by mining is ongoing in old coal mining regions and in places where the tailings of arsenic, gold, or other mines have left streams and watersheds exposed to poisonous chemicals. These pollution sources are eliminated by filling in old mines or mine pits, the installation of chemical treatment systems, or the restoration of the land surface. The U.S. Federal Strip Mine Law now requires topsoil removed for mining be reapplied after the mining is finished. However, even this form of land reclamation may require fertilizer treatments in order to create a new layer of protective vegetation.

Another significant cause of environmental degradation, chemical dumping, has created areas that are virtually uninhabitable. In previous decades, chemical dumping was unregulated and the filled-in land was thought to be safe. However, in recent decades tragic consequences have come from the failure to properly reclaim land used for waste chemical disposal.

Reclamation of urban areas is a new activity, but one that has been growing in need. When municipalities need to remove old buildings, the issue of where to take the rubble arises. This is particularly the case in areas where the aftermaths of hurricanes or floods have created an enormous volume of building waste, which has to be placed somewhere and the area from which it came has to be cleaned of materials that could be hazardous to health.

The intentional destruction of abandoned building or factories has the advantage that the unwanted materials are removed and deposited in a location that will be supervised. By using evolving engineering techniques, the land is cleared of debris and rendered usable for natural or human activity much more quickly.

SEE ALSO: Agriculture; Mining; Soil Erosion; Urbanization; Wetlands.

BIBLIOGRAPHY. M.C.R. Davies, *Land Reclamation: An End to Dereliction?* (Taylor & Francis, Inc., 1998); Andrew S. Goudie, ed., *Techniques for Desert Reclamation* (John Wiley & Sons, 1991); James A. Harris, John Palmer, and Paul Birch, *Land Restoration Reclamation: Principles Practice* (Pearson Education, 1996); Lawrence J. MacDonnell and George Vranesh, *From Reclamation to Sustainability: Water, Agriculture, and the Environment in the American West* (University Press of Colorado, 1999); C. Paul Nathanail and R. Paul Bardos, *Reclamation of Contaminated Land* (John Wiley & Sons, 2004); Malcom Prat, ed., *Remedial Processes for Contaminated Land* (The Institution of Chemical Engineers, 1993); William E. Sopper, *Municipal Sludge Use in Land Reclamation* (Lewis Publishers/CRC, 1993); Terrence J. Toy and Richard F. Hadley, *Geomorphology and Reclamation of Disturbed Lands* (Elsevier Science & Technology Books, 1987).

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Landscape Architecture

LANDSCAPE ARCHITECTURE IS an academic discipline and a profession whose aim is the analysis, planning, design, and management of built or nonbuilt environments in order to conserve, restore, change, or create sites according to specific human or ecological needs. Its main task is to relate the multiple elements comprising a landscape, such as topography, fauna, flora, buildings, and inhabitants with all the aesthetic and social values and uses associated with it in order to undertake specific action on sites. Landscape architecture is not a branch of architecture since it focuses not only on the design of single elements but also on the integration of diverse elements in a landscape.

Traditional landscape architecture projects include the design of gardens, parks, and grounds.

During the 20th century the discipline extended to streets and transportation infrastructures, such as highways and train stations, and to larger facilities, such as monuments, hospitals, malls, and residential housing. Now landscape architects are also increasingly designing sites meant to be natural, such as wetlands, rivers, or woods.

Design concerns about the arrangement of gardens, courtyards, and even streets existed in several ancient civilizations such as Greece, Rome, and China. However, it was not until the 17th century that designing sites became a separate, specialized activity. French royal gardener André Le Nôtre, who designed the parks at the castles Versailles and Vaux-le-Vicomte in France, is sometimes considered to be the precursor of landscape architecture. He was the first gardener of his kind to acquire an international reputation through his personal style.

The title of landscape architect was used for the first time in 1858 for Frederick Law Olmsted, one of the designers of Central Park in New York City. A few decades later in 1899 the American Society of Landscape Architects became the first national association created in this field. Throughout the 20th century the title was used more frequently as landscape architecture became an established profession requiring specific training and degrees.

Because landscape architecture deals not only with the design of buildings but also takes ecological functionalities into account, it is sometimes considered to be at the border between art and science. On the one hand its concern with aesthetics and well being, as well as the importance of individual creativity during the design process, makes landscape architecture a normative field. On the other hand, its concern with organizing complete sites, including biological organisms such as plants, trees, and soils, compels landscape architects to have a strong scientific background. Even when there are aesthetic considerations behind the planting of trees or the inclusion of biotopes in landscape architecture projects, proper living conditions must be maintained to retain these aesthetic values.

Landscape architects are divided when it comes to defining whether their approaches should rely on normative or scientific consideration. Different tendencies came to light in the second half of the 20th century. Increasing urbanization and the ecological consequences of industrial activity have pushed landscape architects to pay more attention to the environment. They have had to try to limit the impact of buildings or conserve portions of the environment in built areas and there has been a growing incorporation of ecological knowledge in landscape architecture projects.

Landscape architects are increasingly designing sites meant to be natural, such as wetlands, rivers, or woods.

Simultaneously the multiplication of environmental projects near or in urbanized areas has led environmental agencies to pay more attention to social needs and sustainability when carrying out ecosystem conservation or restoration projects. Project promoters increasingly rely on landscape architects because of their capacity to link heterogeneous elements in a landscape design and integrate the values of local residents, users, and visitors.

SEE ALSO: Design (and Ecodesign); Gardens; Urban Ecology; Urban Parks Movement; Urban Planning.

BIBLIOGRAPHY. Meg Calkins, "Strategy Use and Challenges of Ecological Design in Landscape Architecture," *Landscape and Urban Planning* (v.73/1, 2005); Simon Swaffield, ed., *Theory in Landscape Architecture, A Reader* (University of Pennsylvania Press, 2002); Ian Thompson, "Sources of Values in the Environmental

Design Professions: The Case of Landscape Architecture," *Ethics, Place and Environment* (v.1/2, 2000).

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Landscape Ecology

THE SCIENCE OF landscape ecology is a comparatively young knowledge discipline that is concerned with the variation in types of landscape or land cover and the implications that this variation has on human settlement, land use, and planning. Landscape ecology and the tools it provides may be used as a means of envisioning and conducting spatial planning through such parameters as heterogeneity, fragmentation, and connectivity. Heterogeneity refers to the degree to which different types of land cover exist within a particular area. Fragmentation refers to the degree to which individual areas of heterogeneous land are or become insufficiently large to maintain the biodiversity that might otherwise obtain. Connectivity refers to the extent to which heterogeneous or fragmented pieces of land with similar land cover may be linked to each other at different scales.

Landscape ecology techniques are used in urban and spatial planning to help integrate people into the landscape with a view to minimizing energy use and hence promoting resource efficiency. In doing this, techniques from a wide range of other disciplines are employed and integrated, including zoology, botany, geology, and sociology, among others. The use of Geographic Information Systems (GIS) has become a very important tool for landscape ecologists and much of the practical work of the discipline is focused on accurate data collection, management, and analysis.

Landscape ecologists frequently concentrate on the borders between different areas of land. These borders may be termed *ecotones* as they mark the distinction between different types of land cover or other environmental difference. The ecotone might be obvious and distinct in nature or else gradual and "fuzzy"—as in hard to discern where one area of land begins or ends. In some cases, ecotones arise naturally, for example through a sudden change in altitude or a water barrier; in other cases, the ecotone might have been man-made, as in the case of a stretch of farmland or the presence of a herd of livestock.

Different ecotones may support different forms of flora and fauna, although some may be held in common. An ecotone that occupies a significant portion of land might support biodiversity that is not supported in the neighboring areas of land. Ecotones are important in providing possibly diverse sources of food and make good habitats, especially for species that are nomadic and can follow the ecotone as it moves in response to environmental or climatic change. This phenomenon has been used to explain the rise and fall of empires created by the nomads of the Asian steppes by identifying the motivation for the nomads to expand away from their traditional lands.

Studying the formation and movement of ecotones and related phenomena requires extensive, long-term analysis of the earth's surface and this in turn requires cooperation from many states in providing access to data on land use and cover within their jurisdiction. This can be problematic when secretive or security-conscious states are unwilling to yield such data. Global coverage of the earth's surface by satellites can partly resolve this problem but will not necessarily promote scientific cooperation and understanding.

One large-scale landscape ecology mapping project that has already been completed is the Multi-Resolution Land Characteristics Consortium (MRLC). Begun in 1992, this project mapped the landscape ecology of 48 U.S. states. The Environmental Protection Agency (EPA) of the U.S. Government conducted the project in partnership with the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA) and the National Atmospheric and Space Administration (NASA). The effort required to complete the task was considerable and it has yet to be extended around the world at a sufficient level of detail.

Techniques within landscape ecology include the mapping of gradient change, multivariate analysis of resource usage within patches of land and the identification of fragmentation of land use and connectivity between different patches of land. Many complex statistical techniques are being employed in this field of research. Additionally, it has become increasingly evident that spatial patterns are dynamic rather than static and, hence, it is necessary to integrate temporal change into spatial change patterns. Unfortunately, accurate measurements have only started to be taken in recent years and so it will only be possible to develop a comprehensive database of land use and change from a point after which rapid climatic change has already begun. Consequently, understanding past patterns of use will only be possible through the use of recreation and simulation.

The principles and techniques of landscape ecology have been facilitated by the introduction of modern technologies such as aerial and satellite-enhanced mapping techniques. In addition the enormous increase in the scope and capacity of computational power has made large-scale analysis possible. Even so, these innovations are only starting to be integrated into the discipline. Research is still being aimed in part at determining what can be done and how it should be managed. Concepts such as metapopulations, source-sink models, and percolation are being explored in this sense with a view to understanding how they can be used to help plan the use of space efficiently.

As global climate change has an increasingly negative impact upon the use of the land, with growing populations making more intensive use of fresh water resources, it will become more important to understand in what ways—if at all—it will be possible to improve land use planning. Of course, it may be found that improvements in planning will be insufficient to cater for the increased demand for land and its resources.

Landscape ecology can help in forestry management and in the management of many forms of land cover. Previously most environmental management programs tended to be fairly small-scale in nature and generally focused on specific sites or issues. Landscape ecology has helped to demonstrate the interconnections between land use in patches of land that may be widely spread. Indeed, it has become increasingly clear that the environment of the whole world (and the atmosphere beyond it) is part of a single and to some extent self-regulating system in which change at any one point may bring about change in other points. Solving environmental problems can only be meaningfully undertaken with an understanding of the holistic nature of the global environment. This means that environmental issues can only rarely if at all be tackled without a cross-border perspective and international cooperation. The need for internationalized responses to environmental issues is becoming increasingly evident.

SEE ALSO: Forest Management; Geographic Information Science; Land Cover; Land Use; Land Use and Cover Change; Urban Planning.

BIBLIOGRAPHY: Almo Farina, *Principles and Methods in Landscape Ecology: Towards a Science of Landscape*, 2nd ed. (Springer, 2006); Daniel Franco et al., "The Evaluation of a Planning Tool through the Landscape Ecology Concepts and Methods," *Management of Environmental Quality* (v.16/1, 2005). Multi-Resolution Land Characteristics Consortium, www.epa.gov/mrlc/ (cited January 2007). Monica Turner, R.H. Gardner, and R.V. O'Neill, *Landscape Ecology in Theory and Practice: Pattern and Process* (Springer, 2003). John A. Wiens et al., eds., *Foundation Papers in Landscape Ecology* (Columbia University Press, 2006).

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Land Tenure

LAND TENURE (or rural property rights) is generally regarded as a system of rights and obligations about land and property within a society or community. Land tenure can be viewed as a "bundle" of rights, where rights can be added, removed, or divided.

FORMAL VERSUS INFORMAL TENURE

There are several broad types of land tenure prevalent in most countries. Private property is a popular form, particularly in developed Western countries. In a private property system a piece of land belongs to a person or corporation, and this person or group has the right to sell it, lend it, use it as collateral, or split it up. Rights in the bundle are usually prescribed, as in zoning for a particular purpose (commercial, residential, agriculture, and so on), and are often specifically delineated, such as surface, mineral, water, or timber rights. With private property there exists a documented title, and a paper trail documenting the steps taken to obtain title.

Socialist tenure in various forms has been common in the past, most typified by the approach pursued by the former Soviet Union and its then-satellite states. With socialist tenure approaches, collective agricultural programs held that property rights and land use decisions are not made by individuals, but by either a group made up of the land resource users, or a state-appointed committee.

Socialist tenure can take a number of forms, but generally an individual household is assigned a portion of a farm or piece of land, but such an allocation might or might not be their first choice about where to farm. Individuals may have shares in the production (farm yield) or in the revenue from sales of the produce. Or, individuals may work as wage laborers on a collectively owned farm. This form of tenure also included villagization programs in Africa and elsewhere, where people were brought together from a more dispersed farming arrangement into a nucleated settlement and given land to farm. The logic here was usually that populations were more easily taxed, educated, provided with health care, and controlled, but in addition, villagization freed up vacated land.

Another form of land tenure currently favored by a number of developing countries is state ownership, whereby the national government declares all land to be property of the state. Usually this arrangement allows large areas to be declared "vacant and ownerless" national property to be subsequently distributed according to the state's priorities. In this approach there can be considerable confusion over exactly what rights are possessed by individuals, communities, and the state. Land nationalization can be a problem when a country changes from other tenure systems to state ownership. The logic behind such nationalizations can include the state's attempts to throw off an exploitative system, thus preventing what is thought to be a form of "re-colonization" via land purchases by large numbers of foreigners, or preventing the creation of a large landless class. A number of African states currently pursue this approach.

Customary tenure systems are informal, unwritten systems. Also called indigenous or traditional tenure by some, customary rights of access to land can be backed by "law-in-action." In other words, what establishes itself are the ad hoc arrangements that develop to meet the variety of situations in which people find themselves. Such informal behaviors outline the undocumented rules of land and resource use that are actually in operation.

There exists a pervasive disconnection in land tenure systems in many areas of the world. This occurs where both customary forms of tenure exist alongside formal tenure systems (such as private property, socialist, or state-owned approaches) with little ability for the two to connect as a system. The result includes land disputes, evictions, and tenure insecurity. The problems include the fact that customary systems are already in place, and have often developed over long periods of time. Formal systems, on the other hand, are imposed as peoples, areas, and countries are incorporated into a global system and feel pressure to have a land tenure system that can accommodate foreign investment; or, as they become decolonized, newly independent governments want to have a national land tenure system that they view as more fair than what occurred during the colonial era.

Formal systems are also imposed as governments express the desire for power over land allocation decisions and as governments want to regularize land tenure from many different informal systems belonging to indigenous groups within a country. The imposition of formal tenure systems onto customary systems can be problematic, because they must be enforced by the state, which means state intervention in the activities of communities, tribes, and religious groups, with potentially negative repercussions.

TENURE SECURITY

A primary component of all land tenure systems is tenure security. Tenure security is usually defined by how secure one's claim to access and use of land resources is. How secure one feels then influences decision making regarding agriculture, investments, resource management, and property transactions and is thought to be important to agricultural productivity and rational use of environmental resources. This is because the more secure the landholder, the more he or she will invest, and become invested in, the long-term viability and productivity of land resources. As a result more care will be given to how land resources are treated. Insecure land tenure, on the other hand, often results in environmental degradation, because affected populations feel there is little incentive to care for land resources they could be easily evicted from.

Much social science research and development work has been focused on the nature of tenure security and how it functions. However, tenure security can be difficult to understand, measure, and provide for in a consistent and predictable way. This is because tenure security is not very tangible, and many variables, processes, and contexts are bound up in it.

Tenure security embodies the idea that a claim to land resources is secure because it is to a significant degree defendable against virtually all other potential claimants. Thus tenure security necessarily resides within (and depends on) some notion of community (or "others"), and one's position within the community; as well as an ability to access and utilize what others in the community regard as legitimate and workable institutions (rule sets) used in defending claims.

While a community can be a local farmer village in a developing country, such a village can exist within a wider commercial or national community. This is important because a local community can be unable to defend its claim against "others" in a national community—with impacts on tenure security and resource use strategies. Ultimately this becomes a problem for indigenous land rights and environmental degradation.

SEE ALSO: Indigenous Peoples; Land Degradation; Land Use; Land Use Policy and Planning; Private Property; Property Rights.

BIBLIOGRAPHY. T.A. Benjaminsen and C. Lund, eds., *Securing Land Rights in Africa* (CASS Publishing, 2003); J.W. Bruce and S.E. Migot-Adholla, *Searching for Land Tenure Security in Africa* (World Bank and Kendall/Hunt Publishing, 1994); H. Demsetz, "Towards a Theory of Property Rights," *American Economic Review, Papers and Proceedings* (v.57/2, 1967); A. Durand-Lasserve and L. Royston, eds., *Holding Their Ground: Secure Land Tenure for the Urban Poor in Developing Countries* (Earthscan, 2002); R.C. Ellickson, *Order without Law: How Neighbors Settle Disputes* (Harvard University Press, 1991); Q. Gausset, M.A. Whyte, T. Birch-Thomsen, eds., *Beyond Territory and Scarcity: Exploring Conflicts over Natural Resource Management* (Nordiska Africkainstitutet, 2005); K.B. Ghimire, *Land Reform and Peasant Livelihoods: The Social Dynamics of Rural Poverty and Agrarian Reforms in Developing Countries* (ITDG Publishing, 2001); M.E.S. Jordan and A. Gambaro, eds., *Land Law in Comparative Perspective* (Kluwer Law International; 2002).

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Land Trusts

A LAND TRUST is a legal agreement by which one party holds ownership of a piece of land on behalf of another party. The laws by which such agreements are regulated vary across different countries and change over time. Land trusts may be divided between broadly public sector and broadly private sector agreements. The latter are most commonly used as a means of maintaining the integrity of a patch of family-owned land or as a way of minimizing tax requirements. The former are more typically organized by a state agency as a means of protecting environmentally important areas and of influencing the commercial and residential development of areas previously used for agriculture or not brought under human use.

Land trusts in a recognizable form have a long history and examples date back to at least the time of Henry VIII of England, when land ownership formed the basis of taxation and military *corvée*. However, a claim might be made that the land set aside for former soldiers and colonists in, for example, the Roman and Chinese empires also represented forms of land trusts in that the state could revoke ownership if certain responsibilities were

The Land Trust Movement

When governments step too far toward commercial interests and fail in their duty to protect the environment, people at the community or state level may intervene to make the necessary adjustments, volunteering extensive amounts of personal time and money if necessary.

In recent years the number of privately held land trusts aimed at protecting the environment has greatly increased in the United States, having been stimulated by the slashing of federal funding for this function during the Ronald Reagan administration. The creation of the U.S. Land and Water Conservation Fund (LWCF) in 1964 enabled the provision of some $11 billion for the federal purchase of lands to maintain and conserve environments. However, LWCF funding was slashed in the early 1980s and the burden was picked up at personal and state levels through the mushrooming of smaller-scale conservation projects and the emergence of the concept of "smart planning," which married the innovation of private sector solutions in well-defined and controlled geographic areas. Between 1998 and 2002, voters in the United States approved the use of $25 billion for creating land trust sites, realizing the failure of the federal government to meet this need and the depredations of many private sector developers whose goals are antithetical to the need for sustainable, livable, and aesthetically pleasing urban development. Inevitably, there has been a reverse side to this coin as some private sector corporations have used similar tactics to disguise ownership of land and buy numerous small pieces in order to obtain control of tracts of desirable land at comparatively low costs.

not discharged appropriately. Many states awarded land to newly created aristocratic elites or religious orders on similar bases.

In the modern world, international organizations such as the United Nations have been able to designate certain areas as places of outstanding historical interest and hold them on behalf of local people to prevent unwanted or unplanned development. Most developed countries have schemes that aim to protect wildlife or water resources or else to maintain a "green belt" around urbanized areas to provide recreational and aesthetic opportunities for residents.

In countries where such schemes are not operational or not well policed, nongovernmental organizations (NGOs) may aim to purchase or otherwise acquire land for similar purposes. Since there is often a conflict between the intentions of developers and conservers, the use of land trusts can be contested, controversial, and even subject to coercion of various kinds.

There is considerable scope for increasing the use of land trusts internationally, especially in those countries where inadequately maintained and supported legislation prevents the poor from registering and obtaining leverage from those assets that they do have. Incentives to improve land would be much greater for many such people if they could have confidence that they would be able to reap the long-term benefits for themselves and their families. However, providing common land for people is always subject to the free-rider problem that created the original economics conundrum called the Tragedy of the Commons. Consequently, strict regulation and maintenance of use is required to guard against such an occurrence.

SEE ALSO: Common Property Theory; Land and Water Conservation Fund Act (1965); Nongovernmental Organizations; Private Property; Public Land Management; Tragedy of the Commons.

BIBLIOGRAPHY. Richard Brewer, *Conservancy: The Land Trust Movement in America* (University Press of New England, 2003); Mike McQueen and Edward McMahon, *Land Conservation Financing* (Island Press, 2003); Jeffrey O. Sundberg, "Private Provision of a Public Good: Land Trust Membership," *Land Economics* (v.82/3, 2006).

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Land Use

LAND USE REFERS to the way, if any, in which land is used. In many cases, the use to which land is put is directly related to the type of land cover or the "observed (bio)physical cover on the earth's surface." More than two-thirds of the world is covered by seawater and is therefore unsuitable for much use by humans other than fishing or extraction of underwater resources. Of the remainder, land use varies from agriculture, urban infrastructure and residential use, commercial development, and fallow ground.

In most developed or developing countries, governments enforce a set of zoning regulations to ensure a balance between agricultural, commercial, and industrial development of the land. Various legal agreements such as land trusts and covenants regulate these agreements. However, the degree to which these are policed around the world varies significantly.

One of the principal problems faced by the world's poor is the difficulty they have registering their assets and leveraging them to borrow for future investment. The lack of clearly defined and policed regulations determining the ways in which land may be used has a direct influence on the ability of the poor (or anybody else) to take advantage of their assets. This reveals the importance of a coherent, transparent, and accountable government in promoting an environment in which people can obtain better economic and social opportunities.

Land use has been radically transformed over time due to the spread of humanity. The understanding of how to conduct intensive agricultural or industrial use has resulted in the homogenization of land use. For example, the colonization of Southeast Asia led to the large-scale change of land use from forest or jungle to rubber plantations or rice paddy field maintenance.

The ability of people to transform land use so that it produces some kind of surplus encourages urbanization and drives further alterations in land use to sustain growing populations. However, not all peoples follow the same pattern. Nomads and herders prefer to reserve land use for animal maintenance. In these cases, there has been conflict throughout history between nomadic and sedentary peoples. Previously the superior martial abilities of the migratory peoples dominated. but this is no longer the case.

Modern approaches to land use planning have tended to feature concepts relating to sustainability. Top-down approaches to land use have focused largely on the commercial benefits that can be obtained, irrespective of the impact upon local people. Community-based initiatives in many countries have challenged this, stressing the importance of traditional knowledge in maintaining and conserving the land and its fertility without inputs such as unnatural insecticides or fertilizers.

SEE ALSO: Agriculture; Land Cover; Land Use and Cover Change; Land Use Policy and Planning.

BIBLIOGRAPHY. Food and Agriculture Organization (FAO), *Land Cover Classification System (LCCS): Classification Concepts and User Manual,* (FAO, 2000); John Randolph, *Environmental Land Use Planning and Management* (Island Press, 2003); Joe Silberstein and Chris Maser, *Land-Use Planning for Sustainable Development* (CRC, 2000).

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Land Use and Cover Change

THE TERM *land use* refers to the purpose to which land is put—for example, agriculture, industry, urban, or untouched. Land cover refers to the observable physical or biophysical cover of the earth's surface such as forest, sea, or desert. Clearly, there are direct relationships between many aspects of the land cover and the use to which land is put.

In general terms, the type of land cover that exists influences the type of land use that is possible: the presence of forested areas limits agriculture, while rivers and waterways promote fishing and irrigation. Since the interaction between land use and land cover does not always appear to be convenient for human settlement, the land cover can be changed to what appears to be a more profitable form of land use. This has happened extensively over the past thousand years: the virgin forests of Southeast Asia have become irrigated rice fields and rubber plantations; the Great Plains region of the United States has become in many parts intensively farmed. These changes in land cover have had many impacts on climate change, along with other effects on the environment. While these changes have been occurring over an extensive period of time and are in some cases caused by naturally occurring phenomena, such as volcanoes and earthquakes, it is undeniably true that changes intensified in the 20th century and are set to do so even more in the future.

Land use and cover change (LUCC) may be complex and the underlying causes may be difficult to identify. Causes may also be quite obvious: for example, the intensification of agriculture in many parts of western China has involved the unsustainable use of water resources. This has led to the desertification of much of the land. This desertification has impoverished the local people pursuing agricultural activities, made traditional herding very difficult, and caused sandstorms in which cities such as the capital, Beijing, can be subject to intense bombardment by particles whipped up by winds in the desertified areas. In Thailand the intensive logging of teak forests and other valuable woods has all but removed the once dominant land cover and left the land increasingly subject to flooding and mud slippage. This phenomenon is also evident in Malaysia, the Philippines, and Indonesia.

The large-scale deforestation of the Amazon River region has led to significant reductions in the ability of the earth's land cover to sequester carbon from the atmosphere and has contributed to global warming. Other impacts include the loss of habitable land and attendant land conflict, and increases in poverty and negative health outcomes. These effects tend to cause land cover change to accelerate, as the remaining resources of the land are acquired as rapidly as possible before disappearing completely.

When the land is subject to additional pressure resulting from population increases or from the desire for commercial exploitation, then the land use change can be further intensified. Peasants—the poor land-users—will use whatever forms or combinations of land use that will minimize risk and provide a regular income in the foreseeable future. This tends to mean that, freed from external influences, the poor find methods of land use that are generally sustainable. However, when external influences are brought into play, perhaps because of central government advice for a more productive set of practices or through large-scale extraction of resources, then the local wisdom is generally discarded and the land use change becomes unsustainable.

The use of dams has also caused considerable changes in land use both through the act of their creation and in downstream regions. The world's largest dam, the Three Gorges Dam in China, has involved the creation of a reservoir stretching more than 600 kilometers upstream and has seen the relocation of more than 1.25 million people. Hundreds of villages and even small cities have been dismantled and rebuilt or just abandoned and the traditional lifestyles of all those affected have been changed, often radically.

Downstream effects have included changes in the migratory patterns of fish and, hence, ability to catch those fish, as well as the restricting of water flows which, together with industrial extraction of water from rivers has meant that many large waterways now frequently fail to reach the sea. Clearly, this has considerable impact on the ability of people to pursue long-standing agricultural activities in the downstream regions. Rapidly growing urban areas are also forced to maintain public health services in the absence of accustomed water resources. A lack of interest in the welfare of the displaced is also evident in the projected dam building projects on the Salween River in Burma and to various extents in projects around the world.

DATA COLLECTING PROJECTS

In recent years, international cooperative scientific efforts have sought to establish data collecting projects to document LUCC and to study the implications of changes around the world. For example, a Land Use and Cover Change Project was a Programme Element of the International Geosphere-Biosphere Programme (IGBP) and the International Human Dimensions Programme on Global Environmental Change (IHDP), based in Belgium. Its primary objective was "to obtain a better understanding of global land use and land cover driving forces; to investigate and document temporal and geographical dynamics of land use and land cover; to define the links between sustainability and various land uses and to understand the interrelationship between LUCC, biogeochemistry and climate." This resulted in a series of investigative projects aimed at integrating comparative case studies, diagnostic and empirical observations, and analyses at different geographical levels. Projects like these have gathered baseline information about the nature of LUCC around the world. However, much remains to be done before it is possible to accurately predict implications of future changes.

GOVERNMENT RESPONSES

Responses to LUCC at the governmental level have taken place at both national and international levels. At the national level, governments have considered zoning systems and schemes to encourage sustainable land use, although these have not always been well-planned or executed. At the international level, some agreements have been made to deal with specific phenomena such as acid rain or with respect to damming of rivers but, in general, these have proved to be very difficult to establish in practice.

SEE ALSO: Deforestation; Desertification; Land Cover; Land Use; Land Use Planning and Policy; Three Gorges Dam.

BIBLIOGRAPHY. Leiwen Jiang et al., "Water Resources, Land Exploration and Population Dynamics in Arid Areas—The Case of the Tarim River Basin in Xinjiang of China," *Population and Environment* (v.26/6, 2005); Eric F. Lambin and Helmut J. Geist, eds., *Land-Use and Land-Cover Change: Local Processes and Global Impacts* (Springer, 2006); Land Use Change and Agriculture Program of the International Institute for Applied System Analysis, www.iiasa.ac.at (cited January 2007); LUCC Project, www.geo.ucl.ac.be (cited January 2007); A.M. Mannion, *Dynamic World: Land-Cover and Land-Use Change* (Hodder Arnold, 2002); Stephen G. Perz, Carlos Aramburú, and Jason Bremner, "Population, Land Use and Deforestation in the Pan Amazon Basin: A Comparison of Brazil, Bolivia, Colombia, Ecuador, Perú and Venezuela," *Environment, Development and Sustainability* (v.7, 2005); James C. Scott, *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia* (Yale University Press, 1976); Makoto Taniguchi, ed., *Subsurface Hydrological Responses to Land Cover and Land Use Changes* (Springer, 1997).

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Land Use Planning and Policy

THE EARTH'S LANDSCAPE performs a multitude of functions, from providing the natural resources for human activities to recycling carbon dioxide to produce oxygen. It is the home of city-dwellers and desert nomads, along with aquatic, terrestrial, and avian species. Activities performed on the landscape range from nonrenewable extractive industries to landscape modifications by natural events such as volcanic eruptions. No matter what the activity, function, or purpose, the human population manages the landscape according to their environmental, cultural, and political philosophy.

LAND OWNERSHIP AND COMMUNITY

Land is owned either by the private or government sector. Attached to land ownership are basic responsibilities and rights to the use and maintenance of the property. The private landowner, however, is part of a local government that provides goods and services to the property. The jurisdictional control is the power of the local government to manage and regulate private activities that impact on the general public's "health, safety, and welfare." Land use planning provides a balance between preserving the rights of the individual property owner and meeting the needs of the community. The community can represent the local population or the nation.

Currently in the United States, there are no national land use policies even though different federal agencies manage large tracts of land. Overall, federal land encompasses approximately 1.29 million square miles (3.34 million square kilometers) or 34 percent of the total land area of the United States (3.79 million square miles). Each federal agency adheres to management policies that have

There are no national land use policies in the United States even though federal agencies manage large tracts of land. Federal land encompasses approximately 1.29 million square miles or 34 percent of the total land area of the country.

been established by law. In addition, national laws have specific standards for establishing air and water quality, solid waste disposal, noise pollution, and transportation that directly or indirectly regulate land use activities. Thus, federal agencies manage lands and federal laws regulate land activities, but individual states have the responsibility of land use policy through their police powers.

States' police power provides the ability to establish laws and ordinances to maintain civil order and provide for the public health, safety, and general welfare of their citizens. Through enabling legislation, the states have established the procedures and methods for land planning and regulation. They have also laid the foundations for local level planning by identifying specific statewide goals or allowing the individual local entities to construct their own land use goals. In addition, the state may impose specific health and environmental standards and guidelines that the local government must follow. Thus, the local government possesses the ability to manage land use within the powers and methods provided by the state government.

Several states have identified specific areas or types of land as "critical" and have imposed specific land management techniques to ensure their protection. These areas may be vulnerable to human impacts, and need to be preserved, enhanced, or protected. The area or land type may possess valuable natural resources or have historic, cultural, or scenic value. Land types—e.g., prime agricultural land, forested areas, or wildlife habitats—can be granted special protection to preserve their production capabilities or their contribution to the ecosystem.

States may use financial or investment entitlements to support or locate specific land use. Forty states provide preferential property tax treatment to farmland as a means to sustain this activity. States regularly invest in new or expanded infrastructure, facilities, or services to promote development. The placement of a new state prison, centers of higher learning, or hospitals encourage development to support new employment opportunities, complementary services, and economic diversity.

State-enabling legislation generally provides the local government with the authority to regulate the density, type, location, and height of buildings and structures. The local authority can divide their jurisdiction into districts and regulate and restrict building construction, use, alteration, and repairs. In addition, local land use plans are employed to: lessen congestion, create safe environments, reduce overcrowding, provide adequate light and air, and facilitate adequate infrastructure. All of this is done by local government to provide for public health, safety, and general welfare.

PRINCIPLES

Land use policy is based on the interactions between the environment, society, and the political/economic structure. The framework upon which land use planning is built depends on the sustainability of a system that recognizes the importance of meeting the complex needs of human society while maintaining the integrity of natural systems that support all life.

Land use planning goals and decisions are best determined at the local level with community knowledge of the environment, economy, and society. There are five basic principles that should be integral to land use decisions. These principles are: (1) create a land use system that is sustainable for future generations, (2) analyze local impacts in a regional context, (3) provide for social equity, (4) produce an economic system that produces community well-being, and (5) preserve cultural/historical and environmentally-sensitive areas.

There are four dimensions to the land that need to be considered in land use planning: (1) land as a functional space, the overall parcel dimensions and location, the environmental characteristics, the building(s) and structural/infrastructure dimensions and capacities, and use characteristics; (2) land as an activity center, the interactions that take place on the site, human interactions or ecosystem dynamics; (3) land as a commodity, the value of the land for economic exchange or value to society; and, (4) land as an image or aesthetic resource, its psychological value to the community. The land use is the expression of the particular dimension the citizens want to emphasize.

LAND CLASSIFICATION

The land classification system used to describe the characteristics of the land depends on the purpose of the classification. Land use refers to the activities taking place on that parcel of land, but a parcel of land can have multiple uses. For instance, land in the national forest can be used for: hiking, camping, bird watching, as protection of our nation's woodlands, a source for timber harvesting, protection of our watersheds, an area for mining, and as a scenic landscape. Thus, the purpose for the classification system will depend on: (1) the legislative responsibilities of the government entity; (2) the type of impact assessment (environmental, social, economic, transportation, or technological); and (3) the interaction between land use elements (residential and commercial, urban and environmental).

PLANNING PROCESS

In developing a land use plan, identification of community values is an essential first step. These values assist in the articulation of the idea of "sense of place," what is important to the local community. The next step in the process is to produce the overall land use goals and objectives. In order to obtain the goals and objectives, the third step is to identify different policy strategies and evaluate their feasibility. The fourth step is to select and implement the policies that will attain the community's goals. The final step is the establishment of a system to monitor and evaluate the policies to ensure they produce the desired outcome. Decisionmakers integrate citizen input into the process so that it is assured to be a community-based land use plan.

POLICY OPTIONS

Land use policies generally align to one of six approaches. The most often cited approach relates to regulation—most notably zoning—but this also includes subdivision ordinances and different types of codes (buildings, architecture, landscaping, etc.). Incentives are another set of policy approaches to provide options for land owners and developers. The incentive policies do not punish or restrict land uses but give beneficial options based on set action criteria. The third approach is land acquisition, the purchase or entitlement of land (conservation easements) by the local authority and placing the land in a specific use, e.g., recreation, land conservation, or preservation. Another policy approach is to use the placement of capital infrastructure to direct land use into specific areas or dimensions. Thus, the local community and not market pressure dictate the position of roads and utilities. Fifth, financial policies can serve two purposes—a method of collecting needed revenues to acquire land or build infrastructure or as a means to make development fiscally responsible for its impacts. Finally, the least utilized policy is educating the community about the benefits and impacts of land use decisions to this generation and future generations.

SEE ALSO: Land Cover; Land Use; Property Rights.

BIBLIOGRAPHY. V.H. Dale and R.A. Haeuber, eds., *Applying Ecological Principles to Land Management* (Springer-Verlag, 2001); H.L. Diamond and P.F. Noonan, *Land Use in America* (Island Press, 1996); E.J. Kaiser, D.R. Godschalk, and F.S. Chapin, *Urban Land Use Planning* (University of Illinois Press, 1995); R.H. Platt, *Land Use and Society: Geography, Law, and Public Policy* (Island Press, 2004); J. Silberstein and C. Maser, *Land Use Planning for Sustainable Development* (Lewis Publishers, 2000).

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Laos

THE LAO PEOPLE'S Democratic Republic (PDR), or Laos, is a nation of 6.4 million people and nearly 237,000 sq. km. situated in the heart of mainland Southeast Asia. It is bordered by China and Vietnam to its north and east, respectively; Myanmar and Thailand to the west; and Cambodia to the south. The climate is dominated by tropical monsoons, with a fairly well-defined rainy season from May through November alternating with a dry season from December through April. Laos is, by many

The Plain of Jars

On the plains of Xieng Khuang Province in north-central Laos, large numbers of enormous stone jars litter the landscape. Rival archaeologists dispute both their age and their purpose. The general views are that they were either used for wine fermentation, for rice storage, or for sarcophagi—or possibly for all three purposes. A few surviving stone lids have been used to advance all of these theories. Human remains have been found in jars, and rice has been found in others. Many local people associate legends with them, including one that tells of an ancient king who used the jars to brew large amounts of rice wine to reward his supporters after a great battle.

Madeleine Colani, a French archaeologist, worked on the jars for three years during the 1930s and found a nearby cave which held some bones. She also found artifacts in one of the jars and wrote about them extensively. However, during the Vietnam War, there was massive damage to the area and the cave was destroyed. Colani felt that the jars lay along a caravan route to northern India and that the area was also an important burial ground over a long period of time. Her work dated the jars at around 1,500 to 2,000 years old.

Although many archaeologists have wanted to work on the site, and tourists visit it regularly, it is a hazardous pursuit. Large numbers of unexploded bombs blight the land—the result of the Secret War in Laos, during which the United States embarked on one of the largest bombing campaigns ever. The area is gradually being cleared of ordnance but many places remain dangerous and visitors are are forced to keep to certain well-marked paths.

socioeconomic measures (such as life expectancy, infant mortality, and literacy) one of the least-developed countries in the world.

Ethnically diverse and largely dependent on agriculture and natural resources for their livelihoods, the people of Laos practice rice paddy cultivation in the low-lying plains (only four percent of the land area of the country is arable) near the capital city of Vientiane, while those living in the mountainous regions of the north and east rely on a variety of livelihood practices, including upland rice cultivation, fishing, collection of nontimber forest products, and hunting of wild game.

The most pressing environmental issues facing the Lao government and people revolve around efforts to stimulate economic development through the exploitation of the country's two primary natural resources: forests and hydropower. Nearly half of Laos's entire Gross National Product is generated through the sale of these two resources. Deforestation and the exploitation of resources more generally has accelerated since the government's adoption of economic reforms in the late 1980s stressing foreign investment and market-oriented policies.

While forest cover remains at an estimated 55 percent in Laos, illegal logging continues to present a major challenge to the government. Although Laos has been ruled by the socialist Lao People's Revolutionary Party for the past 30 years, the governors of its 16 provinces and individual military commanders retain a good deal of independence from the central state. This has contributed to the unregulated sale of timber at the provincial and regional level to firms from Thailand, South Korea, Japan, and other Asian countries.

The Lao state has long planned to convert the energy of its numerous streams and rivers into electricity through the construction of large hydroelectric dams on the main stem of the Mekong River and its numerous tributaries. Major hydroelectric dams include the 1,150-megawatt Nam Ngum project on the Ngum River near the capital city Vientiane and the 210-megawatt Nam Theun-Hinboun project on the Theun River in the province of Khammouane. The government is constructing the massive Nam Theun 2 project on the Theun River in Borikhamsai province with funding provided by the World Bank, the Asian Development Bank, and other sources of international finance. The Nam Theun 2 dam has engendered considerable controversy, with several transnational and regional NGOs arguing that the project's social and ecological disruptions, including displacement of local communities and loss of valuable fisheries, are considerable and not fully accounted for in dam planning.

The conservation of biodiversity is another major issue in Laos. The territory of Laos comprises several ecological zones of high biodiversity, especially in terms of large mammals and other large fauna. Endangered species found within Lao territory include the Asian elephant, Eld's deer, western black-crested gibbon, Siamese crocodile, and tiger. While the Lao government, with the assistance of international conservation groups such as the World Conservation Union, has designated over 14 percent of its land area as National Biodiversity Conservation Areas (NBCAs), illegal logging and other environmentally damaging activities remain rampant in these sites.

Another critical environmental issue concerns ongoing soil erosion and loss of arable land, particularly in the highland areas where a form of shifting cultivation continues to be practiced by a variety of the region's ethnic groups such as the Yao and Hmong minorities. A relic of the war between Vietnam and the United States in the 1960s and 1970s, unexploded ordnance in the form of land mines, artillery and mortar shells, rockets, and grenades continue to present a tremendous danger to rural families, particularly in those provinces bordering Vietnam.

SEE ALSO: Biodiversity; Hydropower; Mekong River; Rice; Vietnam; Vietnam War.

BIBLIOGRAPHY. Grant Evans, ed., *Laos: Culture and Society* (Silkworm Books, 1999); Michael Goldman, "Constructing an Environmental State: Eco-governmentality and other Transnational Practices of a 'Green' World Bank," *Social Problems* (v.48, 2001); Philip Hirsch and Carol Warren, eds., *The Politics of the Environment in Southeast Asia: Resources and Resistance* (Routledge, 1998).

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Latitude

LATITUDE IS THE measure of the geographical distance from a point on the earth's surface to the reference parallel or equator, symbolized by phi. Latitude and longitude are the two angular distances—using either degrees, minutes, and seconds, or decimal degrees—in the geographic coordinate system to precisely communicate the position of a certain location, and their measurement is fundamental for mapping representation and navigation.

Latitude is an angle formed by the plane that crosses a certain location on the earth's surface, the center of the earth, and the equatorial plane. Latitude values range from 0 degrees and 90 degrees to the north of the equator, expressed as a positive angle, and from 0 degrees and 90 degrees in the Southern Hemisphere, expressed as a negative angle—or respectively accompanied by the letters N or S.

The lines that connect the points with the same latitude are called parallels or lines of latitude. There is a constant distance between any two parallels and they cross meridians at right angles. Parallels are constant true east-west lines that decrease in their length toward the poles, represented as straight lines in the Mercator projection. The equator is the longest parallel, which makes it the natural reference or origin parallel and separates the Northern Hemisphere from the Southern Hemisphere. The poles are points, not lines, of latitude 0 degrees. The length of a degree of latitude along any meridian varies little, from 110.567 meters in the equator to 111.699 meters in the poles.

There are four other latitudes of specific interest, which are due to the obliquity or the angle between the equatorial plane and the ecliptic of the earth. The Tropic of Cancer (23 degrees 27'N) is the northernmost latitude where the sun is vertical at noon on summer solstice in the Northern Hemisphere. The Tropic of Capricorn (23 degrees 27'S) is the southernmost latitude where the sun is vertical at noon on summer solstice in the Southern Hemisphere. Both parallels comprise the tropical latitudes.

The Arctic Circle (66 degrees 33'N) is the southernmost latitude in the Northern Hemisphere and the Antarctic Circle the northernmost in the Southern Hemisphere where the sun does not set in summer and does not rise in winter. Polar latitudes are comprised within each circle. Mid-latitudes extend between the tropics and the polar circles.

The determination of latitude was achieved very early using a fairly accurate method, based on celestial navigation. This method involved measuring the angle of the sun above the horizon at noon during the day, or the position of any other astronomical object using common instruments such as the astrolabe, sextant or octant. Celestial navigation during the night consists of measuring the angle of the pole star in the Northern Hemisphere and the Southern Cross in the opposite. Latitude is the result of operating 90 degrees minus the measured altitude angle plus the sun's declination for the date.

SEE ALSO: Global Positioning Systems (GPS); Longitude; Maps.

BIBLIOGRAPHY. Lev M. Bugayevskiy and John P. Snyder, *Map Projections. A Reference Manual* (Taylor and Francis, 1995); Bill Carter and Merri Sue Carter, *Latitude: How American Astronomers Solved the Mystery of Variation* (Naval Institute Press, 2002); Arthur H. Robinson et al., *Elements of Cartography* (John Wiley & Sons, 1995).

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Latvia

LATVIA IS LOCATED on the eastern shore of the Baltic Sea, bordering Estonia, Lithuania, Russia, and Belarus. Latvia's government became a parliamentary democracy after it gained independence from the Soviet Union in 1991. Latvia has since reduced its trade dependency on Russia, and the majority of Latvia's trading is currently with member countries of the European Union (EU). Latvia joined the EU in May 2004. Since 1993 Latvia's Gross Domestic Product (GDP) per capita has grown each year at an average rate of 5.7 percent per year.

The state of the environment in Latvia has been in transition since independence. There was significant industrial decline after the fall of the Soviet Union, as much of Latvia's economy shifted to the service sector. A result was that pollution levels declined substantially. Latvia recently underwent major land reform. Almost all land in Latvia was owned by the state during the Soviet era and was restituted to its former, pre-Soviet owners after independence. Along with land restitution, Soviet-style cooperative agriculture dissolved, and smaller farms were established throughout the country. To obtain EU membership, Latvia complied with EU directives regarding nature protection and biodiversity. This process has helped lead to the current 542 protected areas, totaling 2.14 million acres (866,800 hectares), or 13.4 percent of Latvia's land territory at the end of 2002.

Latvia's largest export is wood products. Forests cover approximately 44.5 percent of the Latvian land territory, and the total forested area in Latvia has increased continuously since 1935 (except for a small decrease between 1983 and 1988). Latvia's current environmental priorities are the improvement of drinking water quality, sewage systems, household and hazardous waste management, and the reduction of air pollution.

Latvia's current population is 2.3 million. Latvia's total fertility rate (TFR) is one of the lowest in world, with 1.29 births per woman in 2003. The TFR declined from its recent high in 1987 at 2.21 to a low in 1998 at 1.11, and is now on the rise. Latvia's total population, rural population, and urban population have all declined each year since Latvia's independence. Between 1951 and 1990 there was a substantial net in migration to Latvia, primarily from other parts of the Soviet Union. Since 1991 there has been a substantial net out-migration from Latvia, most of which occurred in the few years after independence.

Ethnic Latvians constitute 59 percent of Latvia's population. Thirty-five percent are ethnic Russians, Ukrainians, and Belarusians, most of whom migrated to Latvia from other parts of the Soviet Union during the Soviet era or are descendents of those who migrated. Many of these migrants and their descendents were not granted Latvian citizenship after independence, primarily due to a difficult Latvian language exam required for citizenship: 20.8 percent of current Latvian residents do not have citizenship of any country. This situation has caused some tensions within the country between ethnic groups.

SEE ALSO: Drinking Water; Fertility Rate; Pollution, Air; Russia (and Soviet Union); Timber Industry.

BIBLIOGRAPHY. Central Intelligence Agency, "Latvia," *The World Factbook,* www.cia.gov (cited April 2006); Central Statistical Bureau of Latvia, *Statistical Yearbook of Latvia 2003* (2003); Central Statistical Bureau of Latvia, *Demography 2004* (2004); Zigurds Salinsh, *The Forest—Latvia's National Treasure* [in Latvian] (Jelgava Printing House, 2002); Katrina Schwartz, *Wild Horses and Great Trees: National Identity and the Global Politics of Nature in Latvia,* Ph.D. diss. (University of Wisconsin–Madison, 2001).

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Lawns

LAWNS, AS THEY are commonly understood in the United States today, are expanses of closely mown perennial grass. They are often found around suburban houses, sports fields, parks, and public sites. In order to maintain their uniform evergreen appearance, lawns generally require regular intensive management, including fertilizers, pesticides, and irrigation. Until mid-century, lawns in the north primarily included Kentucky bluegrass, and lawns in the south primarily included bermudagrass. Since the 1970s and 80s breeders have hybridized and cloned grasses to produce varieties suited for high-traffic areas, shade, and disease-resistance, and differing conditions of soil and climate. Current varieties include types of bahia, bentgrass, zoysia, fescues, and perennial ryegrass.

The modern American lawn has its roots in late 18th century Europe. There the Romantic Movement led some aristocrats to convert their formal geometric gardens to a naturalistic style including swaths of lawn. Mimicking flowery meadows grazed low by sheep and cows, these Romantic lawns required servant labor to keep them shorn. In the early 19th century a few wealthy Americans began imitating this style. By the 1880s, the middle classes followed suit by creating smaller lawns on their new suburban house-lots. Magazines promoted the lawn as an aesthetic and social ideal that allowed leisure activities such as croquet, lawn tennis, lawn bowling, and archery. The growing sports of golf and baseball also played a role in the evolution of lawns. By 1912, in response to pressure from the United States Golf Association, the U.S. Department of Agriculture began research into turfgrass breeding. The growing desire for lawns also encouraged private research in grass seed, mowers, sprinklers, chemical fertilizers, and pesticides. First patented in England in 1830, the lawnmower became widely available to wealthier households in the United States during the 1870s.

DEMOCRATIC LAWNS

After World War II lawns truly became democratized. Increasing home ownership and rapid suburbanization created a vast market for the lawn care industry. The prosperity of the postwar years provided many households with the time and money needed for a weed-free, evergreen lawn. New chemicals were also key to the modern lawn. Nerve agents invented for use as weapons during World War II were converted to home use in the 1940s and 50s as insecticides such as DDT, malathion, and parathion. Following Rachel Carson's book *Silent Spring* (1962), the public became concerned about persistent chemicals in the environment. Soon writings on organic lawn care appeared, beginning a wave of interest in reducing the environmental impacts of lawns.

In 2005, researchers completed the first comprehensive estimate of the land area occupied by lawns in the United States. Their conservative estimate of 128,000 kilometers^2 (31.6 million acres) makes lawns the largest irrigated crop in the United States by area. Because of the magnitude of this land use, lawn management practices have profound impacts. Problems include water use, air pollution, petroleum and chemical use, and decreased biodiversity.

If all lawns in the United States were kept watered and green all year, irrigation would use approximately 200 gallons of fresh water per person per day year round. Water use for landscaping, primarily lawns, absorbs 50–70 percent of home water use in the United States. Facing water shortages, especially in the arid West, governments at various levels have begun encouraging "xeriscaping," that is, replacing lawns with native plants that require little to no irrigation.

Americans use up to 800 million gallons of gasoline per year to mow their lawns. Of this, approximately 17 million gallons are spilled while filling up lawn equipment—more than the *Exxon Valdez* disaster. Inefficient motors long made mowers extremely polluting. Running a 3.5 horsepower mower for one hour produces as many volatile organic compounds (VOCs) as driving a new car 340 miles. Because they are often operated on sunny days, mowers' exhaust exacerbates smog and ground level ozone. Since 1997, the U.S. Environmental Protection Agency has established emissions standards and regulates new gas mowers. Electric, solar, and hand-push mowers reduce or eliminate both petroleum use and emissions.

Americans spread 80 million pounds of chemical fertilizers and pesticides on their lawns annually that can run off into fresh water. Excess nitrogen causes eutrophication in surface water. Run-off can be reduced through careful attention to slope, soil moisture, riparian buffers, and other factors. This amount of knowledge may not, however, be practical for home applications. Leaving grass clippings to decompose on the lawn can reduce the need for nitrogen inputs by one-half.

Many herbicides, fungicides, and insecticides commonly applied to both home and "professional" lawns are known or suspected to cause cancer, birth defects, and kidney or nerve damage; though this information is not required to be printed on packaging. Children are especially susceptible as their nervous systems and organs are still developing and they tend to have greater contact with treated lawns through play. To reduce the use of lawn chemicals, insects can be controlled through Integrated Pest Management, while many weeds can be pulled or killed with boiling water or vinegar and lemon.

As extensive monocrops, lawns accommodate minimal biodiversity. Environmental advocates have suggested that lawn size be reduced to a minimum and replaced with native plantings that provide food and habitat for a wide variety of wild crea-

Lawns cover an estimated 128,000 square kilometers (31.6 million acres) of the United States.

tures. This message has gained ground even on golf courses, some of which now incorporate naturalized wetlands and prairies in their "rough" areas.

Lawns do provide a few environmental benefits, especially in urban areas. They can capture environmental carbon, filter some air pollutants, produce oxygen, and reduce urban heat island effect. Two key factors, overall, in reducing lawns' harmful impacts are reducing their area and changing the lawn aesthetic. If lawns were allowed to go dormant (brown) during hot, dry weeks—and to include a mix of broadleaf plants in with turfgrass—the need for water, herbicides, and fertilizers would drop. Researchers have created alternative grass mixes that include clovers, yarrow, and other broadleaf plants in a lower-impact lawn. This aesthetic echoes the origins of lawns as mown meadows.

SEE ALSO: Golf Courses; Pesticides; Water Conservation; Xeriscape.

BIBLIOGRAPHY. F. Herbert Bormann et al., *Redesigning the American Lawn: A Search for Environmental Harmony* (Yale University Press, 1993); Virginia Scott Jenkins, *The Lawn: A History of an American Obsession* (Smithsonian Institution Press, 1994); C. Milesi et al., "Mapping and Modeling the Biogeochemical Cycling of Turf Grasses in the United States," *Environmental Management* (v.36, 2005); Rodale Press Editors, *Lawn Beauty the Organic Way. A Complete Guide to an Attractive Lawn Without Poison Sprays or Commercial Fertilizers* (Rodale, 1970); Warren Schultz, *A Man's Turf: The Perfect Lawn* (Clarkson Potter Publishers, 1999); Ted Steinberg, *American Green, The Obsessive Quest for the Perfect Lawn* (W.W. Norton & Co., 2006); Georges Teyssot, ed., *The American Lawn* (Princeton Architectural Press, 1999).

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Law of the Sea

THE LAW OF the sea defines the rights and responsibilities of states in the ocean. Every society has a law of the sea, as certain norms emerge regarding the relationship between water and land. The modern law of the sea, however, owes much of its legacy to Early Modern Europe, when states began to designate coastal waters—typically defined as three nautical miles from the coast—as their territory (one nautical mile equals 1.15 statute miles or 1.852 kilometers). During this period, the norm also emerged that the high seas—the ocean beyond territorial waters—could not be controlled by any state.

A more recent stimulus for the modern law of the sea occurred in 1945, when the United States asserted a right to manage "fisheries conservation zones" adjacent to its territorial waters and a right

According to the United Nations, a country's Territorial Sea extends 12 nautical miles out from its coastline.

to the mineral resources of its continental shelf. Although the United States was not claiming these adjacent waters as national territory, the proclamations encouraged other countries to pass legislation that came much closer to incorporating adjacent waters and seabed into the territory of the state. This could potentially endanger the "freedom of the seas" norm that had prevailed beyond the three nautical mile limit and that was crucial for global maritime commerce and military activities.

In response, the United Nations (UN) convened Conferences on the Law of the Sea in 1958, 1960, and 1973, eventually leading to the UN Convention on the Law of the Sea, which was signed in 1982 and went into effect in 1994. The Convention divides the ocean into zones: From the coastline out to 12 nautical miles is a country's Territorial Sea. A state can largely control what occurs there, although it must allow passage to other states' "innocent" vessels. An exception to this rule is made for international straits that are fewer than 24 nautical miles wide. High Seas freedoms prevail in these straits. In other words, even if a coastal state thinks that a foreign ship's intention is not "innocent" it must let the ship pass through the strait.

From 12 to 200 nautical miles from the coast is a country's Exclusive Economic Zone (EEZ). The waters and seabed of the EEZ are not state territory; High Seas freedoms of navigation prevail there. However, a coastal state has exclusive rights to manage and extract living and nonliving resources from its EEZ. Beyond 200 nautical miles, coastal states have no special authority. High Seas freedoms of navigation prevail and resources are designated "the common heritage of mankind."

The Convention on the Law of the Sea does not mandate specific environmental conservation measures. Rather, it establishes the level of authority that states have in various zones of the sea, thereby establishing a framework onto which unilateral legislation and multilateral treaties and conventions can be implemented.

SEE ALSO: Coastal Zone; Fisheries; Sailing.

BIBLIOGRAPHY. Robin R. Churchill and A. Vaughan Lowe, *The Law of the Sea,* 3rd ed. (Juris Publishing, 1999); C. John Colombos, *The International Law of the Sea,* 6th ed. (David McKay, 1967); Daniel P. O'Connell, *The International Law of the Sea* (Clarendon, 1992); Philip E. Steinberg, *The Social Construction of the Ocean* (Cambridge University Press, 2001).

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Lead

LEAD IS A soft, heavy, and toxic metal. It is easy to extract and smelt, and is well-suited for many uses. The combination of lead's toxicity with its usefulness has proved to be a particularly hazardous pairing: lead is an extremely toxic and also ubiquitous environmental contaminant.

Lead has been employed throughout history in a variety of ways: in plumbing, paint, gasoline, lead-acid batteries, ceramic glazes, jewelry, glass, wine, firearm projectiles, lead solder, and radiation shielding. Lead has been used by humans for at least 7,000 years. The most memorable appearance of lead historically was in water pipes and wine in the Roman Empire.

Lead is toxic in the body because it is able to mimic other biologically-important metals (such as iron, calcium, and zinc) and thereby interfere with biological processes. The adverse health effects of lead are numerous. They include (but are not limited to): reduced IQ, developmental delays in children, other neurological problems, hearing impairment, hypertension, lethargy, hyperactivity, infertility, anemia, gout, colic, brain damage, seizure, coma, and death. The adverse effects of lead have been recognized for thousands of years. The Romans themselves attributed the prevalence of gout and dementia to lead toxicity. It is likely that Beethoven suffered from lead poisoning.

Acute lead poisoning encompasses a certain set of symptoms, occurring at particularly high levels of exposure (usually blood lead levels above 20 μg/deciliters). It is now widely agreed, however, that exposure to lead at any level is toxic. Lead exposure is especially dangerous to young children because they absorb more lead from their environment and are at a critical stage of their neurobehavioral development. It was not until after 1950 that it was widely accepted that the neurological effects of lead poisoning persist and that lead exposure is dangerous even at low levels.

Lead has a long and illustrious history. While Roman aristocrats acknowledged risks such as madness and death from significant lead exposure, they falsely believed that moderate exposure would not be harmful. Many historians argue that chronic lead poisoning was a major factor in the decline of the Roman Empire. From the Middle Ages through the Industrial Revolution, lead was employed widely in alchemy, printing, weapons, and other industry. By the 20th century, the United States was the leading producer and consumer of refined lead. The per capita usage in the United States in 1980 was approximately 10 times that in Ancient Rome.

Currently, the primary environmental sources of lead exposure are leaded gasoline and lead-based paint. Industry presents an additional source of lead exposure, but such exposure is largely confined to those who live near or work in lead-producing industries such as lead smelters, battery plants, or fuel-burning industrial facilities.

Tetraethyl lead was first added to gasoline in the 1920s to improve engine performance and reduce engine knock. Early in the use of lead, General Motors refinery workers fell sick and died. Despite the warnings of public health advocates (including Harvard professor Alice Hamilton) and journalists (who dubbed leaded gas "loony gas"), lead was approved for use in gasoline. In the following decades, the lead content of gasoline rose, as did the use of gasoline in automobiles. By the 1950s there was an average of 2.4 grams of lead per gallon of gasoline. Lead from gasoline is absorbed into the body directly by breathing in gasoline exhaust and indirectly from contact with lead deposits in soil.

In the early 1970s the newly formed U.S. Environmental Protection Agency (EPA) officially recognized lead as a substantial public health hazard and named gasoline "the most ubiquitous source of lead found in the air, dust, and dirt in urban areas." In 1974, under the authorization of the Clean Air Act, the EPA mandated a timetable for the reduction of lead in gasoline, requiring petroleum companies to meet specified targets of maximum grams of lead per gallon of gasoline. The average lead content of the gasoline produced by each refinery was to be reduced from 2.0 grams per total gallon to a maximum of 0.5 grams per total gallon by 1979. This time table was delayed somewhat, and further reductions implemented. By 1990, gasoline lead had dropped to a mere one percent of its 1975 levels.

Most countries in western Europe followed the United States, using a variety of financial incentives to remove lead from gasoline in the 1980s and 1990s. Worldwide, however, many countries still use leaded gasoline; as of 2005, 67 countries had not yet banned or phased out lead from gasoline. These countries are generally poorer and located in central Europe, eastern Europe, Africa, Southeast Asia, and the Middle East.

Lead in paint is the second major source of environmental lead exposure. Lead was originally added to paint as a pigment and to speed drying and increase durability. Many countries banned lead in residential uses early in the 1920s, but the United

States did not do so until 1978. In the United States, the lead content of paint declined relatively smoothly from 1920 on, with breaks in 1950 when lead-based paint was banned for interior use and in 1978 when it was banned for all residential uses. Lead paint is still used by the military and industry.

Lead in paint is not as readily absorbed as lead from gasoline. Currently, the primary danger stems from older housing with deteriorating paint: the main exposure pathway is via normal hand-to-mouth contact with lead dust. Children also may eat paint chips (because lead makes paint taste sweet). Exposure to lead in paint dust and paint chips represents a significant source of current environmental lead exposure for children. The U.S. government has a variety of programs aimed at increasing parental awareness of the hazards of lead exposure. Many states have residential lead paint regulations that mandate removal or abatement of lead paint in housing occupied by young children.

There is also emerging evidence that lead used in water mains throughout the world presents an additional hazard. Research suggests that water may leach lead from these pipes (either in mains or in residential pipes), providing a steady stream of low-level and largely undetected exposure to lead.

The U.S. experience—a drastic decline in blood lead levels since the 1970s—is widely viewed as a strong success of public health policy. The decrease was brought about by the work of advocacy groups, government agencies, and scientists such as the pioneer Herbert Needleman. This success, however, was not easily achieved: these groups and individuals overcame significant resistance from the paint and petroleum industries. While much has been achieved, hazards remain both in the United States and around the world.

The current public health focus in the United States is on the hazards posed by existing lead paint and the higher likely impact on children of lower socioeconomic status. In addition, many of the psychological effects of childhood lead exposure can persist into adulthood, potentially producing higher rates of adverse social behavior on a societal scale decades after the actual exposure. By affecting societal phenomena, such as learning disabilities and violent crime, lead may in fact have a larger impact on society than has been generally acknowledged.

Worldwide, lead contamination persists, and public health agencies and governments are taking important steps to reduce environmental lead exposure. The removal of lead from gasoline continues, particularly in central and eastern Europe and Southeast Asia. The challenge often encountered is the persistence of deposition from historical usage and the presence of lead in paint. The policy problem, particularly for poorer countries, is that the initial costs of removal may seem high relative to the less tangible and possibly distant health benefits. While the benefit–cost ratios are uniformly high (usually greater than 10), lead contamination presents a challenge for policy implementation.

SEE ALSO: Clean Air Act; Environmental Protection Agency (EPA); Gasoline; Hamilton, Alice.

BIBLIOGRAPHY. David Bellinger, *Lead* (Pediatrics, 2004); Richard Lansdown and William Yule, eds., *Lead Toxicity: History and Environmental Impact* (Johns Hopkins University Press, 1986); Magda Lovei, *Phasing Out Lead from Gasoline: Worldwide Experience and Policy Implications* (World Bank, 1998); Jerome O. Nriagu, *Lead and Lead Poisoning in Antiquity* (John Wiley & Sons, 1983); Julie Wakefield, *Lead History—Violent Future* (Environmental Health Perspectives, 2002).

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League of Conservation Voters

THE LEAGUE OF Conservation Voters (LCV) is an American organization with an independent political voice that lobbies on behalf of the environment. The LCV is the political voice of the national environmental movement and the only organization devoted full-time to shaping a pro-environment Congress and White House. The LCV was created in 1970 as a result of the second wave of U.S. environmentalism that emerged out of the first Earth Day on April 22, 1970. The organization focuses its efforts on influencing politics as they relate to the environment in the United States. Marion Edey, then a U.S. congressional staff aide, and David Ross

Brower, the executive director of the Sierra Club from 1952–69, and then founder of the Friends of the Earth in 1969, created the LCV. Edey sought to create an organization that could act as the electoral wing of the environmental movement in the United States. Together, Edey, Brower, and a directorate made up mainly of members of Brower's Friends of the Earth organized the LCV.

The LCV's mission is to advocate for sound environmental policies and to elect pro-environmental candidates who will adopt and implement such policies. The LCV campaigns to defeat antienvironment candidates, and supports those leaders who stand up for a clean, healthy future for America. To assist voters in selecting pro-environmental candidates, the LCV publishes the National Environmental Scorecard, which gives ratings to all congressional members in terms of their voting records on key environmental and public health issues. These issues include energy, biodiversity, public health, environmental funding, and other priority votes (such as free trade and population policy).

The LCV also produces the Presidential Report Card, and with these publications the league holds Congress and the administration accountable for their actions on the environment while preventing antienvironment candidates from masking their records with pro-environment rhetoric. The LCV's National Environmental Scorecard and the Presidential Report Card are the authoritative record of how members of Congress and the administration handle the most important environmental issues.

In addition to tracking voting records and endorsing or opposing candidates, the group contributes to and participates in political and electoral campaigns. The LCV campaigns have been successful, defeating 23 out of 37 antienvironmental candidates targeted by their "Dirty Dozen" campaigns since 1996. The LCV has helped hundreds of environmental leaders to victory, both on Capitol Hill and at the ballot box. Also, since 1996 over 80 percent of LCV endorsed candidates have won their respective elections. Through regional offices, the LCV builds coalitions, promotes grassroots power, and trains environmental leaders. The League Family of Organizations includes the LCV Action Fund, the LCV Accountability Project, and the LCV Education Fund.

SEE ALSO: Policy, Environmental; Political Ecology; Political Economy.

BIBLIOGRAPHY. Ryan J. Carey, "League of Conservation Voters," in *Encyclopedia of World Environmental History* (Routledge, 2003); Marion Edey, *Sierra Club Bulletin* (v.60/3, 1975); John Tibbetts, *Environmental Health Perspectives* (v.105/4, 1997).

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Leakey, Louis and Mary

FOR LOUIS AND Mary Leakey, the question of humanity's nature is precisely related to human origins. Humanity has a scientific definition, a definition that is directly connected to humanity's evolution and its manipulation of the environment. According to Louis Leakey, "during the slow course of physical evolution it would be impossible to say positively 'this is where the pre-human creature ceased to be sub-human and became a man' unless we have an agreed definition of what we mean by man." For this reason Louis Leakey defined man simply as a "creature belonging to the primate stock which had reached a stage where it actually made tools, as distinct from merely using suitable natural objects as tools."

There are two astonishing things about this definition. First, it describes humanity as a primate, an animal. Second, it describes humanity as a product of its distinct relationship with the environment: the making of tools. Through their tireless excavations in the Olduvai Gorge in Kenya, Mary and Louis Leakey provided striking proof of humanity's origins as a tool-making primate; an animal connected to nature through millions of years of evolution, but also separated from the environment through conscious manipulation and manufacture of simple stone tools: the first "artificial" products.

Louis Leakey was born to missionaries in British East Africa—now known as Kenya—in 1903. He was fascinated by fossils from a young age. After attending Cambridge he set out to prove Darwin's idea that humans first emerged from Africa, not

Asia, as it was then assumed. From 1926 he excavated at the Olduvai Gorge, a chasm that was once a lakebed and a perfect environment for finding ancient hominid settlements and bones.

After decades of excavation without any definitive human fossil finds, Louis Leakey married Mary Nicol in 1936. As a team Mary and Louis discovered several man-made tools and the prehuman jawbone of a creature called *Proconsul*. In 1959 Mary Leakey made an amazing discovery of *Zinjanthropus*—or *Australopithecus boisei*—which made the Leakeys world famous. The Leakeys speculated the fossil to be at least 600,000 years old; recent carbon-14 dating has pushed back the date of the fossil to an astonishing 1.75 million years.

In 1978 Mary made another astonishing discovery of three-and-a-half-million-year-old footprints of two hominid adults and a child in Tanzania. These were probably the same species as the famous Lucy skeleton discovered by Donald Johanson. The Leakeys made further groundbreaking discoveries in Africa of *Homo habilis*, "handy man" and *Homo erectus*, "upright man" that have profoundly shaped current understanding of human origins. Their son Richard and even their granddaughter have continued the family tradition in paleoanthropology. Louis Leakey died in 1972. Mary died in 1996 at the age of 83.

SEE ALSO: Anthropology; Human Ecology; Human Nature; Kenya; Leakey, Richard; Tanzania.

BIBLIOGRAPHY. Louis Leakey, *Adam's Ancestors* (Harper & Row, 1960); Mary Leakey, *Disclosing the Past* (Doubleday, 1984).

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Leakey, Richard (1944–)

THE IDEA THAT humans gradually evolved from a fragile habitat of apelike creatures in Africa to bipedal, technological masters of the world has become an important—if not always accepted—part of defining modern society and culture. Although Darwin spoke of the descent of man, Richard Leakey—the son of the famous paleoanthropologists Louis and Mary Leakey—popularized the idea of human origins through his groundbreaking discoveries, his bestselling books, and his masterful melding of popular writing with scientific rigor.

While being raised in Africa by the world-famous Leakeys as they searched for hominid bones in the Olduvai Gorge in Kenya, Richard developed a keen interest in East Africa's diverse wildlife. His interest in wildlife and his passion for environmental preservation did not stop as he delved into paleoanthropology. His book *People of the Lake*, written with Roger Lewin in 1978, became a sensation as its conclusions about human nature impacted the arguments of several social movements in America.

The accessibility of Richard Leakey and Roger Lewin's work enhanced the understanding of evolution in the popular mind and opened the door for further studies of evolution in schools. He made other famous discoveries in 1984–85: the Turkana Boy, a nearly complete *Homo erectus* skeleton, and WT17000, the first nearly complete skull of the *Australopithecus aethiopicus*. These and other discoveries were outlined in his more recent book, also written with Roger Lewin: *Origins Reconsidered: In Search of What Makes Us Human*.

From 1989–94 Richard led the Kenyan Wildlife Service and successfully combated the poaching of rhinos and elephants. His keen understanding of environmental issues and the fragile balance between humanity and its environment lead him further into environmental politics. He was elected in 1997 to a seat in the Kenyan Parliament and was a leader in the opposition party Safina.

Maeve, Richard's wife, continues to research in paleoanthropology and recently described two new species of human. Louise, the granddaughter of Louis and Mary, is also engaged in paleoanthropology and has recently made her own discoveries. Over three generations the Leakeys have pointed a spotlight on human origins, compelling us to consider the fragile balance between our natural origins in the environment and our own humanity. They have become the most famous family in paleoanthropology, if not modern science.

SEE ALSO: Anthropology; Evolution; Human Ecology; Human Nature; Kenya; Leakey, Louis and Mary.

BIBLIOGRAPHY. Richard Leakey, *One Life: An Autobiography* (Salem House, 1984); Richard Leakey and Roger Lewin, *People of the Lake* (Anchor Press, 1978); Richard Leakey and Roger Lewin, *Origins Reconsidered: In Search of What Makes Us Human* (Abacus, 1992).

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Lebanon

FOR MUCH OF the last quarter of the 20th century, the Lebanese Republic was involved in a debilitating civil war that drained the country of much-needed resources and destroyed the existing infrastructure. In 1991, the Ta'if Accord paved the way for reconciling divisions between the diverse religious populations and the government, leading to the institution of political and economic reforms. Both Israel and Syria established a military presence in Lebanon to assist in maintaining the tenuous peace. Israel's forces withdrew in 2000; and, bowing to pressure, Syria withdrew its remaining forces in 2004. However, in 2006 renewed hostilities and an Israeli invasion throughout the southern part of the country meant a revival of violence with serious implications for environmental conditions throughout the country.

With a per capita income of $5,100, Lebanon ranks 130th of 232 nations in world income. Roughly one million of the workforce of 2.6 million is non-Lebanese. Poverty is pervasive, and unemployment is high at 18 percent. The entire population of Lebanon has access to safe drinking water, and only 2 percent lack access to improved sanitation. The United Nations Development Programme Human Development Reports rank Lebanon 81st in the world on overall quality-of-life issues.

Bordering on the Mediterranean Sea, Lebanon has a coastline of 140 miles (225 kilometers). The Mediterranean climate produces mild to cool, wet winters and hot, dry summers. Heavy snows are frequent during winter months in the mountains. Much of Lebanon is composed of a narrow coastal plain, with the Bekaa Valley marking the division between the Lebanon and Anti-Lebanon Mountains. Sandstorms are common.

Natural resources include limestone, iron ore, salt, and arable land (16.62 percent). Lebanon has a surplus of water unlike most of her neighbors who suffer from severe shortages of freshwater. This is partially due to the presence of the Nahr el Litani, which is the only major river in the Near East that is contained in a single country.

ENVIRONMENTAL ISSUES

Environmentally, Lebanon is experiencing extensive deforestation, soil erosion, and desertification. In a 2006 study, scientists at Yale University ranked Lebanon 36th of 132 countries on environmental performance, well above the relevant income and geographic groups. Lebanon received the lowest rankings in the categories of biodiversity and habitat and air quality.

Roughly 88 percent of the population of Lebanon is urbanized, and pollution is particularly severe in Beirut from carbon dioxide emissions and the burning of industrial wastes. Between 1980 and 2002, carbon dioxide emissions in per capita metric tons climbed from 2.3 to 4.7, with the country producing 0.1 percent of the world's total. Raw sewage and oil spills have contaminated the coastal waters. Desertification in Lebanon is a by-product of poverty and climate, and responsible development is seen as the key to checking further ecological damage.

GOVERNMENT RESPONSE

The long years of civil war led to environmental issues being placed on the back burner in Lebanon, but in the last decade or so, the government has begun to deal with the problems of waste management and pollution. The Ministry of Environment heads up six departments that together have been charged with promoting sustainable development and protection of natural resources. The government has launched education programs at all levels to teach the people about protecting their environment. Spurred partly by the active participation of nongovernmental organizations (NGOs), funding for environmental research has increased significantly. Although only 3.5 percent of Lebanon's land area is forested, 0.5 percent of the land has been brought under national protection with the establishment of seven natural reserves. Of 57 endemic mammal species, five are threatened with extinction, and seven of 116 endemic bird species are endangered.

Lebanon participates in the following international agreements: Biodiversity, Climate Change, Desertification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands. The Lebanese government has signed but not ratified agreements on Environmental Modification and Marine Life Conservation.

It is too soon to determine the environmental implications of the renewed violence in Lebanon, but early indications suggest much of it will be serious and potentially irreparable. Following Israeli air strikes in July 2006, for example, the Jiyeh power plant near Beirut leaked some 15,000 tons of oil into the Mediterranean Sea, with critical implications for marine life. Forest fires, soil erosion, burning oil, and toxic waste are all ongoing parts of the conflict, while overall instability further contributes to an environmental crisis in the region.

SEE ALSO: Deforestation; Desertification; Oil Spills; Poverty; Soil Erosion.

BIBLIOGRAPHY. Central Intelligence Agency, "Lebanon," *World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kassem El-Saddik, "Finding Space in Crowded Agendas," April 2, 2004, uk.oneworld.net (cited May 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); UNDP, "Human Development Report: Lebanon," hdr.undp.org (cited May 2006); World Bank, "Lebanon," *Little Green Data Book,* lnweb18.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited May 2006).

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Legume

LEGUMES ARE PODS or fruits of the *Fabales* order of plants. They include beans, peas, peanuts, alfalfa, soybeans, and vetch. Legumes are important because of their use in human and animal feed and because of the various products they yield, including fibers, edible oils, and plastics. Consequently, industries based on legumes are significant in terms not just of providing nutrition, but also of creating inputs into other economic activities. The current value of legumes is estimated at around two billion dollars annually, with many more used as local food sources and not included in official statistics. Since legumes are of particular importance in improving land quality, the use of legumes is likely to intensify in the future as population growth, climate change, environmental degradation, and desertification de-

Legumes yield many important products, including fibers, edible oils, and plastics.

crease the amount of exploitable and productive land per capita.

Legumes are of importance for their ability to fix atmospheric nitrogen and for the symbiotic relationship they can maintain with rhizobia, which means they are particularly useful in crop rotation schemes to prevent nitrogen depletion in the soil. This also enables legume growers to reduce the amount of artificial fertilizer used to grow plants. The high nitrogen content is also associated with the high level of protein within legumes. Some manufacturers produce rhizobia for use as seed inoculants on a commercial basis.

The rhizobia-legume symbiotic system can fix as much as 300 pounds per acre in the right circumstances. This process means that legume-rhizobia combinations can be of great assistance in promoting sustainable agriculture in areas that previously have not been very fertile. Several thousands of tons of cereal and legume seeds were dispatched to Eritrea, for example, to try to improve the fertility of the land in the wake of the drought of 2002. The necessity of inoculating the legumes is recognized by the Food and Agricultural Organization of the United Nations.

However, the use of genetically modified (GM) rhizobia is more controversial and it is clear that in many countries significant proportions of the population are opposed to any form of GM food. Any use of GM seeds that would contaminate non-GM food, and must be labeled as such, would be resented and rejected by significant numbers of consumers. There is also the risk that GM legumes would have unanticipated impacts on the soil and on surrounding flora and fauna.

SEE ALSO: Eritrea; Food; Genetically Modified Organisms (GMOs); Nitrogen Fixation.

BIBLIOGRAPHY. Food and Agricultural Organization (FAO), www.fao.org (cited July 2006); International Legume Database and Information Service, www.ildis.org (cited July 2006); S.P. Wani, O.P. Rupela, and K.K. Lee, "Sustainable Agriculture in the Semi-Arid Tropics through Biological Nitration Fixation in Grain Legumes," *Plant and Soil* (v.174/1–2, 1995).

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Leopold, Aldo (1887–1948)

ECOLOGIST, EDUCATOR, AND pioneering wildlife manager, Aldo Leopold is best known as the author of *A Sand County Almanac* (1949), a work that explored humanity's proper role in what he referred to as "the land community." Part natural history, part philosophical exploration, and part radical environmental manifesto, Leopold's *Sand County Almanac* begins as a series of natural history essays detailing his rehabilitation of a worn-out farm in Wisconsin, and ends as a philosophical treatise that calls for nothing short of a complete realignment of the ethical relationship between humanity and nature.

Leopold was born on January 11, 1887 in Burlington, Iowa. His boyhood was divided between the study of history and literature inside the classroom, and ornithology and woods-lore outside the classroom. Hunting and camping trips across the Midwest provided Leopold with a passion for conservation as he tramped the region's rapidly diminishing prairies and river bottoms, seeing first-hand the damaging effects of habitat destruction on wildlife populations. After earning a master's degree in forestry from Yale in 1909, Leopold entered the U.S. Forest Service. His first job took him to New Mexico, where he would be instrumental in establishing the Gila National Wilderness, the nation's first official wilderness area.

In 1924 Leopold settled in Madison, Wisconsin, where he continued to work for the cause of conservation. His early work *Game Management* (1933), established him as the nation's preeminent authority on wildlife conservation. As a result, in 1933 Leopold was offered a position at the University of Wisconsin, in the nation's first graduate program in wildlife management.

In 1935, Leopold purchased an abandoned farm in Sauk County on the banks of the Wisconsin River. The tract of abused land quickly became a laboratory where Leopold could experiment with methods of reestablishing ecological health to a damaged landscape, and where he could endeavor to understand humanity's proper role in the natural world.

Leopold's experiences rehabilitating the land found their way into a series of essays that would become *A Sand County Almanac*. The book's key contribution to American environmental thought is its deft introduction of ecological concepts into the discussion of humanity's place in nature. Whereas earlier nature writers, such as Henry Thoreau and John Muir, had intuited an interconnected relationship to the nonhuman world, Leopold was able to use the emergent scientific discipline of ecology as the basis of his philosophical argument that each human should regard himself or herself as a "plain member and citizen" of a "land community," rather than a "conqueror" of nature.

Leopold's text is part of a tradition of American nature writing stretching back to Thoreau's *Walden* (1854), a tradition that blends an isolated narrator's first-person account of the workings of nature with broad social commentary. In both works, a simplified, more nature-centered existence becomes the vehicle for a critique of an increasingly technological, and increasingly misguided, American society.

In the book's final section, titled "The Upshot," Leopold addresses the ethical and philosophical changes that he saw as necessary to reverse the environmental losses of 20th century America. In the most influential of the final essays, "The Land Ethic," Leopold called for a radical rejection of land use decisions based on economics, suggesting instead that ethical consideration be granted to all members of "the land-community."

Rather than evaluating interactions with nature solely in terms of human benefit, Leopold called for a redefinition of proper conduct based on what is beneficial to the entire ecosystem: "A thing is right," he stated, "when it tends to preserve the integrity, stability, and beauty of the entire biotic community."

Leopold died while fighting a brush fire on a neighbor's property in 1948, a year before *A Sand County Almanac* was published. While early readers may have missed the philosophical significance of his ideas, later environmentalists of the 1960s and 70s took note of Leopold's push toward a more biocentric view of the universe, making his work a core text of the era's environmental movement.

SEE ALSO: Ecosystem; Land Ethic; Muir, John; Thoreau, Henry David.

BIBLIOGRAPHY. Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (Oxford University Press, 1949); Marybeth Lorbiecki, *Aldo Leopold: A Fierce Green Fire* (Oxford University Press, 1996); Curt Meine, *Aldo Leopold: His Life and Work* (University of Wisconsin Press, 1988); Thomas Tanner, ed., *Aldo Leopold: The Man and His Legacy* (Soil Conservation Society of America, 1987).

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Lesotho

FORMERLY KNOWN AS Basutoland, the Kingdom of Lesotho attained independence from Britain in 1996. After the return of King Moshoeshoe from exile and his subsequent reinstatement in 1995, constitutional government replaced two decades of military rule. South Africa and Botswana, however, were compelled to intervene when civil protests were followed by a military mutiny. Lesotho has been relatively peaceful since 2002.

Lesotho's natural resources include water, agricultural and grazing land, diamonds, sand, clay, and building stone. Some 86 percent of the population is engaged in subsistence agriculture. Although 35 percent of the adult male population works in South Africa, Lesotho has a 45 percent unemployment rate.

Some economic gains have been made in the past decades. A hydropower facility completed in 1998 allows Lesotho to sell water to South Africa, and a small manufacturing base and growing apparel-assembly sector have surfaced. Lesotho has been approved for an International Monetary Fund Interim Poverty Reduction and Growth Facility.

With a per capita income of $3,000, Lesotho is still a relatively poor country and is ranked 159th in world incomes. Around 49 percent of Basotho live below the poverty line, and great income disparities exist. The richest 10 percent of the population holds 43.3 percent of the wealth, while the poorest 10 percent shares 0.9 percent. More than three-fourths of the population of Lesotho has access to safe drinking water, but only 47 percent have access to improved sanitation. The United Nations Development Programme's Human Development Reports rank Lesotho 149 of 232 countries on overall quality of life issues.

As an enclave of South Africa, Lesotho is surrounded on all sides by its larger neighbor. The terrain of Lesotho is mostly mountainous with highlands, plateaus, and hills. The most distinct geographic features of the country are the Maluti Mountains, part of the Drakensberg Range, which extend from the north to the south. Over 80 percent of Lesotho is above sea level, with elevations ranging from 1,400 meters at the junction of the Orange and Makhaleng Rivers to 4,482 meters at Thabana Ntlenyana in the east. The temperate climate produces cool to cold, dry winters and hot, wet summers. Lesotho suffers from periodic droughts.

ENVIRONMENTAL ISSUES

One of Lesotho's major environmental issues is related to health. With an adult prevalence rate of 28.9 percent, Lesotho has one of the highest HIV/AIDS rates in the world. Out of a population of 2,022,331 people, 29,000 Basotho have died and another 320,000 are living with the disease. The prevalence of AIDS affects many other aspects of health in Lesotho, resulting in a negative population growth rate of negative 0.47 percent and a life expectancy of only 34.4 years. HIV/AIDS is also responsible for the high death rate (28.71 deaths per 1,000 population) and is partially responsible for the high infant mortality rate of 87.24 deaths per 1,000 live births.

Because of overgrazing and soil that has been exhausted and eroded, the Basotho have begun settling in marginal areas. Desertification is expanding, and the country faces increasing problems with air and water pollution. Current methods of dealing with solid and toxic waste management are inadequate.

The Highlands Water Project was designed to use Lesotho's abundance of water to generate needed government revenue, transferring water from the Sengue/Orange River to South Africa while generating hydropower for Lesotho. Critics claim that the project has resulted in overexploitation of Lesotho's resources and deprived many people of their livelihoods. Some people believe that the water should stay in Lesotho to be used during droughts. Only 0.5 percent of the land area of Lesotho is forested, and the government has protected only 0.2 percent of all lands. Lesotho is not rich in biodiversity. Of 33 endemic mammal species, three are endangered, as are seven of 123 bird species.

The National Environment Secretariat of the Prime Minister's Office has been charged with implementing and enforcing environmental laws in Lesotho. The Environment Protection Agency is also involved in this process. In 1989, the government instituted the National Environmental Plan as a framework for enacting laws on Biodiversity, Climate Change, and Desertification Control, with the overriding goal of promoting sustainable development. Specific goals focused on checking soil erosion and land degradation; dealing with water shortages caused by periodic droughts; meeting the needs of an increasing urban population while eradicating poverty in rural areas; preventing further pollution of land and water; devising improved methods of handling solid and toxic waste; promoting biodiversity; protecting and promoting human health; and educating the public about environmental issues. Lesotho has also instituted a universal HIV/AIDS testing plan.

Lesotho participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Marine Life Conservation, and Ozone Layer Protection. The Law of the Sea agreement has been signed but was never ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Desertification; South Africa.

BIBLIOGRAPHY. Central Intelligence Agency, "Lesotho," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Environmental Consulting Services, "Lesotho Environmental Policy," www.ecs.co.sz (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent*

(McFarland, 1993); United Nations Development Programme, "Human Development Report: Lesotho," hdr.undp.org (cited April 2006).

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Levees

SINCE ANCIENT TIMES, in countries where rising water levels present major residential problems and threats to agriculture, governments have built levees and canals to keep settlements and fields from flooding and to control the directions in which water flows. Archaeologists have discovered the remains of levees in China, India, Egypt, and Mesopotamia. In addition to providing flood protection and controlling water flow, the levee is also used in agricultural production and in regulating water and ice flow.

Some experts believe that today's levees are actually less efficient than those of the past and fault modern engineers for ignoring historical knowledge in constructing levees. From an engineering standpoint, the most important factors in constructing levees are the stability of the foundation on which they stand and the capacity of levees to withstand flooding. Most levees used in North America were originally erected around the turn of the 20th century on the Mississippi River in the United States and on the St. Lawrence River in Canada. Debates since then have focused on whether structural solutions (i.e., the construction of engineered control walls and river manipulations) should be favored over other options, including the restoration of wetlands, natural river paths, and the removal of human inhabitants from floodplains.

SEE ALSO: Army Corps of Engineers; Disasters; Floods and Flood Control; Hurricanes; Netherlands.

BIBLIOGRAPHY. *Battle of the Floods: Holland in February 1953* (Netherlands Booksellers and Publishers Association, 1953); Douglas Brinkley, *The Great Deluge: Hurricane Katrina, New Orleans, and the Mississippi Gulf Coast* (Morrow, 2006); Michael Eric Dyson, *Come*

New Orleans

New Orleans lies 20 feet (six meters) below sea level, and the city is bordered by the Mississippi River and Lake Pontchartrain, both of which feed into the Gulf of Mexico. Its levees have been receiving attention in recent years as a result of the continuing devastation of the Gulf Coast that began in the 1930s. The worst fears of residents and environmentalists were realized in 2005 when, in the aftermath of Hurricane Katrina, two levees (of the total 350 miles [563 kilometers] of earthen works and cement seawalls) broke. These levees had been built to withstand Category 3 storms but not Category 4 storms like Katrina. Over the next 72 hours, some 37 billion gallons (140 billion liters) of water flooded over 80 percent of the historic city. The 23 pumping stations that dated to the early 1900s were not equipped to handle the deluge and shut down as stations flooded.

As water inundated the city, thousands of residents were stranded without food, running water, medicine, and other necessities. Human loss was estimated at 1,599 lives, with causes of death ranging from dehydration to lack of medical care to drowning to fire to suicide. Tens of thousands of people were displaced to cities around the country. Property damage was an estimated $75 billion, and Congress was forced to appropriate $100 billion for Katrina relief after refusing to appropriate funds to renovate the levees before Katrina hit.

In the months following Katrina, some experts contended that the levees were poorly constructed by the Corps of Engineers. In the spring of 2006, a new scandal erupted when a videotape provided proof that officials at all levels, including the White House, were aware that the scenario that developed in New Orleans was virtually a certainty. Because most of the stranded residents were black and poor, race and class were a significant factor in assessing risk, constructing and maintaining flood controls, and investing in infrastructure against environmental hazards.

Hell or High Water: Hurricane Katrina and the Color of Disaster (Perseus, 2006); Pavol Peter, *Canal and River Levees* (Elsevier Scientific, 1982).

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Lewis and Clark Expedition

THE LEWIS AND CLARK Expedition (1804–1806) was the first U.S. overland expedition from the east coast to the west coast of the continent. It was led by Captain Meriwether Lewis and Second Lieutenant William Clark. After the Louisiana Purchase expanded U.S. territory in 1803, President Thomas Jefferson, inspired by French ideas for a similar scientific expedition through their territory, accelerated plans for what became the Lewis and Clark Expedition.

Initially there were 33 in the expedition. Captain Lewis, Jefferson's private secretary, was the leader. Captain Clark shared command, although he was technically second-in-command. Sergeant Charles Floyd was the quartermaster; his death early in the trip was the only fatality suffered by the team. There were three other sergeants, one corporal, and the rest were private soldiers, except for York, Clark's black manservant. There was also an interpreter, George Drouillard.

On May 14, 1804, the expedition left Camp Dubois near present-day Hartford, Illinois, and met up with Lewis and others at Saint Charles, Missouri. They then journeyed to La Charrette, the last white settlement on the Missouri River, before heading westward into territory that was then largely or totally unknown to them.

The first Native American tribe encountered by the expedition were the Yankton Sioux, followed by the Teton (or Lakota) Sioux. The first tribe was given five medals, which was a great disappointment, and the second wanted a boat, nearly precipitating a fight. However, the expedition managed to continue on and during the winter built Fort Mandan, near present-day Washburn, North Dakota, where they sheltered for the winter. It was there that they were joined by a French Canadian, Toussaint Charbonneau, along with his Indian wife, Sacagawea. They would become interpreters for the expedition.

In April 1805, Lewis and Clark decided to send back a return party from Fort Mandan. It included a detailed report on what had been discovered up to that point, botanical specimens, and also a prairie dog, which was delivered live to Jefferson in a box.

The rest of the expedition then followed the River Missouri westward. The exact boundaries of the Louisiana Purchase were unknown, and the U.S. government was keen to claim what would later be the states of Washington and Oregon. It was to this area that the expedition headed, finally reaching the Pacific Ocean, an event that Clark recorded in his journal on November 18, 1805.

The expedition spent the winter near the coast building Fort Clatsop. On March 23, 1806, the exhausted group decided to return home. In July, the party split, with Lewis and nine men heading for the Falls of the Missouri, on the same route as the outward journey. Clark followed a southern route along the Yellowstone River.

The two parties reunited on August 12 and returned to St. Louis on September 23, 1806. By that time many people thought the whole party had been killed. Their expedition helped subsequent U.S. claims to the Oregon territories, although there was some anger expressed by the Spanish. The expedition has a unique place in U.S. history as the first successful attempt by people living in the east to cross the entire continent after independence.

SEE ALSO: Native Americans; United States, Midwest (Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, West Virginia, Wisconsin); United States, Pacific Northwest (Washington, Oregon).

BIBLIOGRAPHY. Stephen Ambrose, *Undaunted Courage: Meriwether Lewis, Thomas Jefferson and the Opening of the West* (Simon & Schuster, 1996); David Holloway, *Lewis & Clark and the Crossing of North America* (Excalibur, 1974); Gary E. Moulton, ed., *The Original Journals of the Lewis and Clark Expeditions* (University of Nebraska Press, 1986–93).

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Liberia

THE REPUBLIC OF Liberia was originally founded and settled by black American settlers and freed slaves in the mid-19th century, with a structure of government mirroring to a great degree that of the United States. In the late 20th century, the country suffered through a series of civil wars, with a peace agreement signed in 2003. Despite the fact that the United Nations (UN) maintains a presence in Liberia, the situation remains volatile. Because the war and political strife drained so many resources, the country is still in the early stages of rebuilding its infrastructure and finding its path to economic recovery. Tens of thousands of Liberians were killed during the conflict, and at least 238,500 Liberians remain in other countries, unwilling to return to their homeland.

Liberia's rich natural resources include iron ore, timber, diamonds, gold, and hydropower, and the country exports both timber and rubber. Less than four percent of the land is arable. However, 70 percent of the workforce is engaged in subsistence agriculture. Eighty-five percent of Liberians are unemployed. At least 80 percent of Liberians live in poverty, and 46 percent are undernourished. With a per capita income of only $900, Liberia is one of the 20 poorest countries in the world. The UN Development Programme's Human Development Reports do not rank Liberia on standard of living issues due to insufficient data.

Bordering on the North Atlantic Ocean, Liberia has a 579 kilometer coastline and 15,050 square kilometers of inland water resources. Liberia shares land borders with Guinea, the Cote d'Ivoire, and Sierra Leone. The terrain of Liberia is generally flat with rolling coastal plains that give way to plateaus and low mountains in the northeast. Lagoons, mangrove swamps, and river-deposited sandbars characterize the coastline. Elevations vary from sea level to 1,380 meters at Mount Wuteve.

The tropical climate is hot and humid. Winter days are hot, but nights are cool to cold. Summers in Liberia are wet and cloudy with frequent heavy showers. From December to March, Liberia experiences the harmattan, hot dusty winds that blow in from the Sahara Desert, creating environmental damage.

Liberia's population of 3,042,004 experiences many of the health problems that beset other poor African nations, including a high HIV/AIDS prevalence rate (currently 5.9 percent). The HIV/AIDS epidemic has killed 7,200 people, and at least 100,000 more have contracted the disease. Around 62 percent of the population has access to safe drinking water, but only 26 percent (7 percent in rural areas) have access to improved sanitation. Consequently, Liberians also have a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever, in addition to schistosomiasis—caused by contact with contaminated water—and Lassa fever, caused by contact with infected aerosolized dust and soil. In some locations, Liberians are also at high risk for contracting malaria and yellow fever.

These environmental hazards negatively affect Liberians by producing lower than normal life expectancy (39.65 years) and growth rates (4.91 percent), high infant mortality (155.76 deaths per 1,000 live births) and death rates (23.1 per 1,000 population). Liberian women give birth to an average of 6.8 children each. The low literacy rate (41.6 percent) for females makes it difficult to dispense birth control and other health and environmental information.

The long years of war negatively affected environmental infrastructures, either destroying or damaging the energy, water, sanitation, waste management, and housing sectors. Liberia's other environmental problems are generally centered in the rain forest and along the coast. In order to finance the war, Liberia's forests were stripped of some of their most valuable timber, resulting in soil erosion and a loss of biodiversity. Along the coast, waters were heavily polluted from oil residues and the dumping of raw sewage.

In 2006 a study of scientists at Yale University ranked Liberia 109 of 132 countries on environmental performance, roughly in line with the relevant income and geographic groups. Low scores were assigned in the categories of environmental health and biodiversity and habitat. Just over 36 percent of Liberia is forested, but the rain forest is depleting at a rate of 2.0 percent per year. Only 1.7 percent of land area has been protected. Of 193 mammal species found in the rain forest, 17 are endangered, as are 11 of 146 bird species. Bush meat is being consumed by Liberians and exported to neighboring countries.

In 2002 Liberia enacted the National Environment Policy, the Environment Protection Act, and the Environment Protection and Management Law. By the end of the following year, the Environment Protection Agency Act was operational and charged with implementing and enforcing the existing body of environmental legislation and working with other government agencies and the public to plan and implement new policies and programs. The Forestry Development Authority—established in 1976—and the Division of Wildlife and National Parks—created by the 1988 Wildlife and National Parks Act—work closely with the Environmental Protection Agency on environmental issues. In 2003 the Liberian government created a Protected Forest Area Network designed to prevent further destruction of land and ecosystems.

Liberia participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, and Tropical Timber 94. Agreements on Environmental Modification, Law of the Sea, and Marine Life Conservation have been signed but not ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Deforestation; Rain Forests.

BIBLIOGRAPHY. Central Intelligence Agency, "Liberia," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); UN Development Programme, "Human Development Report: Liberia," hdr.undp.org (cited April 2006); UN Environment Programme, "Desk Study on Environment in Liberia," postconflict.unep.ch (cited April 2006).

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Libya

THE NORTH AFRICAN nation formally known as the Great Socialist People's Libyan Arab Jamahiriya has been dominated by Colonel Muammar al-Qadhafi since 1969 in a unique combination of socialism, Islam, and Qadhafism. Under Qadhafi, the Libyan government became a haven for suspected terrorists, and Libyan oil money was used in repeated attempts to affect politics and access to resources in other countries, as was unsuccessfully attempted in Chad in 1973. In the wake of United Nations sanctions that followed the bombing of Pam Am Flight 103 over Lockerbie, Scotland, in 1992, overt support for terrorism decreased and Qadhafi moved toward normalizing relations with the West, including paying compensation for past terrorist activities.

Libya's only natural resource other than the petroleum and natural gas that dominate the economy is gypsum. Just over one percent of land area is arable, and only 17 percent of the population is engaged in agriculture. Libya imports around three-fourths of its food supply. The oil sector accounts for approximately 95 percent of export earnings and around 25 percent of the Gross Domestic Product. With a per capita income of $8,400, Libya is ranked 95th in world incomes, considerably higher than most African countries. Unemployment is currently 30 percent, however, and oil earnings tend to be concentrated among the richest segment of society.

Bordering the Mediterranean Sea, Libya has a coastline of 1,770 kilometers. Land borders are shared with Algeria, Chad, Egypt, Niger, Sudan, and Tunisia. The terrain of Libya is generally barren with flat to undulating plains, plateaus, and depressions; and over 90 percent of all land area is either desert or semi-desert. Elevations range from 47 meters at Sabkhat Ghuzayyil to 2,267 meters at Bikku Bitti. While the climate is Mediterranean along the coast, the desert interior is extremely dry. In the spring and fall, Libya is often beset by *ghibli*, a hot, dry southern wind that is loaded with dust particles and lasts from one to four days. Dust and sandstorms are frequent throughout the year in the desert that covers much of the country. The frequent dust and sandstorms and the *ghibli* have combined to produce extensive desertification in Libya, and wind breaks have been built in an effort to halt this process.

Libya usually experiences between 200 and 600 millimeters of rainfall each year. Consequently, fresh water resources are limited. The Great Manmade River Project, the largest of its kind in the world, is currently being erected to transport water via aquifers from under the Sahara to cities along the coast. Critics of the project believe that it is only a stopgap because the fossil reserves that propel its operation will eventually be exhausted. Coastal areas have been polluted from the dumping of raw sewage and from agricultural runoff and industrial effluents. Libya also has an extensive problem with handling solid waste, generating some 0.6 million tons per year.

For the population of 5,900,754, which includes 166,510 nonnationals, there is an intermediate risk of contracting food and waterborne diseases such as bacterial diarrhea, hepatitis A, and typhoid fever. From April to October, Libyans in some areas face a significant risk of contracting vectorborne diseases. Only three percent of Libyans do not have access to improved sanitation, but 32 percent of rural residents and 28 percent of urban residents do not have sustained access to safe drinking water. The United Nations Development Programme's Human Development Reports rank Libya 58 among 232 nations in overall quality of life issues.

More than 86 percent of the population of Libya lives in urban areas where they work for industries that include petroleum, iron and steel, food processing, textiles, and cement. As a result of the extensive population concentration, carbon dioxide emissions rose from 8.9 per capita metric tons in 1980 to 9.1 by 2002. Libya produces 0.2 percent of the world's carbon dioxide emissions. Just over nine percent of Libya's land area is forested, and it is only in oases that date palms, olives, figs, oranges, and wild pistachio nut trees grow. The government has protected 0.1 percent of all land. Of 76 endemic mammal species, eight are endangered, as is one of the 76 endemic bird species.

Environmental protection is still in its early stages in Libya, and the Environmental Agency is working with regional and international groups to formulate environmental policy for Libya. Libya participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Marine Dumping, and Ozone Layer Protection. The Law of the Sea agreement has been signed but was never ratified.

SEE ALSO: Desertification; Mediterranean Sea; Waste, Solid.

BIBLIOGRAPHY. Central Intelligence Agency, "Libya," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); Library of Congress, "A Country Study: Libya," lcweb2.loc.gov (cited April 2006); United Nations Development Programme, "Human Development Report: Libya," hdr.undp.org (cited October 2006); World Bank, "Libya," lnweb18.worldbank.org (cited April 2006).

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Lifeboat Ethics

LIFEBOAT ETHICS ARE a set of guidelines for avoiding a global overpopulation crisis outlined in an influential 1974 *Psychology Today* article of the same name by microbiologist Garrett Hardin. Hardin argues that rich nations act against their own long-term interests by subsidizing continued population growth in nations already in excess of their local carrying capacity through humanitarian aid. Drawing equally from Malthus's *Essay on the Principle of Population* (1798), the Club of Rome's *Limits to Growth* (1972), and earlier publications by Hardin, "Lifeboat Ethics" maintains a firmly Darwinist view that populations inevitably grow to the limits of their environment, inevitably increasing faster than parallel increases in food production and other necessary resources. The article links this perception of Malthusian scarcity to an earlier article by Hardin, "The Tragedy of the Commons" (1968), which argues that any resource not protected through direct ownership will be exploited relentlessly. In both "Lifeboat Ethics" and "Tragedy of the Commons" Hardin argues that the surest path to global sustainability is through implementing policies of enlightened self-interest.

To illustrate his point Hardin asks that readers imagine a drifting lifeboat filled near to capacity, surrounded by hundreds of people in the water demanding to be let aboard. One option is to allow everyone aboard until the boat swamps. To Hardin this result is clearly self-defeating and irresponsible—an obvious reference to current aid policies that will inevitably overrun the global capacity to provide for everyone, and in the end save no one.

Another option is to allow as many swimmers aboard as there is surplus capacity. Although this appears to be a compassionate response, Hardin argues that the need to choose who survives from the multitude in the water renders this a fundamentally amoral option. This solution also presents a heightened risk of the absorption of the small surplus of resources on the boat, and if we wish to guarantee survival this is also an unsatisfactory solution.

An ostensibly selfish response is therefore the only moral option in this context, and abandoning those in the water and using the surplus as survival insurance is the only real solution. This improves the chances of those with the best hope at survival while not sacrificing anyone not already at risk. Against accusations that this is actually a thinly veiled rationalization for scientific racism, Hardin responds that it is foolish to risk the well-being of the whole species for the sake of a subset of superficial physical differences and imagined diversity. The rational choice in Hardin's scenario is to demonstrate our fitness for survival by making realistic appraisals of our options. In the lack of an authoritative global leadership that can make these decisions of resource allocation, the only real authority is invested in those in possession of the resources, which happens to be the developed world.

In common with many of the debates about population written immediately following the publication of *The Limits to Growth*, the argument presented in "Lifeboat Ethics" assumes an imminent overpopulation crisis in the underdeveloped world, which has, as yet, failed to occur. The avoidance of a classic Malthusian disaster has done nothing to deter Hardin from his conviction that the threat of a global population collapse is growing rapidly, and that climate change, conflicts over water and oil, ozone depletion, and other hallmarks of a looming environmental crisis are clear indications that we are nearing the global carrying capacity. Indeed, according to Hardin, the lack of a Malthusian crisis has only increased the danger by intensifying resource demands and the sheer numbers of people at risk. The avoidance of crisis through advances in science, particularly the Green Revolution and contraception, and the steep decline in global fertility rates since the 1970s has led many to doubt that resource crises are inevitable and cannot be circumvented through innovation and adaptation.

SEE ALSO: Malthusianism; Overpopulation; Tragedy of the Commons.

BIBLIOGRAPHY. D. Brzozowski, "Lifeboat Ethics: Rescuing the Metaphor," *Ethics, Place and Environment* (v.6, 2003); G. Hardin, "The Tragedy of the Commons," *Science* (v.162/3859, 1968); G. Hardin, "Lifeboat Ethics: The Case Against Helping the Poor," *Psychology Today* (v.38/43, 1974); G. Hardin, "Living on a Lifeboat." *BioScience* (v.24/10, 1974); G. J. Hardin, *The Limits of Altruism: An Ecologist's View of Survival* (Indiana University Press, 1977); G. J. Hardin, *The Ostrich Factor: Our Population Myopia* (Oxford University Press, 1998).

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Life Cycle Assessment

IS IT BEST to use cups made of paper, polymer foam, or ceramic? Which ones cause the least environmental damage? Paper, of course, comes from wood, and wood is a natural renewable resource. On the other hand, foam cups are made of polystyrene, which is obtained from crude oil, a nonrenewable resource. Does this mean a paper cup is more environmentally friendly than a foam cup? However, even though paper is from a renewable source, many harmful chemicals are emitted during its manufacture. Do the advantages of renewability outweigh the harm from emissions? Life Cycle Assessment (LCA) aims to answer questions such as these and can be useful for making technological choices.

LCA evaluates the environmental impact of a product throughout its life cycle starting from raw material extraction, going through product manufacture, use, recycle, and disposal. The life cycle of a paper cup would thus include cutting down the trees to obtain wood chips, transporting them to paper mills where they are converted to paper cups, transportation of cups to the market, sale of cups to consumers, and use by consumers. The cycle would end when the cups are reused, recycled, or discarded.

A typical LCA of a product consists of four steps: goal and scope definition, inventory analysis, impact assessment, and improvement analysis. The first step consists of specifying the purpose of the life cycle study and in simple cases means comparing the environmental burden of two products with similar uses. Scope definition implies identifying and specifying the important processes to be included in the life cycle of a product.

For the second step, inventory data are collected for each of the processes in the life cycle. Input data typically includes material and energy consumption data, while output data includes the emissions of various substances. There can be a variety of emissions during the entire life cycle, such as carbon dioxide, sulfur dioxide, methane, or benzene. These have different impacts on human health and ecosystem quality.

Impact assessment, the third step, aims at understanding the quantitative magnitude and significance of the potential environmental effects of all these emissions in different impact categories. For example, carbon dioxide and methane can cause global warming; sulfur dioxide and benzene can affect human health. This is the step in life cycle assessment where the results are used to draw conclusions and make recommendations for improving the environmental performance of a product.

Returning to the example of the paper, plastic, and ceramic mugs, it turns out that each of these three cups has a dark side. A ceramic mug is made from clay, which is relatively clean; it can also be used multiple times, which reduces waste. These properties make it attractive. But is it better than a paper or plastic cup?

Wood, the original source material of paper, is supposedly green, but during the transformation of wood to paper, steam is needed to heat the wood, machines are used to grind the wood fiber, and vacuum pumps and dryers are essential to remove the water from the pulp. All of these consume energy. Additionally, many inorganic chemicals—chlorine, sodium hydroxide, sodium chlorate, sulfuric acid, sulfur dioxide, and calcium hydroxide—are used during the pulping and bleaching phases. Also, although paper is biodegradable, it releases methane during its degradation, which contributes to global warming.

A foam cup is made entirely from materials derived from crude oil, a nonrenewable resource. Impacts from extraction of crude oil and its subsequent refining are significant. Any accidental spill during drilling, production, or transportation of crude oil can pose an ecological disaster. In the manufacture of a foam cup, pentane, an organic compound that may cause smog, is employed as the blowing agent. Since polystyrene is relatively inert to decomposition, it will persist much longer than paper in a landfill.

The last example is that of a ceramic cup. Although it requires a lot of energy during its manufacture, a ceramic cup can be used many times, therefore it should probably be better than a paper or plastic cup. However, the cup needs to be cleaned after each use, and this requires a large amount of hot water and soap. Energy is necessary to get hot water. The soapy wastewater needs treatment. These requirements might offset the benefits obtained from reuse. A ceramic cup is not biodegradable either, and may stay in the landfill forever.

This simple example illustrates that significant use of materials and energy, and emission of pollution, can occur in any phase of the life cycle: In the resource extraction phase for a foam cup, in the manufacturing phase for a paper cup, in the use phase for a ceramic cup, and in the disposal phase for all three of them.

This suggests that LCA is crucial to evaluating and comparing the broader environmental burden of products that perform similar functions. In addition, it can help identify opportunities for improving the efficiency of existing processes.

SEE ALSO: Ecological Modernization; Green Production and Industry; Industrial Ecology; Industry; Recycling; Sustainable Development.

BIBLIOGRAPHY. Chris T. Hendrickson, Lester B. Lave, and H. Scott Matthews, *Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach* (RFF Press, 2006); Guido Sonnemann, Francesc Castells, and Marta Schuhmacher, *Integrated Life-Cycle and Risk Assessment for Industrial Processes* (CRC, 2003).

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Life Expectancy

LIFE EXPECTANCY IS a term employed to statistically describe the average length of time a person within a given human population, such as a particular country or time period, lives from birth until death. Like other tools for determining the nature of demography, the measuring of life expectancy rates is sensitive to various factors. As a consequence, it can be calculated in different ways. For example, life expectancy may be measured without utilizing the infant mortality rate—this form of calculating life expectancy is commonly employed within nations that suffer from high child mortality levels.

Average life spans are longer today than in the past, thanks to modern technology and scientific understanding of disease. Increased wealth and improvements in standards of living have also led to better diets, making humans healthier and less

In some African nations, such as Swaziland and Botswana, citizens live on average for less than 34 years; in wealthy societies like Hong Kong and Andorra, people commonly live more than 81 years.

susceptible to particular diseases than in prior times in many parts of the world.

The introduction of technologies has been important in augmenting average life expectancies. Sir Joseph Bazalgette first developed urban sewage systems on a citywide scale in London during the Victorian age (in the mid-1800s). In addition, medical advances have played an important role in lessening the presence and influence of disease. Progressive medical thinking has helped make once life-threatening illness curable. Also in Victorian London, medical practitioners like Dr. John Snow were pivotal in understanding the true nature of disease. Dr. Snow, with his studies on cholera, was able to scientifically prove that cholera was a waterborne illness. Consequently, not only was the nature of disease better understood, but public administrations were better prepared to deal with incidents of illness. Over time this allowed levels of disease to decline and life expectancies to rise.

A variety of factors can influence life expectancy levels. Dietary patterns, in particular poor nutrition, greatly influence the level of life expectation. In places where diets are nutritionally poor, possibly as a result of famine or natural disasters like floods and typhoons that can devastate local harvests, occurrences of disease increase and life expectancy levels fall.

Of similar significance is the character of a society's urban places that may have rapidly grown to unprecedented levels in terms of spatial size, demographic scale, and urban density after the onset of industrialization. Extraordinary pressure may be put on the local infrastructure, which can result in environmental degradation such as water pollution and higher rates of disease, deprivation, and death. Under such conditions, epidemics may push up the mortality rates among those most susceptible to disease, such as old people, children, and disadvantaged social groups, thereby lowering life expectancy rates within the urban locale and the nation as a whole.

Generally, as the world has developed economically, life expectancy has increased. However, when a nation initially industrializes and experiences rapid urbanization for the first time, the poorest in society, especially in urban settlements, experience difficulties on an unprecedented level. Furthermore, as the number of poor within a nation may be great, this can negatively influence the life expectancy rate within the country. Immediately following industrial progress the country may experience a decline in average life span, even while national levels of wealth increase. On the other hand, as time passes following the onset of industrialization, life expectancy levels increase dramatically, especially when compared over a time frame of 100 years or more.

In England, the world's first industrial and urban country, life expectancy rose from about 36 years on average in 1801 to 49 years by 1901. By 2001 the English life expectancy was about 78.5 years, although great regional variances were known to exist. In industrial cities like Manchester, men on average live for just 69 years and women for 76 years. In contrast, in affluent suburbs of West London like Kensington and Chelsea, men usually live to 80 and women to 85. In the United States, life expectancies also vary and it is common to observe differences between ethnic groups and genders.

Worldwide, the level of life expectancy varies. The varying prevalence of poverty is commonly acknowledged as a reason for why national life expectations differ from place to place. Present life expectancies vary between that of African nations such as Swaziland and Botswana, whose citizens on average live for less than 34 years, to wealthy societies like Hong Kong, Macao, Andorra, and San Marino, where people commonly live for more than 81 years.

As a result of such differences, global strategies have been composed by organizations such as the United Nations to improve life expectancies in many parts of the world and so lessen life expectancy discrepancies between continents. In particular, much focus has been placed on nations within Latin America, Africa, and parts of Asia, where poverty and treatable disease, like malaria, typhoid, and influenza, still have the greatest influence on quality of life, longevity, and mortality rates, especially for children and the poor. In forging policies to deal with such human inequalities, it is hoped social justice can be demographically manufactured, allowing people within less developed and poorer continents to extend their life spans.

SEE ALSO: Birth Rate; Death Rate; Demographic Transition Model; Disease; Food; Human Ecology; Industrialization; Population; Urbanization.

BIBLIOGRAPHY. Robert Fogel, *The Escape from Hunger and Premature Death, 1700–2100: Europe, America, and the Third World* (Cambridge University Press, 2004); Stephen Manuck, *Behavior, Health and Aging* (Lawrence Erbaum Associates, 2000); Christine Overall, *Aging, Death and Human Longevity: A Philosophical Enquiry* (University of California Press, 2003); James Riley, *Poverty and Life Expectancy: The Jamaica Paradox* (Cambridge University Press, 2005); Terry Tirrito, *Aging in the New Millennium: A Global View* (University of South Carolina Press, 2003); Zeng Yi, *Longer Life and Healthy Aging* (Springer, 2006).

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Linnaeus, Carl (1707–78)

CARL LINNAEUS, NATURALIST and taxonomist, was born May 13, 1707, at Råsult, near Stenbrohult, Småland, Sweden. He was educated at Växjö school and the universities of Lund and Uppsala. In 1732 he travelled to Lappland to study its little known natural history and economy. Linnaeus left Sweden for the Netherlands in April 1735, graduating with an M.D. from the University of Harderwijk that year. He then moved to Leiden where he published his *Systema naturae* (1735), which classified the three kingdoms of nature (plants, animals, minerals) and outlined the sexual system for the classification of plants. He became physician and garden superintendent to George Clifford, a wealthy Englishman living in the Netherlands.

Linnaeus visited England in 1736, where he persuaded leading naturalists to adopt his systems for classifying plants and naming all living organisms. His systems were developed at a time when European travellers were bringing back unprecedented numbers of plants and animals from previously unknown lands. It was extremely important that his methods were adopted by naturalists from imperial countries such as Britain and the Netherlands, especially when those naturalists were, like Sir Joseph Banks, actively involved in voyages of discovery. Linnaeus's pupils also helped to spread his ideas, which came to be almost universally accepted.

Linnaeus's main contributions are the sexual system for the classification of plants, and the design of his classification scheme, which is hierarchical and uses binomial nomenclature. The sexual system, described in successive editions of *Systema naturae* and *Fundamenta botanica* (1736) and *Classes plantarum* (1738), uses the number and arrangements of the sexual organs of stamens (male) and pistils (female) to group plants into 24 classes. The classification produced some anomalies and later classifications generally follow John Ray's practice of using morphological evidence from all parts of the plant and all stages of plant development, later attempting to infer evolutionary relationships from this evidence.

What survives from Linnaeus's sexual classification is its hierarchical nature (species are grouped into genera, genera into orders, orders into classes, and classes into kingdoms) and his use of binomial nomenclature in which the two elements of genus and species name form short names, much more convenient for quick reference than the discursive and mutable labels suggested by his contemporaries. Linnaeus was not the first to use binomial forms, but his consistency, precision, and rigor promoted the general acceptance of the practice.

Returning to the Netherlands in 1736, Linnaeus published further important botanical works before returning to Sweden in 1738, largely in order to marry (in 1739) his Swedish fiancée. He turned to medicine to make a living, but continued his scientific work, being a founder member and first president of Kungliga Vetenskapsakademien (the Swedish Royal Academy of Sciences) in 1739.

In 1741 Linnaeus became professor of botany at Uppsala University, reviving the botanical garden there. He was an inspiring teacher, drawing pupils from all over the world. Similarly he was honored by scientific societies worldwide. Linnaeus undertook several journeys in Sweden at the behest of the government, searching for plants that might be economically useful.

In 1758 Linnaeus bought an estate at Hammarby, near Uppsala. He was ennobled, taking the name Carl von Linné in 1762. His health deteriorated and he died on January 10, 1778, in Uppsala and was buried at Uppsala Cathedral. When his son Carl died, his family sold most of Linnaeus's botanical collections to a British naturalist who brought them to what became the Linnean Society of London. Most of the rest of the collections remain in Uppsala. In 1905 Linnaeus's *Species plantarum* (1753) was accepted as the starting point for modern botanical nomenclature and the 10th edition (vol. 1) of Linnaeus's *Systema naturae* (1758) is the starting point for modern zoological nomenclature. About 12,000 internationally agreed-upon names have "L" appended to them to indicate that they originate in a description published by Linnaeus.

SEE ALSO: Bioprospecting; Botany; Plants; Zoology.

BIBLIOGRAPHY. Gina Douglas, "Carl Linnaeus," in H.C.G. Matthew and Brian Harrison, eds., *Oxford Dictionary of National Biography* (Oxford University Press, 2004); Tore Frängsmyr, ed., *Linnaeus, the Man and His Work* (University of California Press, 1994); William T. Stearn and Gavin Bridson, *Carl Linnaeus, 1701–78: A Bicentenary Guide to the Career and Achievements of Linnaeus and the Collections of the Linnean Society* (Linnean Society, 1978).

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Lithuania

AFTER BEING PART of the Soviet bloc for 50 years, Lithuania declared its independence in 1990, becoming the first country to seek independence after the dissolution of the Soviet Union. Lithuania joined the European Union (EU) in 2004. With the Baltic Sea forming part of its western boundary, the country of 3,596,617 people has 61 miles (99 kilometers) of coastline. The climate of Lithuania is transitional, alternating between maritime and continental, with wet, moderate winters and summers. The terrain is made up of lowlands dotted with small lakes. Lithuania has almost no natural resources except for arable land and peat.

Lithuania has gradually severed economic ties with Russia as it forges ties with the West. The government is still in the process of privatization, having converted around 80 percent of all industries. With a per capita income of $13,700, Lithuania ranks 67th in income among the nations of the world. The high unemployment rate that accompanied Russia's economic crisis of 1998 has been halved, and inflation is under control at 2.6 percent. One-fifth of the Lithuanian workforce is involved in agriculture. The United Nations Development Programme Human Development Reports rank Lithuania 39th on general quality-of-life issues.

ENVIRONMENTAL ISSUES

Environmentally, Lithuania experiences extensive air pollution and contamination of soil and groundwater from petroleum products and chemicals derived from military bases and industries. The greatest potential threat comes from the Ignalina nuclear power plant, which operates two reactors that are remarkably similar to the one that precipitated the disaster at Chernobyl, Russia, in 1986. Other threats arise from fertilizer and chemical plants, oil refineries, power stations, and cement factories that pollute the air around them and deposit chemical effluents in the rivers and lakes. Air pollution is so severe in Lithuania that at times it covers one-third of the country. Around 67 percent of the population resides in urban areas, and there are 346 cars for every 1,000 people. As a result, Lithuania produces 0.1 percent of the world's total carbon dioxide emissions.

Water quality in Lithuania has traditionally suffered from a shortage of purification plants, and untreated water has been released directly into waterways. Beaches have been closed to the public because of heavy pollution, and acid rain has damaged forests, particularly in the area of Jonava, Mazeikiaia, and Elektrenai, where chemical, oil, and power generators are located.

Some 28 percent of Lithuania's land area is forested, and the government has protected 10.3 percent of the land with the creation of national parks and reservations aimed at protecting biodiversity. Five of 68 mammal species endemic to Lithuania are endangered, and four of 201 bird species are threatened. Plant life has also been seriously threatened as a result of poor agricultural practices.

Although some environmental laws were passed during the Soviet years, widespread apathy and an emphasis on economic production meant that little was done to correct the problems. In 1990 Lithuania established the Environmental Protection Department, which became the Ministry of Environmental Protection in 1994. Working with eight regional departments, the ministry is responsible for monitoring and implementing environmental legislation. The focus of environmental policy is on preventing new sources of pollution and on providing economic incentives to facilitate enforcement of existing laws and regulations. In 1992 Lithuania passed the Environmental Protection Act to provide an environmental framework and to supplement earlier legislation such as the Atmosphere Protection Act and the Water Code. While some environmental legislation has been enacted, other bills are still in abeyance.

Lithuania's commitment to the global environment is demonstrated by participation in the following international agreements: Air Pollution, Biodiversity, Climate Change, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands. The agreement on Air Pollution–Persistent Organic Pollutants has been signed but not ratified.

SEE ALSO: Acid Rain; Groundwater; Nuclear Power; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Central Intelligence Agency, "Lithuania," *The World Factbook,* www.cia.gov (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Library of Congress, "A Country Study: Lithuania," lcweb2.loc.gov (cited March 2006); Ministry of the Environment, *Manual for Environmental Impact Assessment in Lithuania* (Finnish Environment Institute, 2001); UNDP, "Human Development Reports: Lithuania," hdr.undp.org (cited March 2006); UNEP, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Lithuania," *Little Green Data Book,* hlnweb18.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited July 2006).

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Litigation, Environmental

ENVIRONMENTAL LITIGATION—the filing of lawsuits to protect the environment or to prevent or remove pollution, or countersuits to defend against environmental legal actions—has grown enormously in the United States since the 1970s. The legal basis for these suits has been a complex, growing web of federal and state statutes, which have also created environmental regulatory agencies to develop policy rules and regulations for implementing environmental public policy.

Environmental regulatory agencies, in fulfilling their legislative mandates, have developed a vast number of environmental regulations that are now part of administrative law. Their administrative rules and regulations are quasi-legislative and are usually enforced by the environmental agencies, which also have quasi-judicial powers. The net effect is that polluters can be fined or imprisoned for violating bureaucratic rules as easily or more easily than for actions violating some general laws.

HISTORY

Everyone lives in some kind of environment, whether natural or man-made. Whatever affects the environment can affect the personal health, social practices, or economic health of a community. The governmental actors, and especially the courts, have recognized this for centuries with health ordinances controlling sanitation practices in many forms. What is new is the explosion in environmental litigation.

Prior to the 1970s most environmental suits were filed on the basis of the common law or on earlier judicial decisions in specific cases. If a party in a suit claimed that an injury had occurred, then tort law allowed them to have cause for action. Cases were based on negligence to stop environmentally destructive practices, nuisances, trespasses, or acts for which a party is strictly liable. Other actions sought recovery of damages as compensation for environmental injuries.

Tort-based environmental litigation was often difficult to initiate because it was often hard to prove who caused an environmental injury. In addition, courts tend to favor property rights and were reluctant to restrain business activities with injunctions to prevent future environmental degradation.

POST-1970 ERA

While these earlier remedies for environmental torts are still available, since the 1970s the federal and state governments have passed comprehensive sets of environmental laws. These laws were designed as wholesale remedies for environmental problems. They were eventually followed by amendments that focused on manageable parts of environmental pollution problems.

Today the federal environmental policy program includes broad policy statutes, conservation statutes, and public health statutes. The broadest federal statute is the National Environmental Policy Act, which mandates that the federal government assess the environmental impact of its projects before they are begun. The conservation policy statutes include the Endangered Species Act, the National Forest Management Act, and the Wilderness Act. The latter two acts mandate how the nation's forests are to be managed. Congress has adopted a wide array of laws to protect the public's health. These include the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, the Comprehensive Environmental Response, Compensation, and Liability Act, and other laws.

These federal laws, along with a growing number of state laws, have been used by both the federal and state governments as the basis of environmental litigation. In addition because some of these allow standing, or standing has been sought by environmental groups, the volume of environmental suits has grown enormously since the 1970s. So large and serious has the judicial business of environmental litigation grown that there are now law firms that specialize in environmental litigation as champions of plaintiffs or as counselors for environmental defendants.

With the adoption of massive new environmental laws in the 1970s, the legislation and the courts increasingly allowed private citizens to acquire standing for bringing a suit. The courts showed a growing willingness to allow citizen suits, even on a class action basis, to be brought to enforce the National Environmental Policy Act. The courts, in the absence of legislative authority for judicial review and in the face of bureaucratic indifference to environmental practices by the federal government, decided cases that forced the practice of developing environmental impact statements. Many of the suits that forced both federal and state bureaucracies to change old behaviors were brought by citizens or environmental action groups.

The exercise of judicial review to examine the constitutionality of governmental actions has been the basis of numerous suits, especially from business or industry seeking relief from environmental litigation. On the other hand, many environmental groups have also challenged governmental activities as unconstitutional violations. The use of tort law and judicial review are the basis of most environmental suits.

The political climate in which environmental litigation emerged in the 1970s was one of suspicion and hostility toward government. The Vietnam War had angered many on the ideological left from which the environmental movement's activists were usually drawn. Many court battles were fought with very hostile feelings driving the litigation. This original litigious atmosphere often made negotiations or compromises difficult to achieve. The consequences were legal duels to settle disputes over environmental issues that generated serious legal costs and more acrimony.

THE 1980s AND 1990s

In the 1980s some environmental groups resorted to civil disobedience and, in some extreme cases, to ecological terrorism. However, in the main the use of the Endangered Species Act and other legislation brought numerous environmental issues into the courts where the tendency was to favor the environment. In some liberal courts, the green political views of environmental extremes were often favored.

In the legal world of environmental litigation, business and industry have found that even if they have complied as fully as possible with current environmental law—they have used the best practices and worked with both federal and state agencies—they have not done enough to satisfy some litigiously minded environmental groups. The reason some lawsuits arise is due more to environmental philosophy than to actual illegal activity. For example, the forest philosophy of Gifford Pinchot was to manage resources; however, John Muir wanted the nation's forests left as unspoiled wilderness. Very different environmental philosophies abound in the United States, where litigation is relatively easy compared with the rest of the world.

As a consequence of the litigious environmental atmosphere some law firms have organized on a national basis and have legal incident reaction teams to respond to the filing of an environmental suit almost immediately and almost anywhere no matter how remote. The goal of these environmental defense firms is to promptly protect the interests of companies and individuals from suits that may have the power to damage or destroy a business.

In response to environmental litigation many businesses have engaged in SLAPP (strategic lawsuits against political participation) countersuits. These are punitive suits that seek to punish citizens or groups for using the courts or even for using public forums to criticize business activity. SLAPP suits usually lose in court; however, they can have a chilling effect and can be expensive to defend against.

The Environmental Protection Agency has been the source of many suits. It has also reflected the philosophical policy differences of the ideological spectrum in its history as different administrations have controlled the agency. In the long run environmental litigation will continue to flourish because technological changes will continue to have significant environmental consequences, and because the American public is concerned about individual and environmental health in at least a general sense.

Because of the expense of litigation and because using court decisions often creates a zero-sum game, the use of mediation has attracted attention since the 1990s as a way of negotiating environmental policies that avoids enormous legal costs. Mediation also allows all the parties interested, including environmental groups, to have a place at the bargaining table. Environmental litigation is also growing in many countries as resource extraction or manufacturing without regard to the environmental consequences causes severe environmental damage. International agreements are increasing to deal with global environmental issues.

SEE ALSO: Clean Air Act; Clean Water Act; Endangered Species Act; Environmental Protection Agency; National Environmental Policy Act; National Forest Management Act; Pollution, Air; Pollution, Water; Wilderness Act.

BIBLIOGRAPHY. James F. Berry and Mark S. Dennison, *The Environmental Law and Compliance Handbook* (McGraw-Hill, 2000); Cyrille de Klemm and Clare Shine, *Biological Diversity Conservation and the Law: Legal Mechanism for Conserving Species and Ecosystems* (IUCN, 1993); Roger W. Findley and Daniel A Farber, *Environmental Law in a Nutshell* (West Group, 2004); Laksham D. Guruswamy, *International Environmental Law in a Nutshell* (West Group, 2003); Jonathan Harr and Marty Asher, eds., *A Civil Action* (Knopf Publishing Group, 1996); Richard J. Lazarus, *The Making of Environmental Law* (University of Chicago Press, 2004); Robert V. Percival et al., *Environmental Regulation: Law, Science and Policy* (Aspen Law & Business, 2003); Robert V. Percival and Christopher H. Schroeder, *Environmental Law 2005: Statutory Case Supplement with Internet Guide* (Aspen Law & Business, 2005); Philippe Sands and Paolo Galizzi, eds., *Documents in International Environmental Law* (Cambridge University Press, 2004); Gerald M. Stern, *The Buffalo Creek Disaster: How the Survivors of One of the Worst Disasters in Coal Mining History Brought Suit Against the Coal Company—and Won* (Knopf Publishing Group, 1977); Thomas F. Sullivan, ed., *Environmental Law Handbook* (Government Institutes, 2005).

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Livelihood

SINCE THE EARLY 1990s the notion of a "sustainable livelihood" has come to prominence as a way to analyze poverty and natural resource use in international development circles. The sustainable livelihoods approach has been particularly influential in the study of community-based natural resource management, but it originates in studies of the relations between development, poverty, and food security. In its simplest sense, a livelihood is a means of gaining a living, but the concept has broadened with the recognition of the full range of diverse activities and resources that make up a person's or household's ability to survive over time. Rather than conceive of people as "peasants," "farmers," "laborers," or some other fixed category, the sustainable livelihoods approach recognizes that households may employ multiple economic strategies simultaneously, sometimes in different locales.

A livelihoods approach recognizes a household's reliance on natural resources like thatching grass, fish, and game.

DEFINITIONS AND AN EXAMPLE

In an important article, Robert Chambers and Gordon Conway defined a livelihood as comprising the full range of "capabilities, assets...and activities required for making a living." Later authors refined the concept of assets, identifying five key forms of "capital": human capital, natural capital, financial capital, physical capital, and social capital. The sustainable livelihoods approach also draws attention to the context of vulnerability in which livelihoods exist, typically conceived in terms of *stresses* and *shocks*. The former term refers to long-term, predictable processes like population growth, seasonal variation, or declining availability of resources, while the latter refers to sudden and unpredictable events like drought, flood, death or illness of a family member, loss of a job, and so on. A livelihood may be considered sustainable when it can avoid, resist, and/or bounce back from such stresses and shocks, while maintaining its capabilities and assets, and without undermining its natural resource base.

An extended example can illustrate both the kind of complex livelihoods that the concept was designed to understand and the advantages of the livelihoods approach. Consider the household of Sipho Mazibuko (a pseudonym). Sipho is a retired labor migrant living in rural South Africa and drawing a state old-age pension. His eldest son, Jongisizwe, works on a mine outside Johannesburg where members of his community have worked for generations and sends money home to his family. Sipho and his wife, Nokhaya, have a large garden adjoining their household, and a field a few miles away. They plow their land by combining their oxen with those of Sipho's extended family. Sipho's younger son, Patrick, is responsible for herding their cattle, sheep, and goats. Jongisizwe's wife, Vuyo, also lives with the family, caring for her two young children. While Sipho and Patrick are responsible for plowing, Nokhaya and Vuyo do most of the everyday work in the garden. At certain times in the agricultural cycle, when extra labor is needed for harvesting or weeding, Nokhaya brews beer and invites people from the neighborhood for a work party. Occasionally she brews beer for sale locally. Vuyo and Nokhaya are responsible for fetching water and for cutting thatching grass to repair the roof of the family's houses. Sipho and Patrick cut wood from nearby forests for building and maintaining the family's houses and the fences of their garden and livestock enclosures. Patrick also fishes in a nearby river, and sometimes sells fish to white tourists who stay at a hotel in a nearby nature reserve. At certain times of year, Nokhaya also gathers wild fruit from the forests for domestic consumption.

To return to the definition of a livelihood, the different members of the household have capabilities: the knowledge and ability to farm, to care for livestock, to find a job in an urban area, to negotiate government bureaucracy and secure an old-age pension, to brew beer, to locate wild foods, and so on. Together, this diverse package of capabilities gives the household the ability to respond to changing economic and ecological conditions and to manage stresses and shocks. In doing so, they draw on different forms of capital: human capital (the labor of the different household members), natural capital (land, water, livestock, forests, fish, and more), financial capital (wages, pension payments, and the proceeds of selling beer and fish), physical capital (their houses and domestic structures and the infrastructure that enables travel to and from the workplace), and social capital (extended family and neighbors). As is evident, the household draws on a wide range of activities. The household's diversification gives it the ability to manage stresses: for example, it has a way to recruit labor during seasons of scarcity; it also has some insurance mechanisms in the event of shocks: for example, it could sell livestock to cover hospital bills in an illness.

CONTRAST WITH OTHER APPROACHES

The livelihoods approach can be contrasted to older, sector-specific conceptions of poverty and its alleviation. A production-focused approach might conceive of Sipho as a "farmer," and propose measures to improve the agricultural output of gardens and fields, but this would ignore the contribution of wages and pensions to the household. An employment-focused approach might focus on the fact that several household members of employable age are not working, but this risks ignoring the contribution of their labor to agriculture. In contrast, notes Colin Murray, a livelihoods approach "acknowledges the need to transcend discrete sectors—urban and rural, industrial and agricultural, formal and informal, etc." Moreover, rather than focus on what households lack, the approach focuses on identifying their existing strengths and their potential.

The approach is particularly useful for facilitating community-based natural resource management because it calls attention to the contribution of the local environment to livelihoods. In the example above, note that neither a focus on production nor on employment would take into account the household's reliance on natural resources like thatching grass, building wood, fish, and wild fruit. Conventional socioeconomic surveys often tend to omit the value of natural resources. In contrast, the sustainable livelihoods approach draws attention to the role of the environment in the household economy, illustrating how the sustainability of a livelihood may be connected to the sustainable use of natural resources.

The example above came from South Africa, but the analysis of sustainable livelihoods has been applied throughout the world, to topics as diverse as understanding the impact of irrigation on fisheries in Sri Lanka, involving the poor in urban services development in Ethiopia, and analyzing the relation of climate variability and household welfare in the Andes. The approach has been used both to formulate new development interventions and to analyze and refine existing programs.

INFLUENCE AND SHORTCOMINGS

The approach has spread widely in international development and conservation circles. The 1987 Report of the United Nations Commission on Environment and Development (also known as the Brundtland Report), the 1987 Greening of Aid Conference at the International Institute for Environment and Development, and the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (the Earth Summit) set the stage for Chambers and Conway's influential paper by linking conservation to poverty alleviation. In the 1990s, the United Nations Development Programme, Oxfam, CARE, and the British Department for International Development (DFID) have all developed programs aimed at promoting sustainable livelihoods. Drawing on the experiences of these organizations and others, the UK-based Institute of Development Studies has developed an important Web site (www.livelihoods.org) documenting the approach, providing "guidance sheets" on research methods and planning techniques to operationalize it, and offering dozens of examples of its application in development and conservation programming.

Despite its influence and widespread use, several significant critiques have been made of the approach. First, while access to different forms of capital depends on political processes, the livelihoods approach may lead to a focus on individuals and households, rather than changing the political and economic macro-environments that create "vulnerability contexts." Second, the focus on the household may lead to potentially false assumptions that households act in a unified manner toward common goals and may ignore inequalities of gender and age within households. Third, as Murray points out, the notion of "sustainability" is also seen to beg important questions: "'Sustainable' for whom? By what criteria? In the short term or the long term?" Finally, the holism of the approach may make it effective as a tool for describing existing diverse livelihoods but may lead to undue complexity when it is used as a basis for defining policy priorities and formulating interventions.

SEE ALSO: Brundtland Report; Conservation; Development; Poverty; Sustainability; Underdeveloped ("Third") World; United Nations Conference on Environment and Development (Earth Summit, 1992).

BIBLIOGRAPHY. Robert Chambers and Gordon Conway, "Sustainable Rural Livelihoods: Practical Concepts for the 21st Century," Institute of Development Studies Discussion Paper no. 296 (1991), www.ids.ac.uk/ids/bookshop/dp/dp296.pdf (cited April 2006); Leon de Haan and Annelies Zoomers, "Exploring the Frontier of Livelihoods Research," *Development and Change* (v.36/1, 2005); Frank Ellis, *Rural Livelihoods and Diversity in Developing Countries* (Oxford University Press, 2000); Institute of Development Studies, "Livelihoods Connect—Support for Sustainable Livelihoods," www.livelihoods.org (cited April 2006); Colin Murray, "Changing Livelihoods: The Free State, 1990s," *African Studies* (v.59/1, 2000); Dan Start and Craig Johnson, "Livelihood Options? The Political Economy of Access, Opportunity and Diversification," Overseas Development Institute Working Paper no. 233 (2004), www.odi.org.uk (cited April 2006).

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Livestock

THE TERM *LIVESTOCK* refers to domesticated animals utilized for food, fibers, hides, fertilizer, and/or labor. The category of livestock includes such domesticated ungulates as bison, camels, cattle, donkeys, goats, horses, llamas, reindeer, sheep, swine/pigs, water buffaloes, and yaks, with cattle and sheep being the two most abundant types of livestock worldwide. Nonungulate livestock include first and foremost poultry, as well as rabbits, guinea pigs, and even honeybees, among other animals. Livestock are usually distinguished from wildlife and pets, although there occasionally is categorical overlap (e.g., farmed ostriches or herding dogs).

The domestication of plants and animals for food began some 11,000 years ago in southwest Asia and was a hallmark of the Neolithic, or New Stone Age. Some humans transitioned from hunting, gathering, and fishing sustenance strategies to more stationary ones based on the deliberate production of foods. Based on archaeological evidence from northern Mesopotamia, it appears that sheep and goats were among the first animal domesticates ancestral to today's livestock. Although dogs appear to have been domesticated by 16,000 years ago, they apparently served as hunting companions and not a food source. Aurochs, the now extinct ancestors of today's cattle, were likely independently domesticated in multiple sites through Asia and Europe. Domesticated pigs had become popular in parts of southwestern Asia and chickens in southeastern Asia perhaps by 8,000 years ago. The domestication of these latter species overlaps with increasing trends of humans becoming less nomadic and the expansion of agriculture. From that point onward, humans intentionally and unintentionally reconfigured their environments, as they constructed ways to raise their domesticated plants and animals, as well as protect them from pests and predators.

Although domestic animals and animal husbandry practices have varied greatly around the world, livestock have become crucial to agricultural life in general. Livestock convert low quality (by human standards) roughage into protein, fat, and other nutrients fit for human consumption and provide fertilizer for croplands. Ungulates supply additional labor power as pack animals, transport, and plowing aids, and their manure can also be dried and then burned for fuel. With increasing specialization in agriculture and the growth of pastoralism, people have endeavored to control the reproductive rates and birth timing of their livestock and to breed them selectively for certain qualities.

Specialized pastoralism in precolonial East Africa serves as an example of how livestock-keeping, under certain conditions, fits ideals of ecological sustainability. In this semiarid savanna region, pastoralists focused on cattle, sheep, and goats, while also keeping donkeys and sometimes camels. They practiced transhumance, moving herds and family between wet-season pasturelands near temporary water supplies and dry-season grazing lands based near permanent water sources. They managed the grasslands by moving livestock in such a way as to limit encroaching bush while not overgrazing and thus damaging grasslands, and would practice what have been called "cool burns" of dry, nonnutritious grasses to promote new grass growth, with a side livestock benefit of reducing tick populations.

It appears that such management techniques also generally benefited wildlife, as wild ungulates grazed the new grasses and were afforded some protection from predators by remaining close to human activity. Conflicts arose between humans and predators when the latter attacked livestock. Still, the livestock and wildlife populations remained relatively stable for more than a century prior to the onset of the colonial enterprise in the late 1800s.

Colonialism in East Africa, as elsewhere, introduced new concepts of land management and ownership. Efforts to commercialize pastoralist livestock production and to make pastoralists stationary led to a series of land laws that restricted pastoral movement to more marginal lands, introduced commercial livestock industries, and placed various pressures on pastoralists to increase livestock turnover rates and sell animals for slaughter. The essential components of pastoralism—land, livestock, and labor—were largely appropriated and reconfigured into quantifiable, commodified units, managed by experts, i.e., government authorities and eventually outside development agents. In a context of an ever-growing global population, rural farmers and pastoralists became increasingly tied to regional and world commodity markets, had reduced access to land and other necessary resources, and thus became ever more vulnerable to natural disasters.

Meanwhile, in North America, the development of mechanical refrigeration enabled the dramatic expansion of the meatpacking industry. By the late 19th century, the Chicago stockyards had become an iconic representation of American capitalism and economies of scale. In 1906, Upton Sinclair's *The Jungle* exposed the brutal working conditions within the slaughterhouses and meatpacking plants, and Congress enacted the Pure Food and Drug Act and the Federal Meat Inspection Act that same year. Labor organizations began to improve some aspects of meatpacking, securing better wages and somewhat reducing job hazards. In the 1960s, a major revolution in meatpacking occurred when IBP (Iowa Beef Packers) redesigned the slaughter and packing process to fragment tasks and deskill work, thus reducing wages while making it easier to replace laborers; sped up the chain of production; and relocated plants to rural areas, which were less expensive operation locales and also without organized labor. The IBP model dominated beef processing and was adopted in poultry and swine operations.

Approximately 600 million rural poor people base their livelihoods on livestock.

Changes have also occurred in the rearing of livestock, as many moments in the production of milk, meat, and eggs have been consolidated by large, even transnational agribusinesses. For example, swine and poultry may now be raised entirely indoors to control all aspects of their growth. Concentrated Animal Feeding Operations (CAFOs) confine beef cattle to small areas and large amounts of grain (hard for the animals to digest) to fatten them up prior to slaughter.

Artificial insemination, antibiotics, and hormones are commonly used in industrial livestock to control for breed quality and durability. Genetic engineering and modification of livestock has expanded beyond selective breeding to include cloning, transgenic processes through which certain qualities of animals might be enhanced, and animal bioreactors (genetically modified livestock that produce pharmaceuticals used to treat human diseases).

Critics note that there are many negative repercussions of such practices, including problems with the general health of the livestock, as well as threats to the health of people and other animals in the ecosystem; high concentrations of manure leading to water, ground, and air pollution; heavy reliance on fossil fuels for the production of feed, as well as the transport and processing of the animals.

According to the International Livestock Research Institute (ILRI), demand for livestock foods is expected to more than double over the next twenty years. ILRI argues that this Livestock Revolution will see so-called developing countries producing 60 percent of the world's meat and 52 percent of the world's milk by 2020, and that could provide several hundred million people with the opportunity to raise themselves out of absolute poverty.

Currently, some 600 million rural poor people base their livelihoods on livestock. Although livestock contributes up to 80 percent of agricultural GDP in developing countries, livestock production efficiency is only one-fourth that in developed regions like the United States. Small-scale farmers and pastoralists face a variety of problems, including unfavorable policies, inadequate access to markets, degraded natural resources and poor livestock feeds and forage, and in some settings, debilitating livestock diseases. Whether they can overcome these problems and not be consumed or outperformed by agribusinesses will impact not only their individual livelihoods, but also the very future of livestock production and ecology.

SEE ALSO: Bison; Cattle; Developed World; Domestication; Eutrophication; Overgrazing; Pastoralism; Pets; Savanna (or tropical grassland); Sheep; Sinclair, Upton; Wildlife.

BIBLIOGRAPHY: International Livestock Research Institute, www.ilri.org (cited December 2006); John G. McPeak and Peter D. Little, eds., *Pastoral Livestock Marketing in Eastern Africa: Research and Policy Challenges* (Intermediate Technology Publications, 2006); Oklahoma State University's Department of Animal Science, "Breeds of Livestock," www.ansi.okstate.edu/breeds (cited December 2006); Michael Pollan, *The Omnivore's Dilemma: A Natural History of Four Meals* (Penguin Books, 2006); Valerie Porter, ed., *Mason's World Dictionary of Livestock Breeds, Types, and Varieties* (CABI Publishing, 2002); Donald D. Stull and Michael J. Broadway, *Slaughterhouse Blues: The Meat and Poultry Industry in North America* (Wadsworth/Thomson Learning, 2004).

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Lobbyists

LOBBYISTS ARE INDIVIDUALS and groups organized to influence legislation or administrative action on legal, political, economic, environmental, and other issues. Lobbyists are advocates in the public policy arena who present themselves as providers of reliable information, analysis, and assessment relevant to legislators and government for informed and balanced decision making.

LOBBYISTS THEN AND NOW

The term *lobbyist* was first used in the mid-17th century. Citizens gathered in a large lobby near the British House of Commons to express their views to members of Parliament. In the early 19th century, the term *lobby-agent* was used in the United

States, where it was applied to citizens seeking legislative favors in the New York Capitol lobby. By 1832 *lobby-agent* had been shortened to *lobbyist* and was widely used on Capitol Hill in Washington, D.C. The term *lobbying* is claimed to date from the presidency of Ulysses S. Grant, who used to drink brandy and smoke cigars while relaxing in the lobby of the Willard Hotel, where he was often approached by those seeking favors.

The process of lobbying allows for competition among diverse interest groups. The All American League of Lobbyists lists the principal elements of lobbying as: researching and analyzing legislation or regulatory proposals; monitoring and reporting on developments; attending congressional or regulatory hearings; working with coalitions interested in the same issues; and educating not only government officials but also employees and corporate officers as to the implications of various changes. Lobbying is part of any democratic society and may take many forms including organizing petitions, running public relations campaigns, writing letters to the editor, or making telephone calls to public officials.

In order to prevent political corruption, lobbying in Western countries is regulated by law. The right "to petition the government for a redress of grievances" is protected in the First Amendment to the U.S. Constitution. In the United States, where the Congress dominates the legislative function, professional lobbyists represent interest groups and associations. The Federal Regulation of Lobbying Act (1946) requires that lobbyists register and report financial contributions they receive and their expenditure and that groups whom they represent make similar reports. Lobbyists representing foreign interests are required to register with the Department of Justice.

Many lobbyists are former politicians, government officials, or senior public servants. In the United States, the number of Members of Congress who turn to lobbying as a profession after they leave the legislature has increased in recent years. Only three percent of those who left Congress in the 1970s became lobbyists in Washington, but the figure increased to 12 percent in the 1980s, and by the 1990s, it had risen to 22 percent. Analysis shows that at least 128 former members of Congress were working as lobbyists in 2005.

In 1995 a ban was imposed upon former Members and most staff, preventing them from lobbying their former colleagues for one year after they left the Hill. This ban does not, however, prohibit them from devising strategies and then sending others employed by their firms to do the direct lobbying.

While lobbyists in the United States target the U.S. Senate, the U.S. House of Representatives, and state legislatures, lobbyists in the European Union (EU) focus primarily on the institutions and organizations of the EU. The European Commission estimated in 1999 that approximately 3,000 special-interest groups of varying types are based in Brussels, with up to 10,000 employees working in the lobbying sector.

Groups involved in active lobbying differ in relation to origin, size, and performance. They can also be seen in terms of "inside" or "outside" lobbyists, depending on their target audience. "Inside" lobbyists aim to influence politicians and legislators inside the legislature, while "outside" or "grassroots" lobbyists focus on changing public opinion. More than 6,000 lobbyists are registered in Washington, D.C. They lobby on behalf of 40,000 clients, including doctors, senior citizens, foreign governments, and religious organizations, as well as environmental public interest organizations and industries affected by environmental issues.

ENVIRONMENTAL LOBBYING

Environmental organizations combine inside and grassroots actions. Since the establishment of the first lobbying groups, which were concerned with the pollution that arose from industrial development and urbanization in the late 19th century, direct-protest actions have been merged with the lobbying of policy makers and political representatives. The objective of environmental lobbying is to influence the government leaders and influential persons in the community and to change public opinion.

The environmental community in the United States can claim many victories as result of both lobbying and coalition building, such as the Clean Water Act (1990). There are 12 major environmental organizations lobbying on issues at the national level. Studies of environmental lobbying indicate the mainstream Sierra Club (700,000 members) prefers grassroots action, while the more radical Earth First! (15,000 members) prefers to use 1960s-style protest and street theater to avoid the strategy of lobbying Congress directly. The Environmental Defense Fund (150,000 members) and the Natural Resources Defense Council (125,000 members) prefer legal action and employing lawyers to lobby and litigate.

One of the most influential environmental organizations, Greenpeace—with a presence in 40 countries across Europe, the Americas, Asia, and the Pacific and 2.8 million supporters worldwide—has built its powerful organization by emphasizing direct action rather than lobbying. It and other transnational environmental organizations, such as the World Wildlife Fund or Friends of Earth, use research, lobbying, and diplomacy, as well as nonviolent protest, to raise the level and quality of public debate and influence governments to work harder for environmental well-being. Activists lobby government officials in diverse countries and try to influence state officials at international conferences and other forums to support environmental protection measures. Centralized coordination of international campaigns makes possible the exchange of information and expertise while simultaneously supporting lobbying at the global level.

Lobbyists, no doubt, have a significant impact on the legislative process, whether they come from industry, the environmental community, or science. But many say the way lobbying is done needs improvement. There is a call for campaign finance reform, stricter disclosure laws so the public knows where a campaign's money is coming from, and restrictions on former government officials and employees becoming lobbyists. Despite the imperfections, there seems to be a consensus that lobbyists have a legitimate role to play in environmental policy making in forums such as Capitol Hill or the European Parliament.

SEE ALSO: Earth First!; Environmental Organizations; Greenpeace; National Resources Defense Council; Sierra Club; World Wildlife Fund.

BIBLIOGRAPHY. Jill Abramson, "The Business of Persuasion Thrives in Nation's Capital," *New York Times,* (p. A22, September 29, 1998); Timothy Doyle and Doug McEachern, *Environment and Politics* (Routledge, 1998); Masashi Sekiguchi, ed., *Encyclopedia of Life Support Systems* (EOLSS, 2003); Paul Wapner, *Environmental Activism and World Civic Politics* (State University of New York Press, 1996); Paul Wapner, "Politics beyond the State: Environmental Activism and World Civic Politics," in Ken Conca and Geoffrey D. Dabelko, eds., *Green Planet Blues* (Westview Press, 2004); The White House, "Ulysses S. Grant," www.whitehouse.gov/history (cited June 2006).

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Locke, John (1632–1704)

JOHN LOCKE WAS a British empiricist and social/political philosopher whose ideas on property, self-determination, and liberty influenced American politicians such as Thomas Jefferson. Locke asserted that humans initially existed in a God-created state of nature governed by divinely established moral rules that transcend social and economic "best use" considerations.

Locke believed that all humans have the right to sustain themselves and to accumulate wealth as long as they do not harm themselves, one another, or another's property. All laborers, he declared, must be granted equal access to the resources necessary to sustain themselves while discouraging the overuse or waste of the limited land and resources provided by God.

The *Lockean proviso* asserted that the right of humans to maximize their freedom to use the planet's land and resources is limited both by the equal access right of all humans to the land and resources and by the moral obligation not to waste the land and resources provided by God. Individuals may use the land and resources as they deem appropriate as long as they do not waste those resources and do not restrict the right of other humans to control their own lives. This provision was not as restrictive at the close of the 17th century as it is in the 21st century because there were substantially fewer people seeking access to finite land and resources. Today, resources are much scarcer as growing human populations use more land and expend resources while producing waste that the planet must absorb.

Locke did not envision the production of waste from land and resource use. He regarded waste as produced goods that were not used or that spoiled. He asserted that individuals could accumulate as much property and use as many resources as long as they abided by the *Lockean proviso*. Locke believed that trade, barter, and the use of money to purchase goods or assets eliminated both the inequality of individual overuse, accumulation, and waste by recompensing those whose access to the property or resource was limited by the one accumulating or using the asset. He argued that there is no waste when one accumulates money rather than assets that spoil. Any spoilage or waste is the responsibility of the purchaser. Locke believed that these transactions and the accumulation of monetary wealth were justifiable as long as the land and resources available to all humans were sufficient for all to live without the abrogation of their rights.

Locke believed that the need to protect these accumulated assets, private property, and the rights of all humans involved in these transactions gave rise to social contracts among the participants and the creation of governments to enforce the provisions of the contracts. He also asserted that a government exists as long as the people who formed the government consent to its existence and that consent is contingent on the protection of the rights of the people, especially their private property rights. Locke realized that some humans will accumulate assets at the expense of other humans but implied that it is not the government's role to equalize these disparities because they result from the proper exchange of assets. He also implied that it was the role of government to moderate inequalities that develop from these disparities, although he does not outline specifics on how this ought to be done.

SEE ALSO: Conservation; Land Use; Preservation.

BIBLIOGRAPHY. John Dunn, *The Political Thought of John Locke: An Historical Account of the Argument of the 'Two Treatises of Government'* (Cambridge University Press, 1983); W.M. Spellman, *John Locke* (St. Martin's Press, 1997); John W. Yolton, *The Two Intellectual Worlds of John Locke: Man, Person, and Spirits in the Essay* (Cornell University Press, 2004).

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Locks and Dams

DAMS ARE IMPOUNDMENTS of rivers and streams. They block the free flow or water, or they may direct or retard the flow of water. Usually a dam impounds water behind it, creating a lake or reservoir. Dams have an outlet for the water that they impound. The spillway or weir is usually a trough or pipe or some outlet that allows the build up of water behind the dam to flow out at the rate that it is flowing in once the reservoir had been filled. The water may flow out continuously or be released intermittently.

Dams may be the results of acts of nature. Landslides or earthquakes that block the flow of streams or rivers have formed numerous lakes. Animals, especially beavers, also build dams on streams. Farmers or developers have often fought their impoundments; however, beaver engineering of dams increases the amount of water available for fish, birds, and other wildlife. Their dams also raise the local water table providing for a different ecology than if their dams were not there.

Human construction of dams began over 2,000 years ago in China when dams were built on tributaries of the Yangtze. The first dams were built from earth, timber, and stone. Modern dams may be simple earthen containment dams, or elaborate concrete and steel dams such as the Hoover Dam. Dams have been built for many purposes, including irrigation, water supply, hydroelectric power, recreation, habitat, flood control, or for containing industrial or mining effluent. Many dams are built to facilitate shipping. The level of water in a river or stream usually varies with seasonal rainfall. Dams deepen the water in a waterway and allow shipping to take place all year long, unless the water freezes in the winter.

In order to facilitate shipping or transportation on rivers or other waterways, dams have been built

In the United States, rivers like the Tennessee have numerous dams that can affect plant and animal life.

to maintain a more or less constant water level. At places where rapids exist as a natural barrier, boats and ships have been in ancient times off loaded and then loaded below the rapids. Or they have been hauled overland to the next navigable area of water. Some dams have locks built into them or beside them. The lock is a structure that facilitates shipping on the dammed waterway. It allows cargo or passenger boats to easily navigate over a natural water barrier.

Locks operate by shutting doors to a box that is then filled with water or emptied of water. If a vessel is going upstream, the lock receives it at a lower downstream level. The doors to the lock are closed and water is pumped into the lock to raise the vessel to the higher upstream level. The lock acts like an elevator to raise or lower vessels to the upstream or downstream level. Once the doors of the lock are opened the vessel can then go on its way.

Today many of the rivers and streams in the United States have been dammed. Rivers like the Tennessee have numerous dams with locks in them that permit barges to move vast quantities of goods. Dams can have positive benefits, including the regular flow of water provided by a system of dams that allows for irrigation, recreation, and shipping.

However, damming streams or rivers can have a mild to severe impact on some species of plants, fish, or other life forms. For example, the snail darter in the rivers of east Tennessee were threatened by damming because they need clean gravel beds with flowing water in order to flourish. Other negative impacts that dams can have are the spread of disease and the accumulation of silt. The great Aswan Dam in Egypt has facilitated the spread of "snail fever" (schistosomiasis or bilharzia) and other diseases. It has also caused a decline of fish in the Mediterranean because nutrients needed by fish are being held behind the dam.

SEE ALSO: Aswan High Dam; Dams; Rivers; Snail Darter and Tellico Dam; Three Gorges Dam.

BIBLIOGRAPHY. Michael Collier, Robert H. Webb, and John C. Schmidt, *Dams and Rivers: Primers on the Downstream Effects of Dams* (DIANE Publishing Company, 1998); John J. Franco, *Development of Navigation with Locks and Dams* (U.S. Waterways Experiment Station, 1976); Bruce L. McCartney, *Inland Navigation: Locks, Dams and Channels* (American Society of Civil Engineers, 1998).

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Loess

LOESS (PRONOUNCED "LUSS") is soil comprised almost entirely of silt (soil particles 2–50 µm diameter), with some very fine sand and coarse clay, that has been deposited by wind, often during glacial periods. Most loess soils on the present global landscape are geologically recent, having been deposited during and after the most recent Ice Age (1.6 million to 10,000 years ago). As the climate gradually warmed and glaciers retreated, massive deposits of glacial till and outwash were left on the landscape and in river valleys. Windstorms plucked fine soil particles from these enormous, barren expanses of glacial debris and deposited them equator-ward, where they were layered as bluffs.

Usually several meters thick, extensive loess deposits are found in the central, midwestern, and northwestern United States, eastern and central Europe, Argentina, northwestern Africa, and central Asia. The extensive loess deposits in the central plains of the United States account in part for the high agricultural productivity in that region of the world. Some of the largest loess deposits are located in China, where they range from 30–100 meters thick and extend approximately 800,000 kilometers^2. (Unlike loess deposits that originate from glacial till and outwash, loess in China originated from erosion of silt from central Asian deserts to its west.)

Over time, loess deposits may take on a stepped appearance in the landscape, because mineralogically, silt particles are typically microscopic quartz grains that slide easily past one another. This mineral structure of silt also accounts for the soft, lubricious feel of loess when rubbed between the fingers. Loess soils are fertile and productive for agriculture, particularly when combined with sufficient clay and soil organic matter.

Loess soils are also highly vulnerable to erosion, however, because silt particles are much smaller than sand grains, and they are not as tightly bound to one another (or to organic matter) as clay particles. Because silt is not sticky and plastic like clay, loess cracks when it settles and dries. Thus, water entering cracks in settled loess quickly erodes silt particles and carries them away. As erosion widens the cracks, more surface area is exposed and erosion proceeds more rapidly in a positive feedback process termed *piping*.

Soil texture plays a central role in determining agricultural productivity, and texture is also critical to consider when making decisions about human infrastructure development. This was highlighted by a recent case study in the United States: In 1977, a large earth-fill dam on the Teton River in Idaho failed, killing 11 people and leaving 25,000 people homeless. The dam failed unexpectedly because it had been built on loess, which, unlike clay, cannot be compacted into a water-impermeable mass. Cracks formed in the silt underlying the dam, and piping of silt from these cracks compromised the integrity of the soil base. In a similar vein, much attention has been paid recently to ensuring that enough clay is incorporated into the replacement levees surrounding the U.S. city of New Orleans, where storm surges and flooding from Hurricane Katrina destroyed protective levees in August 2005, killing 1,000–1,500 people and leaving tens of thousands of people homeless.

SEE ALSO: China; Deserts; Erosion; Glaciers; Ice Ages; Soils.

BIBLIOGRAPHY. N.C. Brady and R.R. Weil, *The Nature and Property of Soils* (Prentice Hall Publishers, 2002); W.B. Bryant, *Dirt: The Ecstatic Skin of the Earth* (The Berkley Publishing Group, 1995).

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Longitude

LONGITUDE IS THE measure of the geographical distance from a point on the earth's surface to the reference or prime meridian, the Greenwich meridian, symbolized by lambda. Latitude and longitude are the two angular distances—using either degrees, minutes, and seconds, or decimal degrees—in the geographic coordinate system that precisely communicate the position of a certain location, and their measurement is fundamental for mapping representation and navigation.

Longitude is an angle formed by the meridian plane that crosses a location on the earth's surface, the center of the earth, and the Greenwich meridian plane. Longitude values range from 0 degrees and 180 degrees to the east of Greenwich, expressed as a positive angle, and from 0 degrees and 180 degrees to the west of Greenwich, expressed as a negative angle—or respectively accompanied by the letters E or W.

The lines that connect the points with the same longitude are termed meridians. They converge at both poles, are true north-south lines, and cross parallels at right angles. The distance between any two meridians increases toward the equator and decreases toward the poles, except for opposite meridians, which form a great circle.

Since the earth makes one 360 degree revolution in approximately 24 hours, and one hour represents a displacement of 15 degrees of longitude, the earth has been divided into 24 time zones—plus other fractions—allowing for the same standard time in a time zone. The antipodal meridian of Greenwich forms the International Date Line in the middle of the Pacific Ocean.

The Greenwich Meridian, which separates the Eastern and Western Hemispheres, was agreed upon as the prime meridian in October 1884 at the International Meridian Conference held in the United States. This reference meridian is arbitrary but commonly accepted; historically multiple prime meridians were used for mapping.

Finding longitude accurately at sea was a problem for centuries, making navigation unsafe; many vessels were lost in shipwrecks and voyages impeded until a solution was found. The usual method used to calculate the vessel's position was dead reckoning, measuring the distance traveled in a fixed direction from a previous position. This repeatedly proved unsatisfactory since error was high. While some complex calculations had existed since the 17th century (including measurement of the moons of Jupiter), a reliable solution remained elusive.

Seeking a resolution to the problem, the British Parliament passed the Longitude Act in 1714, and a Board of Longitude was commissioned to examine and judge proposals submitted by the public for methods of calculating longitude at sea, with a prize attached as an incentive.

The problem was solved not through mathematics and celestial observation, but rather through the application of mechanical invention. Since longitude is a function of time, knowing both local time and time at a known position and simply calculating the difference allows a precise measurement of east/west position. With this in mind, John Harrison, a clockmaker, designed an ingeniously accurate chronometer that could keep time without a pendulum (and therefore at sea). Despite the elitist hesitation of the Board of Longitude—who would have preferred both an elegantly mathematical solution and a winner from a higher social class—Harrison was acknowledged the prize winner in 1773.

SEE ALSO: Global Positioning Systems (GPS); Latitude; Maps; Time.

BIBLIOGRAPHY. William J.H. Andrewes, ed., *The Quest for Longitude* (Harvard University Press, 1996); Lev M. Bugayevskiy and John P. Snyder, *Map Projections. A Reference Manual* (Taylor and Francis, 1995); Derek Howse, *Greenwich Time and the Discovery of the Longitude* (Oxford University Press, 1980); Arthur H. Robinson et al., *Elements of Cartography* (John Wiley & Sons, 1995); Dava Sobel, *Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time* (Penguin, 1995).

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Long Term Ecological Research Network (LTER)

THE LONG TERM Ecological Research Network (LTER) was born as a result of a series of workshops sponsored by the National Science Foundation (NSF) to explore the nature of collaborative research within the environmental sciences. Researchers may apply for funding and network membership for a center where meaningful ecological research can take place.

The LTER's mission is to provide the scientific community, policy makers, and society with the knowledge necessary to conserve, protect, and manage the nation's ecosystems, their biodiversity, and the services they provide. It envisages a world in which exemplary science contributes to the advancement of the health, productivity, and welfare of the global environment that, in turn, advances the health, prosperity, welfare, and security of the United States.

The NSF funds the LTER. Consequently, sites accepted to the network are expected to conduct high-quality research, share research data, and participate in the networking activities of the LTER. Other funding comes from government bodies such as the

Department of the Interior, the National Aerospace and Space Administration, and the U.S. Geological Survey. The goals of the network are summarized in six terms: understanding, synthesis, outreach, education, information, and legacies. These activities center on conducting existing and new research, using that research to inform publications in a wide range of styles, and creating a repository of knowledge to assist the general public, fellow researchers, and policy makers in understanding the complexities of ecological research.

In 2006, the LTER consisted of 26 different sites in the United States, ranging from the study of salt marsh and oyster reefs of the Georgia Coastal Ecosystem LTER to the research into the Sonoran desert scrub at the Central Arizona-Phoenix LTER. The sites currently active represent the full range of the diversity of the ecosystems of the United States, and include monitoring of both urban and nonurban areas.

The International Long Term Research Network (ILTER) is an international network of scientists and researchers working in fields relating to ecological research. The network was established in 1993 at an international conference of researchers in Colorado who expressed the desire for greater communication among scientists working on common issues.

Scientists recognized the need to create international links to research issues that are clearly globally interconnected in nature. By May 2006, 32 national networks of scientists had joined the ILTER and another 11 were considering membership. Coverage of the territory of the world was best in the Americas, southern Africa, western Europe, and East Asia. Its activities focus on consolidating relevant data at the international level, improving global networking, and facilitating education and policy making on ecological issues around the world.

SEE ALSO: Ecology; Research Methods; Science and Technology Studies.

BIBLIOGRAPHY. David Greenland, Douglas G. Goodin, and Raymond C. Smith, *Climate Variability and Ecosystem Response at Long Term Ecological Research Sites* (Oxford University Press, 2003); Long Term Ecological Research Network, www.lternet.edu (cited September 2006).

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Lorenz, Konrad (1903–89)

KONRAD LORENZ WAS an Austrian zoologist who is best known for his founding of the science of ethology, which is the study of animal behavior and is also associated with the work of Nikolaas Tinbergen. Lorenz graduated in the field of medicine, following in his father's footsteps, and then began a career of academic study, interrupted by a period of service in the German army during World War II. He was captured on the Russian front and not repatriated until 1948. Subsequently he joined the Max Planck Institute and the brilliance of his work enabled him to rise to high office within that prestigious organization. His work combines careful observation with a lucid style, which makes it accessible to nonspecialist readers.

Lorenz viewed ethology as a means of understanding different forms of behavior that are common across many different species, rather than evident within any particular type of creature. His work focused on representative forms of animal behavior such as aggression, responses to captivity, and daily routines. His observations centered, in particular, on the concepts of instinctive behavior and imprinting. Although he was not the first to create these concepts, his research reinvigorated the ideas with substantial new data, including that of various birds.

He was able to show how different forms of instinct acting simultaneously become integrated into a single, mostly coherent form of behavior. His work has applications in the study of evolution, and this has provoked controversy among those who seek to deny it. However, by concentrating mostly on group selection approaches to evolution, Lorenz's work is considered to have been surpassed by more recent work and, more broadly, many of his research findings have been challenged by those who have followed in his wake. His later work moved on to the study of humanity and those forms of behavior that he had earlier identified among animals that could be used to explain the nature of human societies.

Lorenz won the Nobel Prize for Physiology or Medicine in 1973 with Nikolaas Tinbergen and Karl von Frisch. Some held his joining of the National Socialist Party in 1938 and the framing of some of his research according to Nazi ideology against him. He apologized for one such paper at his acceptance of the Nobel Prize. In 1984 he became involved in supporting the Austrian Green Party and opposition to a proposed power plant that would have led to the destruction of valuable forestland.

SEE ALSO: Animals; Ethology; Evolution.

BIBLIOGRAPHY. Konrad Lorenz, *King Solomon's Ring: New Light on Animals' Ways* (Plume, 1997); Konrad Lorenz, *Man Meets Dog* (Routledge Classics, 2002); Nobel Prize Organization, www.nobelprize.org (cited July 2006).

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Los Angeles River

THE LOS ANGELES River is located in southern California. It is only 52 miles long but is very steep: It drops 795 feet in elevation from the headwaters in the San Fernando Valley to its end in Long Beach. The majority of its sourcewaters flow from the San Gabriel Mountains, which are east of the San Fernando Valley, and from the Santa Susanna Mountains to the north.

The Los Angeles River flows through the San Fernando Valley, the Glendale Narrows, and the city of Los Angeles, and empties into the Pacific Ocean. Major tributaries to the river in the San Fernando Valley are the Pacoima Wash, Tujunga Wash, Burbank Western Channel, and Verdugo Wash; the main tributaries to the river in Glendale Narrows are the Arroyo Seco, the Rio Hondo, and Compton Creek.

Most of the Los Angeles River is bedded by concrete. To prevent flooding and make room for construction, 47.9 miles of the river were channelized from 1914–70. The Glendale Narrows to Long Beach section of the river still has a natural bed, and is surrounded by forest, grassland, savannah, and shrubland, but flora and fauna still exist in the channelized section. Sixty species of native plants have been identified in the river, including fish, reptiles, amphibians, and some mammals.

Despite its concrete bed, the river continues to flood. The Los Angeles River has other problems as well. Due to the high urbanization of the Los Angeles area, much of the Los Angeles River watershed is covered with residential, commercial, and industrial areas, including major refineries and petroleum product storage facilities.

This situation increases the demand for water and also increases the contamination of most local water sources. Although the Los Angeles River boasts water that is cleaner than water in most urban rivers around the world, it is still polluted from residential, industrial, and other urban activities. Contamination is worse during rainy seasons and pollution is more concentrated in some areas than in others. Erosion problems and fires also affect this watershed. These problems in the Los Angeles basin have sparked efforts to decrease water contamination, protect the wildlife habitat, enhance recreational areas, manage storm water quality, and prevent flooding and fires.

The Los Angeles city government has developed several programs to aid in these efforts, such as the Los Angeles River Master Plan, adopted in 1996, which focuses on flood protection and sustainable development, and the Revitalization Master Plan, adopted in 2005, which seeks to restore the river and create a wildlife corridor from the mountains to the sea.

One important aspect of the Revitalization Master Plan is the participation of environmental groups, such as Friends of the Los Angeles River (FoLAR) and Unpave L.A., thus permitting public involvement and participation in the real processes of decision making.

SEE ALSO: Floods and Flood Control; Pollution, Water; Rivers; United States, California; Urbanization.

BIBLIOGRAPHY. County of Los Angeles Department of Public Works, "Los Angeles Master Plan," ladpw.org

To prevent flooding and make room for construction, 47.9 miles of the Los Angeles River were bedded with concrete.

www.folar.org (cited December 2006); Blake Gumprecht, *The Los Angeles River: Its Life, Death, and Possible Rebirth* (Johns Hopkins University Press, 1999); Morrison Patt, *Río L.A.: Tales from the Los Angeles River* (Angel City Press, 2001).

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Lotka-Volterra Curve

IN NATURE, MANY of the phenomena that capture our attention, such as the sight of a large predator in pursuit of prey, involve two or more interacting species. Alfred James Lotka (1880–1949) and Vito Volterra (1860–1940) independently developed a simple model to explain interactions between predators and prey, unlike the single species model. Born in the Ukrainian city of Lviv, then called Lemburg, Austria, Lotka was raised in France and arrived in the United States in 1902. He worked for U.S. government institutions—including the Bureau of Standards—followed by a position at Johns Hopkins University, before retiring as a statistician from the Metropolitan Life Insurance Company in New York in 1947. At that time, biologists were seeking ways to analyze the relationships of organisms with their surrounding environment. Lotka theorized that similar to the laws in physics, such as Newton's Laws of Motion, the idea of natural selection could be established in its own right as a physical law.

Volterra was born in Ancona, Italy, and was interested in mathematics from an early age. Earning a doctorate in physics in 1882, he went on to a distinguished academic career in mathematical physics and was elected to the Royal Society in 1910. Volterra worked on partial differential equations during the 1890s and after World War I became interested in mathematical biology, applying the theory of differential equations to prey-predator interactions. Instead of looking at prey-predator populations as snapshots in time, differential equations allow us to observe population change continuously over time.

The Lotka-Volterra model relies on a set of two assumptions, (a) as the number of prey increases the birth rate of the predator also increases and (b) as the number of predators increases the death rate of the prey also increases. The general model for two species is expressed in the form of the following differential equations:

$$\begin{cases} \dfrac{dx}{dt} = ax - bxy \\ \dfrac{dy}{dt} = -cy + dxy \end{cases}$$

The first equation describes the change in the prey population. The second equation describes the change in the predator population. In these equations, dx/dt and dy/dt are respectively the prey and predator populations at any time, a is the prey's natural growth rate when predators are absent, b is the prey's death rate or rate at which predators eliminate or consume prey, c is the natural death rate of the predator in the absence of prey, and *d* is the efficiency of the predator or the rate at which predator numbers increase in the presence of prey.

Early studies in the life sciences in North America provide a fitting backdrop to the subsequent interest in prey-predator relations that led to the Lotka-Volterra model. The work of fur traders employed by the Hudson Bay Company in Canada in the 18th century resulted in two centuries of fur-trade records. Analysis by wildlife biologists showed that the populations of the snowshoe hare *Lepus americanus* and its predator the Canada lynx *Lynx canadensis* rise and fall at regular 10-year intervals. The highs in hare numbers are closely followed by highs in lynx numbers. These cycles of rise and fall in prey-predator numbers are predicted by the Lotka-Volterra model (Figure 1).

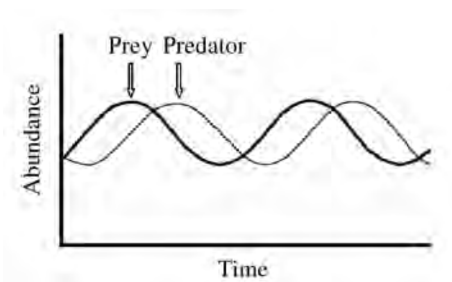

Figure 1 (Modified from Wilson and Bossert, 1971)

The Lotka-Volterra curve is important because it was the first model of biological populations based on sound mathematical principles. The fact that in the wild, numbers of some prey-predators go up and down in a predictable cyclic fashion—as in the case of the snowshoe hare and the lynx—is often seen as a validation of the Lotka-Volterra model. However, dramatic ups and downs in animal numbers puzzle those ecologists who believe that nature tends to prevent the occurrence of such imbalances. Useful as it is, biologists now recognize that the model is too simplistic and does not include environmental factors that may significantly influence animal populations. Depending on the number of external factors investigated, single-factor or multiple-factor studies are conducted; for example, a study on the effect of food limitation will be single-factor, while food and disease taken together is a multiple-factor effect. Tests of the Lotka-Volterra model have resulted in attempts to improve it by incorporating such environmental factors.

The existence of the Lotka-Volterra model has helped improve our understanding of prey-predator interactions and the importance of food supplies. Importantly, the model and ecological studies resulting from it helped explain that the dramatic declines in herbivorous prey numbers affect not only their principal predator, but also have cascading effects on other predators, as well as on the structure of surrounding plant communities. Studies of prey-predator populations have helped provide data necessary for habitat conservation plans to protect threatened species such as the Canada lynx.

SEE ALSO: Animals; Habitat; Predator/Prey Relations.

BIBLIOGRAPHY. Stuart Houston, Tim Ball, and Mary Houston, *Eighteenth-Century Naturalists of Hudson Bay* (McGill-Queen's University Press, 2003); Charles J. Krebs et al., "What Drives the 10-Year Cycle of Snowshoe Hares?," *BioScience* (v.51, 2001); Egbert R. Leigh, "The Ecological Role of Volterra's Equations," in *Some Mathematical Problems in Biology* (The American Mathematical Society, 1968); Alfred J. Lotka, *Elements of Mathematical Biology* (Dover Publications, 1956); Alfred J. Lotka, *Analytical Theory of Biological Populations* (Plenum Press, 1998); Evelyn C. Pielou, *Mathematical Ecology* (John Wiley & Sons, 1977); Vito Volterra, "Variazioni e Fluttuazioni del Numero D'individui in Specie Animali Conviventi," *Mem. R. Accad. Naz. Dei Lincei* (v.2, 1926); Edward O. Wilson and William H. Bossert, *A Primer of Population Biology* (Sinauer Associates, 1971).

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Love Canal

FOLLOWING DISCLOSURE OF toxic dumping in a site that later became residential, the case of Love Canal demonstrated the hazards of buried and long-forgotten toxic chemicals, galvanized grassroots environmental action, and became the paradigmatic case for the control and management of brownfield sites. It also put working people and mothers at the center of environmental action, setting a precedent for environmental justice activity in the decades that followed.

The Love Canal is a neighborhood in the southeast district of Niagara Falls, New York, named for 19th century entrepreneur William T. Love. Love obtained the area approximately four miles upstream from the falls in 1892, hoping to harness water to generate power to the number of industries developing on the seven-mile stretch of the river to the mouth of Lake Ontario. He also intended for the canal to be a bypass route around the falls. After only a few years it was obvious Love's plan had failed, largely due to a nationwide economic depression and the invention of alternating electronic current. Love abandoned the project with only one mile dug, and the area remained a recreational spot into the early 20th century.

In 1920 the land was sold at a public auction and became a landfill and chemical dumping site. Hooker Chemical, a subsidiary of Occidental Petroleum Corporation, used the site from 1942 to 1953 and was the primary corporation responsible for the nearly 21,000 tons (42 million pounds) of toxic chemicals dumped on the site. The City of Niagara Falls and the U.S. Army both dumped assorted wastes there as well. As the landfill reached maximum capacity in 1953, Hooker filled it with dirt. At the same time, the postwar baby boom created a huge demand for housing in the area. The Niagara Falls Board of Education purchased the Love Canal land from Hooker Chemical for a dollar.

Hooker claims they included a brief warning about the chemical wastes buried on the property in the deed transfer, as well as a disclaimer absolving the company from liability. Single-family housing was quickly built on and near the land, and soon the 99th Street Elementary School was erected on the former landfill. Homeowners were not provided any information about the chemicals below their homes or their potential hazards.

Early on, between the 1950s and 1970s, residents of the area complained of odors and "substances" appearing in their yards. Families also complained of their children being burnt. City officials visited the neighborhood and the school and responded by covering the "substances" with dirt or clay. Complaints persisted, however, and the city hired Calspan Corporation to investigate. Calspan's report, completed in 1976, documented the presence of toxic chemical residue in the air and in sump pumps of residents. They also found 50-gallon drums buried just below the surface of the canal cap and high levels of polychlorinated biphenyls (PCBs) in the storm sewer system. The consultants recommended covering the canal cap with a clay cap, sealing home sump pumps, and installing a tile drainage system to control the movement of wastes. No action was taken.

The area continued to grow despite the complaints, with approximately 800 private, single-family homes, 240 low-income homes, and three schools there by 1978. The story broke that year, as a reporter for the *Niagara Gazette,* Michael Brown, wrote a series of articles about hazardous waste problems in the Niagara Falls area. He included the Love Canal dump site, prompting residents to renew complaints to city officials. By this time residents were complaining of more than just noxious smells and substances; many were also documenting mysterious health problems, including a high rate of birth defects and miscarriages. Also in 1978, the New York State Department of Health began to collect air and soil tests in residents' basements and to document the health concerns of 239 families in the area.

On April 25, 1978, Dr. Robert Whalen, New York State Commissioner of Health, proclaimed the area a public health hazard and ordered the Niagara County Health Department to remove exposed chemicals from the site and to install a protective fence around the area. The report prompted further action by residents. Lois Gibbs, mother of two small children, canvassed the area to petition for the closure of the 99th Street School, which her son attended. Residents and state and local health department officials met throughout the spring and summer of 1978. In the fall of 1978, State Commissioner of Health Whalen issued a medical emergency for the Love Canal area and ordered the immediate closure of the 99th Street School.

Immediate cleanup plans began, and it was recommended that pregnant women and children under the age of two move from the area. On August 7, 1978, President Jimmy Carter declared Love

Canal a federal emergency, providing funds for the permanent relocation of 239 families living in the first two rows of homes encircling the landfill. The remaining ten blocks of homes, including that of activist Lois Gibbs, were not included.

SEE ALSO: Brownfields Properties; Cradle-to-Grave Regulation of Hazardous Waste; Dioxins; Environmental Protection Agency; Gibbs, Lois; Justice; Landfills; NIMBY; Polychlorinated Biphenyls (PCBs); Superfund Sites.

BIBLIOGRAPHY. "Background on the Love Canal," October 17, 2001, Love Canal Collection, State University of New York at Buffalo, ublib.buffalo.edu/libraries (cited June 2006); Center for Health, Environment, and Justice, "Love Canal," www.chej.org (cited June 2006); Thomas H. Fletcher, *From Love Canal to Environmental Justice: The Politics of Hazardous Waste on the Canada–U.S. Border* (Broadview, 2003); Lois Gibbs, *Love Canal: The Story Continues* (New Society Publishers, 1998).

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LULU

LULU MEANS "locally unwanted land use" or "locally undesirable land use." According to planner and urbanist Frank Popper, there are many different types of LULUs, including low-income housing projects, junkyards, and strip developments. This definition suggests that nearly any change in the character of a community's land use can be defined as a LULU. The term also ties to the idea of NIMBY (not in my backyard), a term used to describe community opposition to LULUs. Some LULUs, as Popper notes, are obvious. Almost no one wants to live next to a noisy, toxic, dangerous, or ugly facility. Other communities may oppose strip development because it increases traffic and can lead to discordant and unattractive development. However, the nature of a LULU depends heavily on the character of a community. An urban community may support the construction of a stadium because of the business opportunities it would create, while a suburban community may oppose the project because of the significant increase in traffic and other negative outcomes that such a facility would generate.

Popper notes that there are several ways to address community opposition to LULUs. One is to concentrate LULUs in one part of a city, reserving other land for residential or office uses, and another is to disperse LULUs. Ordinances that require bars, adult book stores, and strip clubs be no closer than a fixed distance from a similar business, or a church, school, or other public facility, are common in many cities and seek to avoid the creation of a "red light district." LULUs can be randomly built in a community, thereby avoiding favoring or disfavoring any community, and leaving siting decisions to market forces.

However, it is doubtful that communities with differences in political power will see LULUs sited in areas with the most political power. Popper argues that LULUs' negative effects can be mitigated, although often at a great expense that is borne by the landowner and the user of the services provided on that land (electricity, for example). Declaring anything a LULU means that the overall social benefit of a power plant may be, in the community where it is built, less important than the overall social benefit of the facility. This is one of the major shortcomings of simply compensating neighbors for the costs, or "negative externalities" created by a LULU. Such a compensation scheme may not properly account for the overall benefit to society from a LULU, and the expectation that sometimes people have to bear burdens for the broader community good.

SEE ALSO: Development; NIMBY; Urban Planning.

BIBLIOGRAPHY. Sanda Kaufman and Janet L. Smith, "Implementing Change in Locally Unwanted Land Use: The Case of GSX," *Journal of Planning Education and Research* (v.16/3, 1997); Brian C. Levey, *Locally Unpopular Land Uses: Defending and Challenging "Not in My Backyard" (NIMBY) and Locally Unpopular Land Uses (LULU)* (Massachusetts Continuing Legal Education, 1996); George Noble, *Siting Landfills and Other LULUs* (Technomic Pub. Co., 1992); Frank J. Popper, "Siting LULUs," *Planning* (v.47, 1981).

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Maathai, Wangari (1940–)

WANGARI MAATHAI was born in Nyeri, Kenya. She was trained in biological sciences and pursued doctoral studies in Germany and Nairobi, becoming the first Kenyan woman to receive a Ph.D. In 1977 she founded the Green Belt Movement. This initiative responded to the needs of local women for firewood, clean drinking water, balanced diets, shelter, and income, which they had been unable to meet due to continuous environmental degradation, replacement of household crops by commercial farming, and declining income due to distorted world market prices for Kenyan commodities. The program began with the planting of nine trees in Maathai's own backyard and resulted in a citizen education program that led to the planting of more than 30 million trees that survived all over Kenya, and the creation of similar initiatives in many other African countries after the establishment of the Pan African Green Belt Movement.

Maathai promoted a holistic approach with a vision of "healing Africa," and she encouraged Africans to rediscover the positive aspects of their culture to raise their sense of belonging, identity, and self-confidence, emphasizing the need for the conservation of biodiversity and cultural diversity. Understanding the causes of environmental degradation and their connection to governance, she continuously addressed the need for democracy, combining the protection of the environment with the protection of human rights, the need for good governance, and equality between women and men. She also mobilized citizens to challenge widespread abuses of power, corruption, and environmental mismanagement.

In the 1980s Maathai became the chairperson of the National Council of Women, and she also became one of the leaders of the pro-democracy movement. Her many initiatives exposed her to harassment. She was repeatedly sent to prison, but the government met with little success in its efforts to curb her. Maathai became internationally known and was elected to parliament in 2002, when the previous authoritarian Kenyan regime relinquished power. In 2003, in the broad coalition government that took over, Maathai was appointed deputy minister of environment, natural resources, and wildlife with 98 percent of the vote.

Maathai won many awards for her work. She received honorary doctoral degrees from Williams College in Massachusetts (1990), Hobart and William Smith Colleges (1994), the University of Norway (1997), and Yale University (2004), where she also taught as a visiting professor. Some of her other honors include the Right Livelihood Award (1984), the Woman of the World (1989), the Hunger Project's Africa Prize for Leadership (1991), and the Conservation Scientist Award (2004). Most notably, Maathai was the first African woman to receive the Nobel Peace Prize. By giving her this honor, the Norwegian Nobel Prize Committee challenged and broadened the world's common understanding of peace: that there can be no peace without equitable development; and that there can be no development without sustainable management of the environment in a democratic and peaceful space.

SEE ALSO: Environmental Organizations; Green Movement; Kenya; Plantation.

BIBLIOGRAPHY. Green Belt Movement, www.greenbeltmovement.org (cited August 2006); Wangari Maathai, *The Green Belt Movement: Sharing the Approach and the Experience* (Lantern Books, 2003); Wangari Maathai, *Unbowed: A Memoir* (Alfred A. Knopf, 2006).

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Macedonia

IN 1946 MACEDONIA became an autonomous republic within the Federation of Yugoslavia. Forty-five years later, independence was peacefully obtained, but problems with neighboring Greece followed when the Greek government insisted that the name *Macedonia* was Hellenic in nature. Briefly known as the Former Yugoslav Republic of Macedonia, the country's name was shortened over Greek objections. Economic relations between the two countries have resumed, but the relationship remains tenuous. Although Macedonia is landlocked, it shares Lake Ohrid with Albania and Lakes Prespa and Dyran with Greece. The Vardar River runs through much of Macedonia. Summers and autumns are warm and dry in Macedonia, followed by cold winters and heavy snow. The land is generally mountainous with deep basins and valleys, and the country is vulnerable to high seismic activity.

Due to its strategic location, Macedonia serves as a major transportation corridor from western and central Europe to the Aegean Sea and between southern and western Europe. Despite rich natural resources of low-grade iron ore, copper, lead, zinc, chromite, manganese, nickel, tungsten, gold, silver, asbestos, gypsum, timber, and arable land, the Macedonian economy remains weak. Economic woes have been influenced by outside factors, which include the breakup of Yugoslavia, the fragile relationship with Greece, and civil strife in Albania.

With a population of 2,045,262, Macedonia has a per capita income of $7,400. An accurate picture of the Macedonian economy is virtually impossible because of the large informal sector that employs around one-fifth of the population. Unemployment is estimated at 38 percent, and over 30 percent of Macedonians live below the poverty line. The United Nations Development Programme Human Development Reports rank Macedonia 59th in the world in overall quality-of-life issues.

ENVIRONMENTAL ISSUES

Macedonia's major environmental problems are air pollution from numerous metallurgical plants and a lack of waste management facilities. Nearly 60 percent of the people live in urban areas such as the capital city of Skipje. Like the capital, other areas experience severe problems from industrial pollution. Mining and energy plants in Bitola are responsible for the release of sulfur dioxide, carbon monoxide, nitrogen oxides, and dust. In Veles, metallurgical and chemical plants release gases and heavy metals into the air. Such companies are also responsible for the pollution of groundwater and waterways.

Approximately 36 percent of Macedonia's land is forested, and the government has protected 7.1 percent of the land area. National parks have been established in Mavrovo, Galicica, and Pelister. National reserves on Prespa Lake and Crna Reka Gorge are strictly protected. Macedonia's unique geography, which is derived from the three tectonic lakes and over 30 glacial lakes, merits special care. Consequently, specific sections of lakes and swamps are under natural protection to oversee the rich variety of flora, fauna, and fungi that flourish in these areas. Of 78 mammal species endemic to Macedonia, 11 are endangered; however, only three of the 199 species of birds are endangered.

Environmental compliance has been difficult in Macedonia because monitoring mechanisms have not been in place to enforce existing laws. In response to renewed commitment to environmentalism, parliament passed the Act on Environment and Nature. Under the Ministry of Environment, the Inspectorate for Environment and Nature Protection and Promotion has been given the authority to oversee compliance with the law in the areas of air and water pollution, protection of natural resources, soil degradation and pollution, hazardous noise, and radiation. Violators face a fine of 200,000 to 300,000 denars.

Macedonia's commitment to the global environment has resulted in participation in the following international agreements: Air Pollution, Biodiversity, Climate Change, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Endangered Species; Industrialization; Lakes; Pollution, Air; Poverty.

BIBLIOGRAPHY. Central Intelligence Agency, "Macedonia," *The World Factbook,* www.cia.gov (cited March 2006); Economic Commission for Europe, "Environmental Performance Review of the Former Yugoslav Republic of Macedonia," www.unece.org (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Environment and Physical Planning, "State of Environment Report," www.soer.moe.gov.mk (cited March 2006); United Nations Development Programme, "Human Development Reports: Macedonia," hdr.undp.org (cited March 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Macedonia," *Little Green Data Book,* lnweb18.worldbank.org (cited March 2006).

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Madagascar

IN 1896 THE island of Madagascar lost its status as an independent kingdom to French colonialism. Independence was reinstituted in 1960, launching almost two decades of one-party rule. In the mid-1990s, Madagascar rejected socialism and began a process of privatization and liberalization by following the guidelines of the World Bank and the International Monetary Fund. In 2001, during a hotly-contested presidential election, half the country threatened to secede. Stability was restored when the High Constitutional Court declared a winner in April 2002.

With just over five percent arable land, more than 80 percent of the work force is engaged in agriculture and fishing. In recent years, the economy has become more diversified, and revenue from apparel industry exports is increasing. Natural resources include: graphite, chromite, coal, bauxite, salt, quartz, tar sands, semiprecious stones, mica, fish, and hydropower. With a per capita income of \$900, Madagascar is the 18th poorest country in the world. Half of the population lives below the poverty line, and 37 percent of the people are severely undernourished. The United Nations Development Programme's Human Development Reports rank Madagascar 146 of 232 countries on overall quality of life issues.

With a total area of 587,040 square kilometers, Madagascar is the fourth largest island in the world. Surrounded by the Indian Ocean, the Republic of Madagascar has a coastline of 4,828 kilometers. A narrow coastal plain gives way to high plateau and mountains in the center of the island. Elevations range from sea level to 2,876 meters at Maromokotro in the northeast. Madagascar's climate is varied; it is tropical along the coast but changing to temperate in inland areas and to arid in the south. Madagascar is subject to periodic cyclones, drought, and locust infestations.

Poverty plays a major role in the lives of many Malagasy. Some 55 percent of the population lack sustained access to safe drinking water, and 67 percent lack access to improved sanitation. Consequently, Madagascar's population of 18,595,469 faces a high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea,

The Aye-Aye of Madagascar

One of the rarest animals in the world is the aye-aye, which is the world's largest nocturnal primate. It dwells in forest canopies on the east coast of the Indian Ocean island of Madagascar. Although a primate, it somewhat resembles a rodent with long claws that it uses to pull grubs from trees after tapping at and then gnawing the wood. The animal has black or dark brown fur, with a bushy tail similar to some squirrels. Its face looks like a bat's, and it moves around its habitat like a lemur.

It is thought that the name *aye-aye* comes from a human cry of alarm upon seeing the animal. Many local people have long regarded the aye-aye as an evil creature and have killed them on sight. This is partly from superstition over its long middle finger. There are stories in folklore of an aye-aye coming into a village and pointing its finger at someone, who then later dies, or even of the animal stabbing people with this finger and puncturing their hearts.

Superstition, however, has also resulted in no one wanting to hunt the aye-aye for food. Nevertheless the massive destruction of the animal's habitat has resulted in a large decline in its population and it is endangered. There are many captive breeding programs. At the largest, the Duke Lemur Center at Duke University, there are 22 aye-ayes.

hepatitis A, and typhoid fever and schistosomiasis, a water contact disease. In some areas, Malagasy are at high risk of contracting vectorborne diseases such as malaria and plague. There is also growing concern about HIV/AIDS, which affects 140,000 Malagasy. Social indicators such as infant mortality (75.21 deaths per 1,000 live births), life expectancy (57.34 years), fertility rate (5.4 children per female), and literacy rate (68.9 percent) further reveal the effect that poverty has on the population.

Madagascar is experiencing soil erosion in response to overgrazing and to deforestation, which is occurring at a rate of 0.9 percent per year. Fires intentionally set to clear land for agriculture, particularly for use as rice fields, have done major damage to the environment. Ecologically valuable timber has been stripped from the rain forests and sold, sometimes earning as much as $2,000 a ton. Other trees are used in the production of charcoal. Desertification is also a growing problem, and surface water has been contaminated from the dumping of raw sewage and organic wastes.

The biodiversity of Madagascar's rain forest is unique, and some scientists have dubbed Madagascar the "eighth continent" because of its biology. Eighty percent of the species found in Madagascar are endemic, such as the giraffe-necked weevil and the 33 species of lemurs for which Madagascar is best known. For centuries, the medicine men of Madagascar have known that certain plants had medicinal properties. In 1958, for instance, natives pointed out to foreign researchers that the Madagascar rosy periwinkle could work miracles. It has since been used to develop drugs that fight Hodgkin's disease and childhood leukemia. Several species of flora and fauna that do not grow anywhere else in the world are now endangered.

Of 141 endemic mammal species, 50 are endangered, as are 26 of 172 endemic bird species. Some endangered animals are killed outright in response to local superstitions. The government has also played a role in endangering wildlife. In 1980 troops commandeered the Zinave National Park and set up a meat processing center. The introduction of aggressive alien species into Madagascar has further threatened the existence of endemic species.

A 2006 study by scientists at Yale University ranked Madagascar 116 of 132 countries on environmental performance, in line with comparable income and geographic groups. The lowest scores were received in the areas of environmental health and biodiversity and habitat. Around a fifth of Madagascar's land area is still forested, and the government has protected 4.3 of all land, including an extensive network of national parks and reserves.

In 1988 the government of Madagascar published its first National Environmental Plan, establishing a framework for environmental policy that is focused on sustainable development. The plan was divided into three stages, designed to take effect over a period of 15 years, establishing the priorities of management and protection of biodiversity in conjunction with sustainable development; improving living conditions and production of natural resources; expanding conservation and developing of national parks and reserves; promoting environmental training and education; and establishing research and monitoring mechanisms.

The third stage, launched in 2003, stressed the issues of conservation, sustainable economic growth, and an improved quality of life for the people of Madagascar. The minister of environment was charged with implementing and enforcing all laws derived from the three plans. The government also invested in efforts to discover reliable sources of alternative energy that include wind, solar, and waste-to-energy initiatives.

Madagascar participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, and Wetlands.

SEE ALSO: Biodiversity; Endangered Species; Poverty; Rain Forests.

BIBLIOGRAPHY. Central Intelligence Agency, "Madagascar," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); Guy Razafindralambo and Lisa Gaylord, "Madagascar: National Environmental Action Plan," www.mfdr.org (cited April 2006); United Nations Development Programme, "Human Development Report: Madagascar," hdr.undp.org (cited April 2006); World Bank, "Madagascar," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Mad Cow Disease

MAD COW DISEASE, or bovine spongiform encephalopathy (BSE), is a degenerative disease of the nervous system in cattle. It is always fatal. Cattle with BSE develop minute holes in their brains, have difficulty standing and walking, produce less milk, become irritable, and lose weight. The disease has an extended incubation period. Symptoms usually appear four to five years after infection, and death often occurs within weeks of symptom onset.

BSE belongs to a group of diseases called transmittable spongiform encephalopathies (TSEs). Other TSEs include scrapie in sheep, chronic wasting disease in deer and elk, and Creutzfeldt-Jakob Disease in humans. TSEs can spontaneously arise in individual animals or can occur due to genetic mutations. They are believed to occur when certain cellular proteins, called prions, become misshapen. The misshapen prions then alter the shape of other prions. These proteins clump in the cells and damage nervous tissue. They are difficult to destroy: Heat, UV light, radiation, and disinfectants that destroy infectious agents such as bacteria and viruses do not destroy prions.

BSE was first seen in Great Britain in 1985 and was recognized as a disease in 1996. There are two lines of thought regarding its origin in Britain. Some researchers think the disease was passed to cattle in feed containing the remains of sheep infected with scrapie. Other researchers question this, because the prions of scrapie differ from those of BSE, and suggest the disease arose spontaneously in a single animal.

Whatever the origins of the disease, feeding practices in the United Kingdom (UK) allowed BSE to become established. Meat and bone meal, made from the remnants of animals after butchering, were routinely used as protein supplements in cattle feed. When meat and bone meal from infected animals entered this food chain, the disease spread throughout the UK. Changes in the processing methods for meat and bone meal in the early 1980s, which lowered the heat compared to that used in previous methods, may have led to a higher incidence of the prions in cattle feed. Cattle are not infected with BSE through contact with an infected animal.

The number of confirmed cases of BSE in the UK reached 14,000 by 1990, and 181,376 by 2002. In addition to the UK, infected cattle have been discovered in European, North American, and Asian countries. In 2003 the first cases of BSE were reported in both Canada and the United States.

To contain the outbreak, British cattle thought to be infected were slaughtered, and feeds containing remains of sheep and cattle were banned in the UK. Other countries took similar measures. In addition, some nations banned the import of cattle or beef from countries where BSE is known to have occurred. BSE is decreasing. The disease killed a reported 878 cattle worldwide in 2004 and 474 in 2005.

Since the mad cow epidemic began, a new TSE has been discovered in humans: variant Creutzfeldt-Jakob Disease (vCJD). It was first reported in 1996. It appears that vCJD is caused by eating beef from BSE infected cattle. Most infected individuals are known to have consumed tainted beef in Britain. The prions are similar, as are the patterns of brain damage seen in victims of BSE and vCJD. Victims of vCJD are usually young. The incubation period for vCJD can be as long as ten years. Death occurs, on average, 12–14 months after symptoms appear. Symptoms include depression, difficulty walking, shakiness, a sensation of sticky skin, dementia, and eventually muteness, the inability to move, and death. A cure for vCJD has not been found.

As of 2006, the UK's National Creutzfeldt-Jakob Disease Surveillance Unit reported 158 confirmed and suspected vCJD deaths in the UK. An additional six living individuals are thought to be infected. Seven deaths have occurred in France, plus one death each in Canada, the United States, Ireland, and Italy. Other individuals may be incubating vCJD.

SEE ALSO: Cattle; Chronic Wasting Disease; Disease; Livestock; Transmissible Spongiform Encephalopathies.

BIBLIOGRAPHY. Paul Brown, "Mad Cow Disease in Cattle and Human Beings," *American Scientist* (July–August 2004); Centers for Disease Control and Prevention, "BSE (Bovine Spongiform Encephalopathy, or Mad Cow Disease)" www.cdc.gov (cited December 2006); The National Creutzfeldt-Jakob Disease Surveillance Unit, "CJD Statistics," www.cjd.ed.ac.uk (cited December 2006); Stanley B. Prusiner, "Detecting Mad Cow Disease," *Scientific American* (July 2004); World Health Organization, "Variant Creutzfeldt-Jakob Disease," www.who.int (cited December 2006).

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Maize

MAIZE (*ZEA MAYS*), also known as corn, is one of world's major cereal grains along with wheat and rice. It was domesticated as long ago as 12000 B.C.E. from a tropical grass in the Americas, where it became the foundation of agriculture for the Mayans, Incans, Aztecs, and other American indigenous groups. After European contact with the Americas, maize spread throughout the world, becoming extensively grown in former European colonies from Africa to Asia and in eastern Europe. Today the United States remains by far the top producer of corn, followed by China, Brazil, Mexico, and Argentina. Maize is still a staple in subsistence communities in Mesoamerica.

Maize is a tall grass-like plant that grows from six to twenty feet tall and produces two to six ears of corn per plant. From the top of the maize plant emerges a tassel-like inflorescence of male flowers. Along the stalk several ears emerge with the silk, the elongated stigma of a female flower. Maize is an allogamous (cross-pollinating) plant; each individual fruit on an ear of corn is formed when wind-blown pollen from the tassel lands on the silks. Maize is a C4 plant, meaning that its photosynthetic pathway is different from most crop plants, which are typically C3. This allows a corn plant to produce more dry matter per unit of water.

There are several hypotheses about the origins of maize domestication, which is often cited as one of the greatest achievements in human ingenuity. One theory suggests that indigenous populations domesticated maize from a wild, sexually compatible relative called teosinte. Another argues that it was a cross of teosinte with another wild relative of maize, either *Zea diploperennis* or *Zea luxurians*.

The development of hybrid corn at the beginning of the twentieth century was a watershed event for plant breeding. Employing the principles of the newly rediscovered Mendelian genetics, George Shull coined the term *heterosis* in 1914. Also known as hybrid vigor, heterosis happens when the cross of two inbred lines yields more than either of the individual parent lines. In 1917 Donald Jones discovered that a cross of two hybrids exhibited even more hybrid vigor.

While hybrid seed yielded significantly more, hybrid seed does not breed true, so farmers must return to the seed producer instead of saving seed, an age-old practice of farmers. As pointed out by Jack Kloppenburg, Jr., this hastened the process of seed commodification. Before the advent of hybrid seed, commercial enterprises in seed production were less profitable because once an initial sale was made, the farmer only had to save some seed from his crop to grow the next generation. But hybrid seed decoupled the grain from the seed and by the 1930s hybrid seed production was controlled by a handful of large seed companies including U.S. Secretary of Agriculture Henry Wallace's Pioneer Hi-bred. By 1965 95 percent of corn was grown with hybrid seed produced in the private sector. By this time public sector research in plant breeding was seen as redundant and unnecessary, and research was subordinated to private companies.

This had several unanticipated consequences. To effectively mechanize the harvest, maize ear should fall in approximately the same place on each stalk in a field. Plant breeders turned to making uniform plants that were suitable for mechanization. This led to a reduction in the genetic diversity of the plants being grown, making them susceptible to disease and pest outbreaks, often necessitating the application of pesticides. The significant quantities of agro-chemical fertilizers and pesticides applied to corn grown in the Midwest have been cited as part of the cause of a large dead zone off the Mississippi River Delta.

The massive increases in maize yields in the 20th century have turned the crop into the foundation of the industrial food system. Maize is used to produce citric acid, xanthum gum, lecithin, high fructose corn syrup, and many other foodstuffs that comprise the modern industrial food system. A significant portion of the corn grown in the United States is used as feed at the top of the cattle commodity chain. Another significant amount is used in ethanol production.

Maize domestication is often cited as one of the greatest achievements in human ingenuity.

Much of the maize grown today is grown through advances in genetic engineering, where it has been the subject of considerable controversy. The StarLink™ controversy happened when a genetically engineered variety of maize not approved for human consumption made its way into several brands of processed tortillas. Even though StarLink™ has not been grown since 2001, it is still found by inspectors of Japanese imports of corn. Corn engineered with the DNA segment that expresses endotoxins from the soil organism *Bacillus thuringiensis* (Bt) was at the center of the monarch butterfly controversy when it was asserted that milkweed dusted with Bt caused higher mortality rates when fed to monarch butterfly larvae.

Perhaps one of the most serious of the concerns about genetically engineered maize regards gene flow to wild relatives and landraces in Mexico, the center of crop-wild diversity. In 2001 a study by two Berkeley scientists found that transgenic traits were found in Mexican landraces grown by indigenous farmers despite a moratorium on genetically engineered maize in that country.

SEE ALSO: Crop Plants; Genetically Modified Organisms (GMOs); Genetic Diversity; Genetic Patents and Seeds; Genetics and Genetic Engineering; Landrace.

BIBLIOGRAPHY. Jack Kloppenburg, Jr., *First the Seed: A Political Economy of Plant Biotechnology 1492–2000* (Wisconsin, 2004); Arturo Warman, *Corn and Capitalism: How a Botanical Bastard Grew to Global Dominance* (University of North Carolina Press, 2006).

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Malaria

MALARIA IS THE most serious vectorborne disease in the world. At the end of 2004, approximately 3.2 billion people lived in areas at risk of malaria transmission in 107 countries and territories. Between 350 and 500 million clinical episodes of malaria occur every year. It is a leading cause of death in many developing countries, where young children and pregnant women are most vulnerable. Of the one million deaths every year worldwide due to malaria, about 60 percent of the cases and more than 80 percent of the deaths are in Africa.

Malaria is caused by protozoan parasites of the genus *Plasmodium*. Four species of *Plasmodium*, namely, *P. falciparum, P. vivax, P. ovale,* and *P. malaria,* can produce the disease in its various forms. Among the four species, *P. falciparum* is the most widespread and dangerous. Malaria parasites are transmitted from one person to another by the bite of the female mosquito of the genus *Anopheles*. The parasite develops in the gut of the mosquito and is passed on in the saliva of an infected insect each time it takes a new blood meal. The blood in the victim's liver carries the parasites. After incubating for nine to 16 days, the parasites penetrate red blood cells, multiply, and then progressively break down the cells. This induces bouts of fever and anemia in the infected individual. Generally, antimalarial drugs can cure the symptoms of malaria such as fever, shivering, aching joints, and headache. However, in certain regions, the parasites have developed resistance to some drugs.

Malaria has been known since ancient times, but it was centuries before the true causes were understood. Although people were unaware of the origin of malaria and the mode of transmission, protective measures against the mosquito were used for many hundreds of years. Systematic control of malaria started after the discovery of the mosquito parasite in 1889.

Malaria occurs mostly in tropical and subtropical areas of the world. In Africa, especially south of the Sahara, an estimated 90 percent of the deaths occur due to malaria. Though malaria is a less prominent cause of death in the rural areas of some countries in South America and Southeast Asia, it causes substantial disease and incapacitation and remains a health threat for people who live in these countries.

Factors affecting the occurrence of Malaria can be broadly divided into three main categories: Environmental, biological, and behavioral. First, warm temperature and abundant rainfall provide conducive conditions for the *Anopheles* mosquitoes to breed and survive long enough to complete their transmission cycle. Second, the distribution and abundance of various species of *Anopheles* in the region at a given time will influence the intensity of malaria transmission. Also, if these mosquitoes become resistant to the insecticide(s) used locally for spraying, transmission will increase. Third, human behavior, often dictated by social and economic reasons, can influence the risk of malaria for individuals and communities. For example, poor rural populations often cannot afford the housing and bed nets that would protect them from exposure to mosquitoes. They sometimes also lack the knowledge to recognize malaria and to treat it promptly and correctly. The absence of adequate health services frequently results in recourse to self-administration of drugs and incomplete treatment. Human activities can also create breeding sites for larvae, such as standing water in irrigation ditches and bur-

Dr. Carlos Juan Finlay

The Cuban scientist Carlos Juan Finlay made great strides in research into mosquito-borne diseases. He was born at Puerto Principe, Cuba, and was of French and Scottish descent. After attending Jefferson Medical College in Philadelphia, Pennsylvania, Finlay graduated in 1855 and continued his studies in Havana, Cuba, and then Paris, France. Returning to Havana, he opened a medical practice.

The 1860s saw much interest in yellow fever and other tropical diseases. Finlay wrote a paper for the Cuban Academy of Sciences in 1865 in which he correlated weather conditions with the prevalence of yellow fever. He continued working, and in 1881 was able to theorize that the mosquito was the vector for the transmission of the disease. He was later able to identify the organism causing yellow fever as the genus *Aedes*. His work also led to discoveries regarding the spread of malaria, which were later confirmed by the Walter Reed Commission.

When work began on the construction of the Panama Canal in 1903, many workers started suffering from malaria and yellow fever, with up to 10 percent of the workforce dying each year. The pioneering work by Finlay managed to massively reduce the incidence of the disease.

Finlay was chief health officer of Cuba from 1902 until 1909. He is commemorated with a giant syringe-like obelisk in the Cuban city of Marianao, and also with a postage stamp, which was issued in 1981 on the 100th anniversary of the publication of his theory of biological vectors.

row pits. Agricultural work such as harvesting (also influenced by climate) may force increased nighttime exposure to mosquito bites. War, migrations (voluntary or forced), and tourism may also expose nonimmune individuals to an environment with high malaria transmission.

Malaria has socioeconomic consequences for both individuals and government. Costs to individuals including preventive measures and drugs and treatment expenses, and costs to governments including maintenance of health facilities and lost days of work, add substantially to economic burdens and impede economic growth. It has been estimated that annual economic growth of countries with intensive malaria was 1.3 percent lower than that of countries without malaria.

SEE ALSO: Climate, Tropical; Disease; Mosquitoes; Quinine; Tropical Medicine; Tropics.

BIBLIOGRAPHY. B. Greenwood and T. Mutabingwa, "Malaria in 2002," *Nature* (v.415, 2002); J. Ito et al., "Transgenic Anopheline Mosquitoes Impaired in Transmission of a Malaria Parasite," *Nature* (v.417, 2002); Malaria Vaccine Initiative, www.malariavaccine.org (cited January 2007); J. Sachs and P. Malaney, "The Economic and Social Burden of Malaria," *Nature* (v.415, 2002); World Malaria Report, www.rollbackmalaria.org (cited December 2006).

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Malawi

FORMERLY THE BRITISH protectorate of Nyasaland, the Republic of Malawi won its independence in 1964, setting the stage for 30 years of one-party rule under President Hastings Kamuzu Banda. In 1994, Malawi held its first multiparty elections. The long colonial legacy in the region, which made Malawians the labor force for agricultural and mining economies in adjacent countries, has continued to prevent the country from making substantial economic progress, along with problems in governance and policy.

Malawi is one of the least developed countries in the world even though natural resources include limestone, hydropower, and deposits of uranium, coal, and bauxite. Barely 16 percent of the population is urbanized. More than 23 percent of land area is arable, and over 90 percent of the workforce are engaged in subsistence agriculture, generally in growing tobacco. Prolonged droughts such as the one that hit Malawi in 2005 and 2006 are capable of creating major food shortages.

With a per capita income of only $600, Malawi is the third poorest country in the entire world, outranked only by the newly formed East Timor and the politically turbulent Gaza Strip. Some 55 percent of Malawians live below the national poverty line, and a third of the population is seriously undernourished. Government revenues are heavily dependent on economic assistance from the World Bank and the International Monetary Fund. In 2000, Malawi was approved for the Heavily Indebted Poor Countries initiative.

Although landlocked, Malawi shares a 580 kilometer border along Lake Nyasa with neighboring Tanzania and Mozambique. Malawi also borders Zambia. Except for some rounded hills and mountains, the land area of Malawi is comprised of a narrow elongated plateau with rolling plains. Elevations range from 37 meters where the Shire River meets the international border with Mozambique to 3,002 meters at Sapitwa Mlanje. Malawi's subtropical climate has a distinct rainy season that lasts from November to May when the six-month dry season begins.

Environmental health issues are of major concern among Malawi's population of 13,013,926, in large part because of the HIV/AIDS epidemic. With a 14.2 percent adult prevalence rate, 84,000 people have died from HIV/AIDS since 2003. Another 900,000 are living with the disease. One-third of the population lacks sustained access to safe drinking water, and 54 percent lack access to improved sanitation. As a result, Malawians have a very high risk factor for contracting food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, typhoid fever, and the water contact disease schistosomiasis. In some areas, Malawians are also at very high risk for contracting vectorborne diseases such as malaria and plague.

Because of the high incidence of disease in Malawi, the country is experiencing lower than normal life expectancy (41.7 years) and growth rates (2.38 percent), and higher than normal infant mortality (94.37 deaths per 1,000 live births) and death rates (19.33 deaths per 1,000/population). Malawian women give birth to an average of six children each. The fact that less than half of all females over the age of 15 can read and write makes it difficult for the government to educate them about disease prevention. The United Nations Development Programme's Human Development Reports rank Malawi 165 of 232 countries on overall quality of life issues.

Other major environmental problems include deforestation, which is occurring at a rate of three percent annually, and land degradation. Water has been heavily polluted from the dumping of raw sewage, agricultural runoff, and industrial effluents. Water resources are being depleted, and increasing siltation of spawning grounds has created major obstacles for marine life. Because 60 to 70 percent of protein in the Malawian diet comes from fish, the 40 percent decrease in fish production has threatened food supplies and presented a health hazard.

The destruction of the forests is contributing to a significant loss of biodiversity, and habitats are increasingly being threatened. In 2006 scientists at Yale University ranked Malawi 91 of 132 countries on environmental performance, below the relevant geographic group and considerably below the relevant income group. The overall score was reduced because of the low score in environmental health.

The Constitution of 1995 acknowledges that the government has a responsibility for preventing degradation of the environment and for providing healthy living and working environments. In 1996 the government adopted the National Environmental Policy based on the National Environment Action Plan, focusing on bringing the public into partnership with the government to halt further environmental degradation. The National Council for the Environment was given the authority to mediate when necessary, and the Environmental Affairs Department was charged with coordination of all environmental policy. The government has focused a good deal of attention on reversing the damage to fisheries by protecting breeding grounds and placing restrictions on how fish are caught. With 27.2 percent of Malawi still forested, the government has also protected 11.2 percent of land area. Of 105 identified mammal species, eight are endangered, as are 11 of 210 bird species.

Malawi participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, and Wetlands. The Law of the Sea agreement has been signed but not ratified.

SEE ALSO: Biodiversity; Deforestation; Pollution, Water.

BIBLIOGRAPHY. Central Intelligence Agency, "Malawi," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); One World, "Malawi: Environment," uk.oneworld.net (cited April 2006); United Nations Development Programme, "Human Development Report: Malawi," hdr.undp.org (cited April 2006); University of Arizona, "Malawi Environmental Monitoring Programme," ag.arizona.edu/OALS (cited April 2006); World Bank, "Malawi," *Little Green Data Book*, lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Malaysia

MALAYSIA CONSISTS OF two regions divided by the South China Sea: Peninsular Malaysia, and east Malaysia (on the island of Borneo). Its total land area is about 329,750 square kilometers. The total population is about 25 million, of which 20 million live in Peninsular Malaysia. The population growth rate is 1.78 percent, with a birth rate of 22.86 births per 1,000 people. The capital city (and largest city, with 1.5 million people) is Kuala Lumpur. The prime minister's office relocated to Putrjaya in 1999, but the parliament still meets in Kuala Lumpur.

In 1948 the British-ruled territories on Peninsular Malaysia formed the Federation of Malaysia, which gained independence from the United Kingdom within the Commonwealth on August 31, 1957. In 1963 the Federation was expanded with the admission of the British colonies of Singapore, Sabah, and Sarawak, and was renamed Malaysia. Singapore left Malaysia in 1965. Malaysia is a constitutional monarchy: the nominal head of state is the king of Malaysia, who is selected for five-year terms from among the nine sultans of the Malay states (four states, Melaka, Penang, Sabah, and Sarawak, have governors appointed by the government, and do not participate in the selection). Malaysia has a bicameral parliament consisting of an elected lower house and a nonelected upper house. In 2003, Premier Mahathir bin Mohamad retired after 22 years as the prime minister in favor of his deputy, Abdullah Ahmad Badawi.

The official language is Malay. The population is classified ethnically as: Malay 50.4 percent, Chinese 23.7 percent, non-Malay indigenous (mostly in east Malaysia) 11 percent, Indian (mostly Tamil) 7.1 percent, and other, 7.8 percent. The Malay are by constitution Muslims, and Islamic law is applied to Muslims in matters of family law. Muslims are 60.4 percent of the population, Buddhists 19.2 percent, Christians 9.1 percent, and Hindus 6.3 percent.

The Malaysian climate is tropical, and characterized by annual southwest monsoons from May to September and northeast monsoons from November to February. Peninsular Malaysia is cut by a mountain range that separates the narrow eastern coast from the fertile western plains. The highest peaks are Gunong Tahan (2,190 meters) and Gunong Korbu (2,183 meters). East Malaysia is composed of alluvial and swampy coastal plains, and the hinterland of areas of rolling rain forests interspersed with mountain ranges. The highest peak is Gunung Kinabalu, at 4,095 meters above sea level.

From the early 1970s to the late 1990s Malaysia transformed itself from a producer of raw materials to a manufacturer and exporter of industrial goods, especially computers and consumer electronics. Because of its reliance on exports, the Asian economic crisis of 1997 hit Malaysia hard.

In the early 2000s the economy recovered, and in 2004 Gross Domestic Product (GDP) grew by seven percent, and in 2005 by five percent. In 2005 agriculture accounted for 7.2 percent of total GDP, industry 33.3 percent, and services 59.5 percent; 14.5 percent of the labor force works in agriculture, 36 percent in industry, and 49.5 percent in the service sectors. Strong growth beginning in the 1980s resulted in labor scarcity, which attracted an estimated two million migrant workers from Indonesia (half of them illegal).

Malaysia's main natural resources are tin, petroleum, copper, iron ore, natural gas, bauxite, and timber. It is the world's largest exporter of natural rubber and palm oil. The emphasis on logging and on rubber and palm oil has caused the destruction of most of the natural forests. Although an estimated 59 percent of Malaysia is forested, only an approximate 11.6 percent is primary forest.

SEE ALSO: Climate, Tropical; Rubber; Singapore.

BIBLIOGRAPHY. A.A. Doolittle, *Property & Politics in Sabah, Malaysia: Native Struggles Over Land Rights* (University of Washington Press, 2006); V.M. Hooker, *A Short History of Malaysia: Linking East and West* (Allen & Unwin, 2003); E.G. Terence, ed., *The State of Malaysia: Ethnicity, Equity, and Reform* (Routledge, 2004).

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Maldives

THE MALDIVES CONSISTS of a chain of atolls stretching 860 kilometers southward from Sri Lanka into the Indian Ocean. While the Maldives encompasses a total of 1,192 atolls raging in size from 0.5 to 5.16 square kilometers, only 199 are inhabited. Over time, this number is falling as smaller, less-populated atolls are abandoned by choice or through government policies to centralize populations. Most atolls are highly vulnerable to sea level rise and coastal erosion. Approximately 80 percent of atolls rise less than one meter above mean sea level, with the highest point of the country being only three meters above sea level. This also makes the country highly vulnerable to tidal surges and tsunamis. Significant damage to tourist resorts and inhabited atolls, as well as the loss of approximately 100 lives, resulted from the December 26, 2004, tsunami.

The Maldives, with a current population of 300,000, has undergone a significant economic transformation over the past twenty years. Despite high economic growth rates the economy remains dependent on a limited economic and employment

Cemetery Clearing

The Maldives faces a serious shortage of land as the population continues to increase. This has resulted in the clearing of many of the cemeteries on the main island, Male'. Until the 1970s there were cemeteries throughout Male', mostly attached to mosques, as the Maldives is mainly Muslim. British traveler T.W. Hockly bemoans the sheer number of them in his 1935 account of the country. One that has survived adjoins the Hukuru Miski mosque and is the tomb of Abu Al Barakat, a North African credited with converting the inhabitants of the island to Islam. Many others have not been so lucky. Most were cleared between 1974 and 1978, with some of the mosques also being demolished. Old tombstones have been retained at a few mosques, such as the Henveru Bandara Miskit and the Dolidan Miskit. A monument to the Arab traveler and writer Ibn Battuta at Henveiru Avaru has been lost, although another on Kuredu Island, Fadiffolu, is still maintained.

While most of the cemeteries in Male' have been cleared, more survive on remote islands. On the Addu Atoll, one of the southernmost of the Maldives and the site of a secret World War II British naval base, sixty-eight men from India who died there between 1942 and 1944 are either still buried on the island or were cremated. The monument honoring them is regarded as the most isolated memorial maintained by the British War Graves Commission.

base, which is dominated by fishing and tourism. Economic growth has resulted in higher incomes but also increasing environmental impact from rising levels of production and consumption.

The country's rich marine biological diversity faces threats from coral and sand mining (for use in construction), destructive fishing, waste disposal (few islands treat sewage or can bury solid waste), and intensive use of reefs in tourism (diving and snorkeling). Many atolls face long droughts as water lenses are exhausted, polluted, or made undrinkable by salinity. Pollution and waste management is becoming a challenge in the face of limited space. To date they have only been managed through the development of "new" islands, which act as the primary rubbish sites for both hazardous and nonhazardous waste.

Pollution, especially sewage, and solid waste management pose a considerable problem for the capital, Male'. Male' has one of the highest population densities of anywhere in the world, with approximately 100,000 people living on 1.7 square kilometers. Male' faces considerable problems of future population growth and limited capacity to sustainably deal with demand.

The Maldives remains one of the most vulnerable countries in the world in terms of sea level rise and changes to ocean temperatures, as well as the impact of pollution resulting from changing lifestyles and consumption patterns, and population growth (2 percent per year) and concentration. Though it has achieved considerable success in terms of economic development, the fragility of the country's ecosystem means that it will remain highly vulnerable to both externally driven change and threats arising from its own development patterns and demographic growth.

SEE ALSO: Pollution, Water; Sea Level Rise; Tsunamis.

BIBLIOGRAPHY. Republic of the Maldives, *State of the Environment: Maldives 2004* (Ministry of Environment and Construction, 2004). World Bank, "Maldives," *Little Green Data Book*, lnweb18.worldbank.org (cited April 2006).

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Mali

THE REPUBLIC OF Mali is completely landlocked and lies in the center of the West African landmass. This nation of 1,240,000 square kilometers is the largest in terms of surface area in West Africa. Mali's 10.7 million people comprise 10 ethnic groups of which the Mande groups (Bambara, Malinke, and Soninka) are the most numerous (50 percent). The country is composed of three major climatic zones: a vast desert region in the north, a Sahelian band through the middle of the country, and a Sudanian zone in the south.

About 65 percent of Mali's land area is considered desert or semi-desert. Average rainfall in the desert region ranges from 0 to 350 millimeters, in the Sahel region from 350 to 600 millimeters, and in the Sudanean region from 600 to 1,200 millimeters. Southern Mali (Sudanean region) has two distinct seasons: A rainy season from June to October and a dry season from November to May. The dry season is divided into a cold season (November–February) and a hot season (March–May). Dust-laden harmattan winds from the North often sweep across the country during the dry season.

After several years of above average rainfall in the 1950s and 1960s, Mali experienced severe droughts in the 1968–72 and 1984–85 periods. These droughts led to concerns in the scientific and donor communities that Mali was experiencing a broad pattern of desertification largely caused by human activities. Subsequent research has demonstrated that declining vegetative cover was driven more by cyclical downturns in rainfall than local management practices.

The French ruled Mali from 1916 to 1960 as part of the French Sudan. The French were never very numerous in the country and practiced a highly-centralized and direct form of rule. Mali gained independence in 1960 as part of the Mali Federation with Senegal. Senegal left this federation after only a few months.

While French is the administrative language, Bamanan is the most widely spoken language (particularly in the south), followed by Fulani. Approximately 80 percent of the population understands Bamanan. Islam is the predominant religious practice (90 percent) and has been noticeably influenced by

Timbuktu's Crumbling Buildings

The fabled city of Timbuktu on the southern edge of the Sahara Desert has long been a byword for an exotic, inaccessible, and distant place. It was established by the nomadic Tuareg peoples in the 10th century and was a major city through several empires. In 1591 it was captured by Moroccans. The arrival of the Portuguese on the west coast of Africa changed the nature of trade and gradually eroding the land trade routes, which had operated for hundreds of years.

The account of the city by Leo Africanus, a Spanish Moor, awed many in Western Europe in 1494. An African-American sailor who went by the name of Robert Adams also wrote an account of his time in Timbuktu in 1816. Other visitors included Gordon Laing, a Scot, who was killed on his return journey; René Caillié, a Frenchman who reached the city in 1828; and a German, Heinrich Barth. All their stories emphasized the isolation of a city so remote from anywhere else.

Today Timbuktu is visited by increasing numbers of tourists, who fly in from Mali's capital, Bamako, or come overland via land rovers. The house where Laing stayed is one of the sights, although it is now in such a state of disrepair that visitors are not allowed inside. In the same street is the house Caillié stayed in during his time in the city. The current population is 15,000, down from an imperial high of 100,000. Camel caravans crossing the Sahara still stop in Timbuktu to offer salt and other goods.

now waning animist traditions. One legacy of French colonialism was a militaristic forest service that aggressively established tree plantations and repressed bush fires in the 1980s. This led to popular resentment and the near dissolution of the forestry service following a transition to democracy in the early 1990s.

Mali is ranked among the poorest countries in the world. This poverty, combined with concerns about environmental degradation, led many analysts to assert that Mali was trapped in a vicious downward cycle of poverty-induced environmental degradation. Subsequent research has questioned such causality. Mali's economy is largely natural resource–based with 80 percent of the labor force involved in agriculture.

Mali was sub-Saharan Africa's leading cotton exporter in 1998–99 at 560 million tons, with the crop accounting for half of the country's foreign exchange earning and nearly half of government revenues in recent years. Some analysts have raised concerns about the sustainability of cotton production in Mali. Such concerns receive limited governmental attention due to the importance of cotton exports to the national economy. Other major exports include cattle and gold.

SEE ALSO: Cotton; Desertification; Land Degradation.

BIBLIOGRAPHY. S.M. Herrmann, A. Anyamba, and C.J. Tucker, "Recent Trends in Vegetation Dynamics in the African Sahel and Their Relationship to Climate," *Global Environmental Change* (v.15, 2005); J. Keeley and I. Scoones, *Understanding Environmental Policy Processes: Cases from Africa* (Earthscan, 2003); W.G. Moseley, "Global Cotton and Local Environmental Management: The Political Ecology of Rich and Poor Small-Hold Farmers in Southern Mali," *Geographical Journal* (v.171, 2005); J. Swift, "Desertification: Narratives, Winners and Losers," in M. Leach and R. Mearns, eds., *The Lie of the Land* (Oxford, 1996).

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Malnutrition

MOST FREQUENTLY, MALNUTRITION speaks to an inadequate diet. Two major types of malnutrition are protein-energy malnutrition and micronutrient malnutrition. Malnutrition is especially prevalent in developing countries, particularly in sub-Saharan Africa and southern Asia. In the developing world, one in three children under the age of five is malnourished. While young children are particularly susceptible, pregnant women are also at higher risk for the implications of malnourishment. Other than the forms of protein-energy malnourishment, the primary manifestations in developing nations include iron, iodine, vitamin A, and zinc deficiencies. Malnourishment is estimated to be directly responsible for 300,000 deaths annually and indirectly responsible for about half of all deaths among young children.

Protein-energy deficient malnutrition is of particular concern as it can lead to starvation. In 2000–02 it was estimated that worldwide 852 million people were undernourished, the majority of whom (95 percent) were in developing countries. In some parts of the developing world outside aid and efforts to encourage breast feeding have helped to decrease malnourishment; however, the numbers of undernourished worldwide remain relatively stable.

Protein-energy malnutrition often manifests at an early age, between six months and two years of age, and can affect a child's development. With an insufficient supply of protein, chronic infections such as diarrhea may occur and lead to further malnourishment. The problems of malnourishment and infection-induced diarrhea can result in a persistent cyclic pattern that can lead to further medical problems, and potentially to starvation and death.

Micronutrient malnutrition affects at least two billion people worldwide. Today, approximately 740 million people experience iodine deficiencies. Much of this occurs in underdeveloped nations where seafood or iodine-fortified salt is less available. Iodine-fortified salt has been the primary reason that much of the developed world no longer faces iodine deficiencies. About two billion people worldwide are zinc deficient, one billion experience iron deficiency—which is highly correlated with anemia—and approximately 250 million, primarily children and pregnant women in developing nations, are vitamin A deficient.

The underlying cause of malnourishment is poverty, but several factors play a role in the experience and likelihood of malnourishment. One factor found to be elemental in malnourishment in the developing world is the role of women. In many societies women play an active role in food collection, preparation, and administration, which is especially important in the care of young children. The higher women's educational attainment levels and status are relative to men, the less likely malnourishment will be found among children.

National food security, or the availability of an adequate food supply, is also a primary factor in the existence of undernourishment in a society. In countries with low levels of food security, such as the nations of sub-Saharan Africa and South Asia, improving the food supply is found to be as important as improving women's education and roles when seeking to alleviate malnourishment. In societies with relatively high levels of food security, however, such as many countries in East Asia, the Near East, North Africa, Latin America, and the Caribbean, the availability of food is less impactful than improving the role of women. Environmental factors, such as water sanitization, pollution, and agricultural capability, are also prime factors in the likelihood of malnourishment. The availability of potable water is especially important as water that is not sanitized can harbor pathogens that can lead to infection and illness, thus bolstering the impact of malnourishment.

SEE ALSO: Agriculture; Food; Gender; Poverty.

BIBLIOGRAPHY. Olaf Müller and Michael Krawinkel, "Malnutrition and Health in Developing Countries," *Canadian Medical Association Journal* (v.173, 2005); Lisa C. Smith and Lawrence Haddad, *Explaining Child Malnutrition in Developing Countries: A Cross-Country Analysis* (International Food Policy Research Institute, 2000); E.M. Young, "Globalization and Food Security: Novel Questions in a Novel Context?" *Progress in Development Studies* (v.4, 2004).

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Malthus, Thomas Robert (1766–1834)

THE POLITICAL ECONOMIST Thomas Robert Malthus was born on February 13, 1766, at Wotton, Surrey, England. He was known as Robert Malthus. Taught by radical thinkers, including his father, and at the famous dissenting academy at Warrington, near Liverpool, Malthus then entered Jesus College, Cambridge (1784–88), where he studied under the radical William Frend. Malthus graduated with a B.A. degree and as ninth wrangler (ninth-best mathematician in the university) in 1788. He earned his M.A. degree in 1791 and became a fellow of his college (1793–1804). After being ordained in the Church of England (deacon 1789, priest 1791), he held various curacies and livings and was a conscientious and pious priest. In 1804, Malthus married Harriet Eckersall (1776–1864); they had three children. In 1805 he was appointed professor at the East India Company's College at Haileybury, Hertfordshire, where he taught and lived for the rest of his life and was a well-liked teacher.

In 1798 Malthus anonymously published his *An Essay on the Principle of Population*. He argued that population can increase in a "geometric ratio" (1, 2, 4, 8, 16, and so on), but the food supply can increase at most only in an "arithmetic ratio" (1, 2, 3, 4, 5, and so on). Population is kept in balance with the food supply by "checks," which he characterized as "vice" or "misery," and which included war, famine, plague, delayed marriages, and prostitution. He also characterized the checks as either "positive" (those that increase the death rate) or "preventive" (those that reduce the birth rate).

A second edition of the *Essay* (1803) added much empirical evidence of the population checks at work in various countries and periods. He identified moral restraint (delayed marriage preceded by sexual abstinence) as the most desirable check on population and argued that its operation would tend to increase individual happiness. The edition was thus more optimistic than the first, which had stressed misery and vice. His main idea (that unchecked population tends to outrun the food supply) became known as "the principle of population" and became a central tenet of classical political economy. Although Malthus declared that he had deduced the idea from the works of other political economists, it became firmly attached to his name.

The *Essay*'s argument was highly controversial from the start and Malthus used editions of 1806, 1807, 1817, and 1826 to refute erroneous claims that he had argued in favor of war and immoral practices but also to reiterate his denial that the poor have a right to be supported. He argued that support for the poor funded by taxation tended to increase the price of food, undermine people's independence, and encourage imprudent marriages, thus creating rather than mitigating poverty. Malthus advocated the abolition of poor relief.

Malthus's critics included Karl Marx, who was particularly incensed at his attitude to the poor. His admirers included Charles Darwin, who acknowledged his influence in the development of his theory of natural selection, and J.M. Keynes, who admired his *Principles of Political Economy* (1820), which argued for the importance of distribution and effective demand as causes of economic growth. Malthus wrote on other aspects of political economy, notably on the classical theory of rent (1815). His work brought election to several learned societies and he helped to found new ones to promote the new sciences of political economy and statistics. Malthus died on December 29, 1834, at Bath.

After his death Malthus's name was associated with movements advocating mass contraception as a way of warding off rapidly increasing population, and zero population growth. In fact he rejected both of these approaches. He opposed contraception, partly on moral grounds and partly because he believed that its use would remove the desirable stimulus to work to provide for one's children. He thought population growth desirable, provided that it did not exceed the growth of the food supply.

SEE ALSO: Carrying Capacity; Darwin, Charles; Malthusianism; Marx, Karl; Political Economy; Population; Poverty; Tragedy of the Commons; Zero Population Growth.

BIBLIOGRAPHY. Patricia James, *Population Malthus* (Routledge and Kegan Paul, 1979); John Maynard Keynes, "Robert Malthus: The First of the Cambridge Economists," *Essays in Biography* (Macmillan, 1933); Ronald L. Meek, ed., *Marx and Engels on Malthus* (Lawrence and Wishart, 1953); John M. Pullen, "(Thomas) Robert Malthus," in H.C.G. Matthew and Brian Harrison, eds., *Oxford Dictionary of National Biography* (Oxford University Press, 2004).

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Malthusianism

IT WAS, AS various writers have noted since, a "tract for the times"—a pamphlet published anonymously in 1798 by a young and unknown pastor, challenging the Enlightenment giants and taking a harsh stand on welfare policy in Britain. Its central point was that the prime driver of societal ill is population's tendency to outgrow food production. Its strengths, as its later adherents saw it, were unflinching honesty and scientific legwork; the result, as economist Alfred Marshall later put it, was "one of the most crushing answers that patient and hard-working science has ever given to the reckless assertions of its adversaries." By its second edition it was no longer anonymous: the name Thomas Robert Malthus was attached to the work, and this name has ever since been attached to its central point.

The pamphlet, *An Essay on the Principle of Population*, countered Godwin's and Condorcet's idealistic views on the perfectibility of social institutions, pointing instead to "fixed laws of our nature," specifically that "Population, when unchecked, increases in a geometrical ratio...subsistence increases only in an arithmetical ratio." These "fixed laws" comprised two claims, one agricultural and one demographic. For the demographic claim, Malthus did marshal some empirical support (including data from colonial America), but he mainly supported his case by appeal to the facts of human nature: Godwin may have predicted the triumph of mind over body, but Malthus countered that overpopulation resulting from "passion between the sexes" could only be checked by misery, vice, and death. The agricultural claim was seen more as a given, since he was writing when there was little inkling of how food production could be boosted except by putting more land under, or more men behind, the plow.

The centuries since Malthus's time have brought profound changes not only to human demography and food output, but to the scientific fields devoted to their study. These developments have been unkind to Malthus's basic postulates. On the population side, various effects of social institutions, government policies, education, and economic development have repeatedly overridden the constant effect of "passion"—baby booms and baby busts have come and gone, and total fertility rates have plummeted worldwide (including throughout most of the developing world since the 1960s).

On the agricultural front, it was soon after Malthus died that external-input agriculture began, first with the advent of global trade in nitrogen fertilizer, then by revolutions in mechanization, breeding, pesticides, and information technology. Malthus knew nothing of the common process of agricultural intensification, whereby output is increased by added labor and skill rather than acreage. Overall agricultural production has been outstripping population growth ever since 1798, and is expected to keep doing so for as far out as the Food and Agriculture Organization of the United Nations (FAO) makes predictions. The fact that famine continues to haunt humanity underscores the deep problem in malthusian causality. In recent years, a Nobel Prize has been awarded for an economic historian's work on the nondemographic underpinnings of famine, and overflowing grain stocks have been reported in the country with the world's largest population of undernourished.

Yet Malthus's "tract for the times" has proven to be one of the most timeless documents in Western intellectual history, contributing inspiration for—and adding shape to—a long and varied history of theories, schools of thought, movements, and policies. Much of this persistent power of malthusianism is due to its malleability, and the fact that its basic tenets and implications can be adjusted to changing agendas. (Some writers write instead of Neomalthusianism, but the distinction serves little purpose since Malthus himself tinkered with his basic arguments so much that he would have to be classified as a neomalthusian himself.)

Given the failures of malthusianism to fit the history of fertility and food production, or the dynamics of food shortage, why it has had such a long history of influence is an interesting question. The main answers are political and social, and anthropologist Eric Ross has provided a history of the political and social uses of malthusianism, beginning with its original use to explain and justify the burgeoning slums and short life spans of the Industrial Revolution workforce. In the mid-19th century, malthusianism was used as a justification of ruthless colonial policies. For instance, the Irish potato famine was held up as confirmation of malthusian doctrine, despite the fact that Ireland exported large amounts of meat to England throughout the crisis. Nineteenth century famines in the British colony of India, caused in large part by the forced replacement of food production by commodity production, were likewise attributed to Indian overpopulation—as was the need for high taxes on Indian colonial subjects.

In the first decades of the 20th century, malthusianism provided support for anti-immigrant societies and policies in the United States. Academic books stressed the dangers posed by the reproductive urges of "inferior races" such as Jews and Irish.

Malthusianism shaped cold war thinking in the United States, attributing the spread of Communism to high population densities. These fears were particularly focused on India, where peasant movements in the post-war years were taken as warnings that India might go the way of China. Through the PL-480 program, the United States transferred enormous amounts of grain to India well into the 1960s to check the spread of Communism (and to absorb U.S. grain surpluses). The Indian state therefore invested in industry and allowed the agricultural sector to stagnate, reinforcing the dependence on grain imports and perception of malthusian overpopulation. Therefore, the Green Revolution is often credited with averting a malthusian catastrophe.

Beginning in the mid-1990s, malthusianism helped fill the void in post–cold war thinking, with academic writers and journalists stressing environmental security as the new driver of third world conflict. This surge of malthusianism took local population/resource imbalance as the principal driver in what were presented as gathering crises. Robert Kaplan's lurid essay, "The Coming Anarchy," popularized this perspective in public and policy circles (although detailed case studies by geographers and anthropologists showed that such conflicts were consistently driven by other—nondemographic and nonlocal—factors).

Most recently, malthusianism has been used to great effect in the promotion of genetically modified crops. This began in the late 1990s, largely in response to European rejection of genetically modified foods. Biotechnology media began to raise alarms about population growth and impending food shortages in developing countries, FAO projections notwithstanding. This latest use of malthusianism furthers interests corporations (who stand to make or lose billions), states (who compete for niches in global trade), and universities (whose biology departments have moved rapidly into genetic modification).

SEE ALSO: Lifeboat Ethics; Malthus, Thomas Robert; Overpopulation; Population.

BIBLIOGRAPHY. John Bongaarts and Susan C. Watkins, "Social Interactions and Contemporary Fertility Transitions," *Population and Development Review* (v.22, 1996); Robert D. Kaplan, "The Coming Anarchy," *The Atlantic Monthly* (February 1994); Robert Netting, *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture* (Stanford University Press, 1993); Nancy L. Peluso and Michael Watts, eds., *Violent Environments* (Cornell University Press, 2001); John H. Perkins, *Geopolitics and The Green Revolution: Wheat, Genes, and the Cold War* (Oxford University Press, 1997); Amartya Sen, *Poverty and Famines: An Essay on Entitlement and Deprivation* (Oxford University Press, 1981); Lothrop Stoddard, *The Rising Tide of Color Against White World-Supremacy* (Charles Scribners Sons, 1920); Glenn Davis Stone, "Both Sides Now: Fallacies in the Genetic-Modification Wars, Implications for Developing Countries, and Anthropological Perspectives," *Current Anthropology* (v.43, 2002).

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ENVIRONMENTAL MANAGEMENT IS at once broader than resource management, yet emerged in part from it, as well as from new and emerging approaches in the 1960s and 1970s that drew on systems, ecosystems, and public interest and participation ideas. These ideas were themselves catalyzed by the social and environmental movements of the times. Key concerns of these movements included women's and civil rights issues on the social side, and endangered species and protected areas, pesticides, toxic wastes, and Great Lakes water quality issues on the environmental side. Numerous scientists, including Rachel Carson, Barry Commoner, Ray Dasmann, Rene Dubos, Paul and Anne Ehrlich, Aldo Leopold, Fairfield Osborn, E.F. Schumacher, Paul Sears, and Barbara Ward wrote at the time, or even earlier, about the need for more integrated, careful, and protective approaches to the state of the environment we live in. Such an approach would go beyond the older resource- and development-focused emphases of the earlier postwar period. The goals of environmental management are typically broader than those of resource management. They were initially defined in terms of air and water quality, reduced negative effects of development projects, improved human quality of life, and protecting endangered species. Environmental management goals now also include newer ideas such as biodiversity conservation, maintaining ecosystem services, enhancing human well-being and sustainable livelihoods, ecosystem health and integrity, or overall sustainability.

New environmental management goals take into account biodiversity conservation as well as human well-being.

Growing awareness of the interconnectedness of human systems and ecological systems, and the potential human health and economic effects of pollution, deforestation, wetland loss, or flooding provided a strong push for more comprehensive and systematic planning and regulatory approaches to reducing environmental effects of human activities. This knowledge had numerous roots but certainly included the spread of systems and ecosystem ideas that could be traced back to the 1930s and 1940s; more recent studies of eutrophication in the North American Great Lakes and elsewhere; the wide ranging results of the 1960s International Biological Program (IBP) and the 1970s Man and the Biosphere program (MAB) of UNESCO, as well as the extensive research and management experience in integrated watershed management and multiple use forestry in Canada and the United States in the preceding decades.

Rapid growth in urban and industrial development, intensification of agriculture, and recreation and travel in the postwar period led to particularly intense pressures on parks and other protected areas, forests, water resources, coasts, and agricultural land. Environmental management is a new, more integrated, comprehensive, and participatory approach to the complexity of managing and planning such deeply interconnected human-environment systems. In this context environmental management tries to apply multiple disciplines to environmental challenges, through inter- and trans-disciplinary approaches.

Environmental management has always had a strong base in natural and ecological sciences, as well as ever growing links to social science: initially in terms of participation, and social and economic effects of human activity, in recent years more and more in terms of considering issues of equity, power, and communication as considered in political ecology and ecological modernization theory. In this context, environmental philosophy, through movements such as deep ecology, ecofeminism and environmental justice, pushes environmental management to consider deeper issues of inter- and intra-generational equity, and the long-term merit, or sustainability, of anthropocentric versus ecocentric approaches. There is also a long-running discussion over whether we can, let alone should, manage ecosystems or environmental systems, or only human activities and interactions with them.

The first formal manifestations of modern environmental management are usually seen to be the establishment of national environmental protection legislation, environment agencies, environmental impact assessment requirements, and water management agreements and agencies. The United States established the federal Environmental Protection Agency (EPA) and National Environmental Policy Act (NEPA) in 1970, followed by Clean Air and Coastal Zone Management Acts in 1972. These strengthened numerous requirements, improved coordination, monitoring, and integration, and introduced Environmental Impact Assessment (EIA) requirements. There had been air and water pollution regulation and agencies for a couple of decades before that, and the Clean Air Act (1963) and Endangered Species Act (1966) also came earlier.

Many other countries followed suit with similar agencies, policies, and requirements in the ensuing decade. Canada, for example, created the federal Department of the Environment in 1971 and the Federal Environmental Assessment and Review Process in 1973. Subnational, provincial, and state governments also started taking similar steps during the 1970s. The Great Lakes Water Quality Agreement between Canada and the United States was signed in 1972, then substantially revised in 1978, and did much to promote integrated ecosystem approaches to environmental quality, and large-scale planning, monitoring, and restoration as components of environmental management.

All of these approaches have been further developed since the 1970s. Ecosystem approaches have helped foster ecosystem-based management, emphasizing integrated, transdisciplinary collaborative approaches to planning and management of multiply-defined spatial units such as watersheds, bioregions, or greater ecosystems. EIA has been very strongly developed, first to better include social and ecological, as well as environmental and economic, effects; then to be more participatory and equitable; and more recently to address cumulative effects and strategic assessments.

EIA is also increasingly developing links to land use planning and sustainability initiatives and will only become more important in environmental management in future. Environmental monitoring has been a component of environmental management, and especially EIA, since the start, although it is often more talked about than done. Its profile is rising, although government funding cuts in the 1990s certainly reduced activity. Monitoring is currently supported by strong national, multistakeholder networks in both Canada and the United States, and growing legislative requirements in a range of sectors.

ENVIRONMENTAL PLANNING

Environmental management has been extended to, or has influenced several related areas. Environmental planning focuses on environmental management and protection through land use planning at scales from the local or municipal to regional and larger. It builds on Ian McHarg's work in the 1960s to use mapping approaches and ecological, social, and economic information to identify the best configuration of natural and human land uses in a region to minimize negative environmental and human effects. Today environmental planning applies from urban core densification through urban fringe subdivisions to very large, resource-based wilderness regions.

ADAPTIVE MANAGEMENT

Adaptive environmental assessment and management (AEAM) was developed in the 1970s from the conjunction of ecosystem science, systems and complexity ideas, and simulation modeling as a way to address uncertainty and complexity in the management of large, complex environmental problems. Now known as adaptive management, it emphasizes viewing management as an experiment to foster ongoing learning about ecosystems and management, drawing on multidisciplinary, scientific knowledge. The goal is to recognize uncertainty in decision making and management, but to ensure uncertainty does not prevent necessary action and additional learning.

SUSTAINABLE DEVELOPMENT

Although sustainable development ideas go back to at least the United Nations (UN) Conference on the Human Environment in Stockholm in 1972, they did not become widely influential until the 1987 release of the report of the World Commission on Environment and Development, "Our Common Future." Since then sustainable development has become a key goal for a very wide range of environmental and economic management and planning activities. While there are challenges in defining just what the concept means in a very wide range of contexts, and without watering it down until it is meaningless; the notion has nonetheless been highly influential and likely successful at underscoring the multiple dimensions of sustainability and the change needed to achieve it. Arguably parts (but only parts), of the private sector have most thoroughly adopted and implemented the idea, through Environmental Management Systems (e.g., ISO 14001) and product certifications (e.g., from the Forest Stewardship Council) and broader movements such as the Natural Step, triple bottom line, and corporate responsibility.

RECENT CHALLENGES

While early approaches to environmental management were often strongly regulatory, and led by national or provincial/state government, the 1990s saw major shifts away from this. These have been a reflection of reduced government budgets, reduced priority on the environment, and, arguably, public pressure to reduce taxes and government spending. This trend has been widespread globally, and of course tied to neoconservative political and economic perspectives. In practice it has resulted in federal passing of responsibilities to provinces/states and passing of responsibilities from provinces/states to municipalities. It has also led to greatly reduced staff levels in many government environmental agencies and reduced enforcement and monitoring activities.

It has often been argued that lower tier governments have little of the expertise, personnel, or funds to properly fulfill their new responsibilities. Environmental and human health disasters in a number of places have lead to inquiries, such as Justice O'Connor's investigation into the Walkerton tragedy in Ontario, Canada, which have catalyzed some retreat from these policies. In addition, public opinion seems to have been increasingly returning to environmental issues in the early 21st century and there are signs of a reversal of declining government interest.

Allied issues resulted from efforts to weaken long-standing environmental regulations and policies, e.g., in the United States, in some cases through free trade agreements and in other cases through changes to air, water, protected areas, and endangered species protection. Simultaneously there has been growing interest in market- and incentive-based mechanisms for environmental protection. Such approaches include industry self-regulation, emissions trading, and carbon taxes. While some have certainly been successfully implemented, others remain controversial. A decreased federal presence and devolution of responsibilities can also lead to less standardization of environmental requirements. Different countries, or jurisdictions within a country, may compete to attract industry via lower environmental standards. This frequently has negative environmental and social consequences at both local and global scales.

More positively, since the 1970s a wide range of international environmental agreements have been negotiated (and there are a few, such as the Canada/U.S. Migratory Bird treaty of 1916 that are much older). Some agreements are binational, but many are multinational. These commit national governments that have signed and ratified the conventions to implement particular policies and actions via domestic legislation and action. A few of the more significant are the 1973 Convention on International Trade in Endangered Species (CITES), the International Convention for the Prevention of Pollution from Ships (MARPOL), the 1972 World Heritage Convention, the 1985 Vienna Ozone Convention and 1988 Montreal Protocol, and the 1992 UN Framework Convention on Climate Change and its 1997 Kyoto Protocol.

Environmental management is still developing, through EIA and land use planning in practice, through sustainability, well-being, and related concepts to guide it, and through numerous other initiatives. Interest in environmental stresses and ecosystem responses in the 1970s led to state of the environment reporting and ecosystem health approaches. Environmental and ecological economists have built on these ideas to propose national environmental accounting systems and new measures of progress that go beyond the old throughput or consumption-oriented measures like Gross National Product (GNP). Such initiatives, together with environmental monitoring, are critical for better tracking and evaluating environmental management progress and failures.

Further supporting monitoring, assessment, and evaluation are the benefits of information and observation technologies. Technology has long assisted in resource management and surveying, but now its reach is being extended. Remote sensing and geographical information systems are a great boon to data collection and organization. Communication technologies can facilitate multidisciplinary teams in environmental management and organizing around environmental (and other) issues. Still, technology is no substitute for first-hand field observation or consultation. Combining new technologies with new collaborative and community approaches to resource and environmental management may be key to truly achieving long-term sustainability.

SOCIAL DIMENSIONS

As with resources management, there has been increasing interest in social dimensions of environmental management since the 1980s, and before. This includes the role of participation and communities, and different, often disadvantaged, groups within society.

This implies attention to equity, and gender and discrimination, and the broader issues of power relationships within environmental management. It is also extending, as Western societies become ever more culturally diverse through immigration, to seeking to understand different cultural perspectives on environment. There are political and practical implications to different cultures' perspectives on, for example, environmental health, wildlife conservation, and protected areas. Such perspectives are often different from historical Canadian, American or European perspectives.

There are numerous other challenges for environmental management. One is developing conflict resolution approaches to foster better, more efficient, and more effective solutions to environmental assessment and land use planning conflicts than are often produced by legal or quasi-legal hearings or proceedings in these areas. Facility siting, and "Not In My Backyard" (NIMBY) responses remain a challenge. Better collaboration, communication, and conflict resolution may be part of the answer, along with efforts to reduce the need for new, undesirable facilities.

Great challenges revolve around continuing processes of environmental and landscape change due to land use and resource development and consumption. These may require deeper lifestyle changes than traditional environmental management is usually seen as encompassing. The particular challenges of climate change and water resources management, for example, underscore the need for international cooperation on many issues, and arguably for new mechanisms and institutions of global environmental governance.

SEE ALSO: Land Use Policy and Planning; NIMBY; Resources.

BIBLIOGRAPHY C.J. Barrow, *Environmental Management: Principles and Practice* (Routledge, 1999); *Business and Sustainable Development: A Global Guide*, www.bsdglobal.com (cited December 2006); L.K. Caldwell, ed., *Perspectives on Ecosystem Management for the Great Lakes: A Reader* (State University of New York Press, 1988); A.W. Ewert, D.C. Baker, and G.C. Bissix, *Integrated Resource and Environmental Management: The Human Dimension* (CABI Publishing, 2004); R.B. Gibson et al., *Sustainability Assessment: Criteria and Processes* (Earthscan, 2005); Alan Gilpin, *Environmental Impact Assessment: Cutting Edge for the Twenty-First Century* (Cambridge University Press, 2006); Kevin Hanna and Scott Slocombe, eds., *Integrated Resource and Environmental Management: Concepts and Practice* (Oxford University Press, 2007); Tomas M. Koontz et al., *Collaborative Environmental Management: What Roles for Government?* (Resources for the Future, 2004); *Land and Resource Management Plans* (LRMPs) ilmbwww.gov.bc.ca (cited December 2006); Ian L. McHarg, *Design with Nature* (Doubleday/Natural History Press, 1969); Bruce Mitchell, *Resource and Environmental Management*, 2nd ed. (Addison Wesley Longman, 2002); Forster Ndubisi, *Ecological Planning: A Historical and Comparative Synthesis* (Johns Hopkins University Press, 2002); John Randolph, *Environmental Land Use Planning and Management* (Island Press, 2004).

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Man and the Biosphere Program (UNESCO)

THE MAN AND the Biosphere Program (MAB) is a network of biosphere reserves that are nominated by national governments and designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). It was established in 1971, with the first reserves coming into the World Network of Biosphere Reserves in 1976. The World Network of Biosphere Reserves is the only intergovernmental network whose objectives lie in meeting sustainable development, conservation, and scientific cooperation. The delay in official designation was due to the need for the MAB Coordinating Council to define the procedures of designating biosphere reserves, as well as deciding what the overall objectives and characteristics of the program were.

This scheme was initiated by UNESCO as a follow-up program to the International Biological Program. Unlike its predecessor, the Man and the Biosphere Program was intended to unite the biological information resulting from the International Biological Program and other complementary sources with social science and policy analyses. The purpose of this was to make the resulting knowledge of practical use to policy makers at various levels from municipal to international. In practice, it has taken time to incorporate social science into the framework.

Many nations nominated areas to be biosphere reserves from the outset, often choosing preexisting national parks or other types of protected areas. A significant number of reserves in some nations were recognized in that first round of nominations. For example, the United States received recognition for 27 of the 47 Man and the Biosphere Reserves. Today there are 507 Man and the Biosphere Reserves in 102 countries.

Fourteen program areas were originally designated in order to promote policy-orientated research, synthesis, and comparison. These included studying specific biomes and ecosystems, such as tropical forests, arid lands, and high latitudes. There were also cross-cutting themes such as perception of environmental quality and grazing lands. Most significant was the theme "Conservation for Natural Areas and the Genetic Materials Contained Therein," from which the term *biosphere reserve* itself originated.

Nations nominate areas to be designated as a Man and the Biosphere Reserve. This is done through MAB National Committees, whose designation, organization, and composition varies depending on the individual country. UNESCO reviews nominations and provides the designation as a biosphere reserve. It also facilitates the World Network of Biosphere Reserves. UNESCO provides expertise and occasionally funding to design and implement projects concerning biosphere reserves. In general, though, individual biosphere reserves within the program are expected to find principal funding from sources other than UNESCO, whether they be municipal, national, private, or from business.

The prestige of being designated as a Man and the Biosphere Reserve in developing areas is particularly significant in terms of tourism marketing. National and international tourists have been documented to travel to areas primarily on the basis of the designation. Other draws are often the perception of an ecotouristic experience. UNESCO's management of the system has, however, come under criticism for not revoking the designation in cases where human rights infringements are alleged. Such was the case for the Danube Delta Man and the Biosphere Reserve. This is a transnational biosphere reserve shared by the Ukraine and Romania. The Romanian government sold off the fishing rights to large sections of the Danube Delta to private owners, whose rights supersede those of local people. The claims of local people to traditional fishing grounds and seasonal habitations within the Danube Delta are under question, with the continuity of both extending into prehistory. The case has been protested by activists and academics.

In fact the Statutory Framework of the Man and the Biosphere Program does make provision for periodic review of sites every 10 years. Yet the reports are composed by the managing authority and forwarded to UNESCO, thus leaving open the possibility of a biased submission. One other shortcoming, or challenge, is sharing information between sites when each one evolves individually in terms of management and data collection. Yet, despite these challenges, the Man and the Biosphere Program is seen on the whole to be a very worthwhile and positive endeavor.

SEE ALSO: Arid Lands; Biosphere; Ecosystem; National Parks; Tropical Forests; UNESCO.

BIBLIOGRAPHY. Michel Batisse, "Developing and Focusing the Biosphere Reserve Concept" *Environmental Conservation* (v.9/2, 1986); J. Sanford Rikoon and Theresa Goedeke, *Anti-Environmentalism and Citizen Opposition to the Ozark Man and the Biosphere Reserve* (Edwin Mellon Press, 2000); The Seville Strategy, www.unesco.org/mab/doc/Strategy.pdf (December 2006); United Kingdom Man and the Biosphere, www.defra.gov.uk/wildlifecountryside/ukmab (cited December 2006); UNESCO Man and the Biosphere, www.unesco.org/mab (cited December 2006).

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Manioc

MANIOC, OR CASSAVA yucca, is a tropical root vegetable originally from Brazil that was used for thousands of years by natives in Latin America. European explorers first came across it in the Amazon region in the mid-16th century. Many archaeologists agree that manioc was an important crop in the tropical forest of the Amazon region. Today, the starchy roots of cassava form the staple diet of over 500 million people in dozens of developing countries on four continents.

There are two main types of manioc. Bitter manioc, which can become a staple food after heating, drying, and leaching, is toxic in its natural form because it contains cyanide. Sweet manioc has a lower concentration of toxic elements. According to ethnobotanist Serena Heckler, because of its toxicity, women who succeed in manioc cultivation gain social prestige. Manioc's many uses include flour, bread, tapioca, a sauce called "tucupi," and countless dishes in various cultures and traditions. The history of manioc is linked with slavery, colonialism, and trans-Atlantic history; it was introduced in Africa from Brazil in the 19th century. In his book *Manioc in Africa*, William O. Jones explains that manioc was fundamental to the African agricultural economy, especially in the Congo.

According to the statistics division of the Food and Agriculture Organization of the United Nations (FAOSTAT), the most important producers of manioc are Nigeria, Brazil, Thailand, Indonesia, Congo, Ghana, India, Tanzania, and Mozambique. The productivity of manioc has changed dramatically in recent decades. While South America's volume has decreased in the last 30 years, India's production has risen sharply. In a new development in Brazil, researchers have succeeded in creating high-protein hybrids.

As a strategy to cut greenhouse gas emissions, countries like China are building fuel ethanol plants to produce biofuel for cars; using cassava to generate ethanol is less expensive than grains such as corn or wheat. The extensive production of manioc is sometimes seen as a solution for dire problems like famine, food shortages, and the need for renewable energies. However, the effort to develop disease-resistant varieties of cassava or cassava biofuel has generated controversy among experts debating the possible risks of the transgenic varieties of genetically-modified cassava.

SEE ALSO: Alternative Energy; Brazil; Congo; Food; Greenhouse Gases; Underdeveloped ("Third") World.

BIBLIOGRAPHY. Food and Agriculture Organization of the United Nations, www.fao.org (cited January 2007); Serena Heckler, "Tedium and Creativity: The Valorization of Manioc Cultivation and Piaroa Women," *The Journal of the Royal Anthropological Institute* (v.10/2, 2004); William O. Jones, *Manioc in Africa* (Stanford University Press,

Linked with slavery, colonialsim, and trans-Atlantic history, manioc was introduced in Africa in the 19th century.

1959); Félix I. Nweke, Dunstan S.C. Spencer, and John K. Lynam, eds., *The Cassava Transformation: Africa's Best-Kept Secret* (Michigan State University Press, 2002).

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Maps

MAPS ARE GRAPHIC representations of the natural world and of culture and society. General definitions of maps typically include references to "simplified depictions of space" or "flat representations of some part of the earth's surface" that include "graphic representation of features." Maps are, however, a much more complex phenomenon. Maps are among the most successful forms of visual communication invented by humankind and arguably a critical element of human cognition. Maps are a key way of recording and illustrating information. They enable people to visually comprehend how space is organized. The power of maps to shape opinions, communicate ideas, and influence decision making has ensured their central role in economic and political life for millennia. Maps find uses in a wide variety of areas such as: environmental management, humanitarian aid, urban and regional planning, logistics, travel, trade, business, and war.

In addition to providing basic information about the relative location of places, maps help people to identify complex spatial relationships and distributions. In this way, maps assist humans to imagine, conceptualize, and make decisions about their environment. Maps relate to many aspects of everyday life and can be a central tool in the decisions people make about their mobility. They can be casual aids to navigation, high technologies essential to the function of modern life, or priceless cultural artifacts that have changed the ways in which people see the world and interact within it. Originally, maps were made almost exclusively by skilled scientists and draftsmen known as cartographers, but recent innovations in information technology and publishing has ensured that maps can now be created and used by a much broader constituency of people.

Maps are incredibly diverse in their forms and purpose and have changed dramatically over time

Gerardus Mercator

One of the most famous mapmakers was Gerardus Mercator, a cartographer whose family had previously come from Germany and settled in Flanders, now a part of Belgium. He was originally known as Gerard de Cremer and went to the University of Louvain to study humanities and philosophy.

During this period Mercator started to have some doubts over Biblical stories about the creation of the universe. He grew interested in geography and made friends with Gemma Frisius, a leading theoretical mathematician, physician, and astronomer. Frisius arranged for him to work with a cartographer in Louvain, and in 1535–36 Mercator helped produce a terrestrial globe; in 1537 he also worked on a celestial globe.

As soon as Mercator had finished the second globe, his italic lettering and skill as an engraver encouraged him to try his hand at maps. His first piece of work was a map of Palestine, which he completed in late 1537, and in 1538 he followed this with a map of the world that he transposed onto a flat surface with a double heart-shaped projection. He later worked on other maps, but in 1544 he was arrested and charged with heresy. Mercator was released after seven months in jail and returned to making maps. In 1552 he moved to Duisburg in the Duchy of Cleve, where he helped establish a grammar school and drew up its curriculum. He also set up his own cartographic workshop and hired engravers. Mercator started producing a map of Europe, and then a number of maps of other parts of the continent.

It was during this period that he developed his technique of the "Mercator projection." This appeared for the first time on his map of the world, which was published in 1569. Mercator then produced more maps, and even an atlas. He died on December 2, 1594, at Duisburg.

and between societies. Throughout history, the production of maps was controlled by powerful elites, monarchies, or the state. Special mapping agencies, such as the British Ordinance Survey, were established to survey national territories. The development of new mapping technology was often closely associated with the military. For instance, satellite data, which first emerged from space surveillance technology developed during the cold war, is now commonly used in map production.

HISTORY

The work of mapmakers from the ancient to the modern world—among them Ptolemy, Mercator, Muhammad al-Idrisi, Zheng He, John Speed, and Mason and Dixon—has emerged as a major area of study for geographers and historians. While some of the oldest maps can been seen on Babylonian clay tablets dating from about 2400 B.C.E., it was the ancient Greeks who made the first clearest advances in cartography in terms of technique and geographical range. These advances were preserved and developed further in the Arab world during the so-called Dark Ages.

In the West, the production of maps grew quickly during the Enlightenment. New techniques in land surveying, navigation, geometry, projection, graphic design, and printing technology eventually facilitated cheaper and wider circulation of maps, atlases, and globes. Indeed, cartographic knowledge was one of the basic building blocks of societal progress during this period. Between the 14th and 17th centuries, mapmakers were heavily influenced by European voyages of discovery during an "age of reconnaissance."

Early European cartography involved mapping seas, coastlines, and new found lands. Maps from this time are cherished for their artistic qualities, and often depict fantastic images of beasts and sea creatures, as well as elaborate cartouches celebrating the cartographer's patron. As well as assisting navigation, early European maps supported both facts and myths about faraway places, new worlds that the majority of people would never witness first-hand. Increased demands for accuracy from navigators, however, ensured that maps became increasing reliable and realistic representations of the world. In terms of European expansion, maps also proved to be important tools in the exploitation of natural resources, the development of trade, and the governance of colonies. The growth of literacy, travel, and tourism during the 19th and 20th centuries also created new roles for maps and ensured their continuing relevance to modernizing societies.

MODERN MAPS

Over time, cartography became more scientific and standardized, while at the same time maps became more specialized and thematic. This trend continues in the present day where we see maps for almost everywhere in the world and specialized to assist almost every economic and social activity. There are currently many classifications of maps. For example, orthophoto maps identify land features using photographic images; physical maps identify the earth's landforms and bodies of water; political maps identify boundaries that divide one political entity from another; relief maps identify relief data using contour lines and shading to evidence the elevation; raised-relief maps are three-dimensional portrayals of physical features; road maps assist travelers in moving from one location to another; online road maps often calculate different routes and distances; and thematic maps—such as heritage or tourist maps—provide an artistic element and entertainment and are often commercial products. Other types exist, and some fall into more than one category.

In recent years, the production of maps has been revolutionized by the emergence and development of Geographical Information Science (GIS), which links hi-tech computer mapping with spatial analysis. GIS is used for managing, storing, retrieving, analyzing, and displaying spatially referenced data. Because GIS systems digitize data, it can be manipulated into easily accessible and aesthetic forms. Broad areas of application include mapping environmental data, land use, social phenomena, and economic activities or attributes. GIS can be used from the scale of satellite images of countries to the scale of small towns. Typical categories of plotted information include densities and clusters, rates, and single point distributions of both social and natural phenomena.

Maps continue to evolve as the nature and use of this information technology develops. Maps can be found in mobile navigation systems, e-commerce internet sites, and in the technology supporting advanced mobile phone services. Map production has become a significant area of business, as companies with investments ranging from real estate to telecommunications appreciate the value of an exact knowledge of the geography of their markets. Maps are increasingly also produced by community-based groups with interests in issues related to heritage, identity, and environment. These new uses illustrate the ongoing significance of maps in shaping both the human imagination and man's relationship to the environment.

SEE ALSO: Exploration, Age of; Geographic Information Science; Geography; Global Positioning Systems (GPS).

BIBLIOGRAPHY. Peter A. Burrough and Rachael A. McDonnell, *Principles of Geographical Information Systems (Spatial Information Systems)* (Oxford University Press, 1998); John Noble Wilford, *The Mapmakers* (Knopf, 2001).

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Marine Pollution

MARINE POLLUTION IS caused by the introduction (whether directly or indirectly) of substances or energy into the marine environment, which cause harm to living marine resources. Sources of marine pollution include: (1) direct discharge of effluents and solid wastes into the seas and oceans; (2) land runoff into the coastal zone, mainly from rivers; and (3) atmospheric fallout of pollutants transferred by the air mass onto the sea's surface. Research has shown that two-thirds of the total input of contaminants into the marine environment is from land-based and atmospheric sources, constituting 44 percent and 33 percent, respectively.

Ecological impacts of marine pollution include disturbances in the function of water biotic communities and habitats and changes to hydrology and geomorphologic systems. Impacts can manifest as changes in the abundance, diversity, and fitness of individuals, populations, and communities of living marine resources. Solid wastes, heavy metals, and chlorinated hydrocarbons can damage the respiratory, reproductive, and digestive systems of marine organisms. Excess nitrogen and phosphorous inputs from agriculture can cause algal blooms that disturb the balance and structure of water ecosystems. Sewage outflows can cause oxygen deficiency that can trigger the mass mortality of water organisms.

PESTICIDES, HERBICIDES, AND FERTILIZERS

Pesticides and herbicides used in agriculture and urban gardens are designed to kill unwanted pests. The most common type of pesticides is insecticides. They can be highly toxic and frequently pollute the coastal and marine biota due to storm water runoff. Studies have shown that less than one percent of pesticides actually end up on their target species, leaving 99 percent to pollute and contaminate the environment.

Pesticides have many effects on the marine environment, including changes to reef communities and structure, increases in algae and sponges and damage to seagrass beds and other aquatic vegetation. Further, pesticides move through the food chain as they accumulate in the biota.

An example of the impacts that fertilizers can have on the environment comes from the Great Barrier Reef Marine Park Authority, which analyzed the impacts of growing sugarcane along the coast adjacent to the Great Barrier Reef. To grow sugarcane in Australia, large amounts of inorganic fertilizer, particularly nitrogen, is required due to the abundance of nitrogen-poor soils along Queensland's coast. Approximately 200 kilograms of fertilizer per hectare is applied to the cane to promote growth every year.

Only approximately 70 kilograms are taken up by the crop; the remaining 130 kilograms pollute the environment with a significant percentage reaching the marine waters of the Great Barrier Reef through stream flow runoff. During the flood events common to the monsoonal weather patterns of the Queensland coast, dissolved inorganic nitrogen (DIN) concentrations in flood plumes range between 10 to 100 times ambient concentrations, along with high levels of particulate nitrogen. The impact of this pollution has been significant to the Great Barrier Reef including a major decline in the abundance and diversity of corals and fishes.

SEWAGE

Sewage is a significant marine contaminant. For example, in New Jersey between 1986 and 1992, approximately 8 million tons of sewage sludge was discharged annually in water depths of 2,500 meters. Sewage outflow has significant effects, especially in developing nations. Risks to human health are great, with World Health Organization estimates showing that gastroenteritis and respiratory infections are caused every year by bathing in contaminated seawater. In 1993, the Pan American Health Organization indicated that only 10 percent of the sewage generated in Central American and Caribbean countries was properly treated. Infectious hepatitis A, a serious and debilitating disease of the liver, is a virus frequently transmitted by shellfish contaminated by sewage.

CHEMICAL CONTAMINATION

Chemical contamination derives from the dumping of chemical wastes into the marine environment. Substances include chlorinated hydrocarbons, heavy metals, nutrients, oil hydrocarbons, surface-active substances, and artificial radio-nuclides. Ongoing bioaccumulation and biomagnification of trace elements such as mercury and lead has been found in marine mammals such as the bowhead whale (*Balaena mysticetus*), beluga whale (D*elphinapterus leucas*), gray whale (*Eschrichtius robustus*), and seal. This has serious health implications for peoples such as the Inuit of Alaska and other Arctic areas, who rely upon marine resources as significant sources of protein.

Marine pollution affects human health; for example, hepatitis A can be transmitted by sewage-tainted shellfish.

TOURISM

Coastal and marine tourism is one of the largest and fastest-growing sectors of the global economy. Visitor numbers frequently exceed the carrying capacity of the environment—its water supplies, available space, and the ability of habitats to absorb visitor impacts and provide an enjoyable experience. Coastal erosion, pollution, habitat destruction, and social decay are common consequences. Tourist boats, curio collectors, reef walkers, snorkelers and scuba divers have damaged coral reefs in many tropical countries.

SHIPPING

Shipping, ship groundings, and collisions are a major source of marine pollution. Contaminants include hazardous and noxious substances, hydrocarbons, ballast water discharge that spreads marine pests, and antifouling paints. An estimated 10,000 marine species are being transported in ships' ballast water between bio-geographic regions at any given moment worldwide.

It is estimated that the global shipping industry discharges up to 5.5 million items of waste every day. The application of antifouling paints remains an ongoing problem. For example, in Korea, while the practice of applying antifouling paint containing organotin compounds to ship surfaces was halted beginning in 2003, and antifouling paint is supposed to be completely removed from surfaces by 2008, ships are still frequently dry-docked for repainting in shipyards. There, high pressure water and sand particles are used to remove impurities, such as attached marine organisms, salts and slime, and old paint from the ship's surface. In this process, major contamination occurs from the particles of antifouling paint that are often discharged directly into the marine environment.

MARINE DEBRIS

Millions of tons of plastic and glass enter the oceans each year. Major sources of plastic are from fishing equipment, packaging materials, convenience items, and raw plastics. Wildlife is at particular risk from plastic, with over 100,000 birds, whales, seals, and turtles killed by plastic rubbish each year. Birds get tangled in plastic can holders and turtles ingest plastic bags, perhaps mistaking them for jellyfish. Recent entanglement studies estimate that in Australia, 1,478 seals die from entanglement in fishing nets each year; the entanglement rates for Australian sea lions were 1.3 percent in 2002 and for the New Zealand fur seal 0.9 percent. This issue is compounded by the long "shelf time" most marine debris has before biodegrading fully; plastic bags take up to 1,000 years, glass bottles one million years, and plastic bottles may last indefinitely.

NOISE POLLUTION

In some areas, noise pollution at sea has doubled every decade for the past 60 years. Sources of ocean noise pollution include explosives, underwater construction activities, ship traffic, seismic survey activity, and oceanographic experimentation.

Noise proliferation is a significant threat to the survival of many marine mammals, and to other resources. Research shows that noise pollution is reducing marine faunas' ability to find food, locate mates, avoid predators, and communicate with each other. This is particularly so with marine mammals who use sonar as a guidance mechanism.

MANAGEMENT INITIATIVES

Given the significant effect of marine pollution, there are a number of tools and treaties that attempt to mitigate its impact. The United Nations and others have established over 200 initiatives to manage and mitigate pollution and degradation of the marine environment at the global and regional levels including: (1) the Global Program of Action for the Protection of the Marine Environment from Land-Based Activities (1995); (2) the Protocol Concerning Pollution from Land-Sources and Activities in the Caribbean; (3) the International Maritime Organizations Antifouling Treaty (2001); (4); the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972); (5) the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft (1972); (6) the Convention for the Prevention of Marine Pollution from Land-based Sources (1974); and (7) the Convention for the Protection of the Marine Environment of the Northeast Atlantic (1992).

SEE ALSO: Estuaries; Law of the Sea; Pollution, Water.

BIBLIOGRAPHY. S.M. Adams, "Assessing Cause and Effect of Multiple Stressors on Marine Systems," *Marine Pollution Bulletin* (v.51, 2005); Australian Marine Conservation Society Policy Group, *2003 Fact Sheet*, www.sustainableseafood.org.au (cited April 2006); D. Baur and S. Iudicello, "Stemming the Tide of Marine Debris Pollution: Putting Domestic and International Control Authorities to Work," *Ecology Law Quarterly* (v.71, 1990); A. Boczek, "Global and Regional Approaches to the Protection and Preservation of the Marine Environment," *Case Western Reserve Journal of International Law* (v.39, 1984); M. Champ, "Economic and Environmental Impacts on Ports and Harbors from the Convention to Ban Harmful Marine Antifouling Systems," *Marine Pollution Bulletin* (v.46, 2003); Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection, *Report of the Twenty-Eighth Session of GESAMP*, gesamp.imo.org (cited April 2006); B. Pagea et al., "Entanglement of Australian Sea Lions and New Zealand Fur Seals in Lost Fishing Gear and Other Marine Debris Before and After Government and Industry Attempts to Reduce the Problem," *Marine Pollution Bulletin* (v.49, 2004); W. Pereira et al., "Accumulation of Butyltins in Sediments and Lipid Tissues of the Asian Clam, Potamocorbula Amurensis, Near Mare Island Naval Shipyard, San Francisco Bay," *Marine Pollution Bulletin* (v.38, 1999); M. Schleyer, J. Heikoop, and M. Risk, "A Benthic Survey of Aliwal Shoal and Assessment of the Effects of a Wood Pulp Effluent on the Reef," *Marine Pollution Bulletin* (v.22 2005); Y. Song, J. Woo, S. Park, and I. Kim, "A Study on the Treatment of Antifouling Paint Waste from a Shipyard," *Marine Pollution Bulletin* (v.51, 2005).

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Marine Science

SIMPLY STATED, MARINE science is the science of the sea. It is a multidisciplinary field of scientific inquiry that encompasses the fields of biology, fisheries, ecology, chemistry, geology, physics, and oceanography as they pertain to the marine realm. Marine scientists focus on a variety of marine habitats distributed worldwide in tropical, temperate, and arctic regions, including: coral reefs, estuaries, and lagoons, as well as benthic, pelagic, intertidal, coastal, and deep sea environments.

The marine realm encompasses over 71 percent of the earth's surface. It is a primary driver of the hydrological cycle, plays a major role in the earth's weather and climate system, and provides critical habitat for millions of marine species. The oceans contribute to international commerce, transportation, and tourism. They contain large amounts of valuable minerals such as hydrocarbons and manganese nodules. They are a source of fish, shellfish, algae, and plant species that form the basis of the world's commercial, artisanal, and subsistence fisheries and aquaculture operations. Marine species have given rise to new genetic and pharmaceutical products. The oceans also comprise a realm of strategic military importance. Understanding these mechanisms, roles, and resources is an integral part of marine science. In addition to providing insights into the structure, functions, and human uses of the ocean realm, marine scientific endeavors have also contributed to our understandings of the origins of life, human biology, and evolutionary, developmental, and tectonic processes.

Until recently, a lack of appropriate technology constrained the ability of humans to conduct scientific investigations of the marine environment. The development of the bathysphere, and, more significantly, SCUBA gear (also known as Self Contained Underwater Breathing Apparatus), manned and unmanned submersibles, and remote sensing (acoustic, seismic, optical, and satellite) technologies have generated a number of new insights and substantially enlarged our knowledge base in the field of marine science.

Although premised on the idea of objectivity, science is a particularly human endeavor and no accounting of the field of marine science would be complete without reference to some of the many scientists who have worked in this field to expand the boundaries of knowledge. The following represents an all too brief and incomplete sampling of internationally important marine scientists. Among them is Sir Charles Wyville Thomson, a Scottish scientist who directed the first purely scientific exploration of the oceans aboard the HMS *Challenger* from 1872 to 1876. It took an additional 10 years to complete the 50 volumes summarizing the cruise's findings. As a result of this work, Thomson stimulated the beginning of a modern science of the oceans, identifying thousands of new species of organisms and confirming that there was indeed life in the deep ocean—debunking the azoic theory, which posited that it was absent. The Norwegian scientist and explorer Fridtjof Nansen enhanced human understanding of arctic marine environments, exploring the Arctic Ocean aboard the vessel *Fram* and by dogsled.

Henry Bryant Bigelow conducted seminal studies of the Gulf of Maine, and emphasized the importance of creating interdisciplinary understandings, combining the natural and physical sciences to gain insight into the complexity of the marine environment. He became the first director of the Woods Hole Oceanographic Institution, one of the preeminent marine science institutes in the world, serving from 1930 to 1940. Jacques-Yves Cousteau, although not necessarily one of the great marine scientists in the world, did much to popularize the findings of marine scientists, introducing the general public to the study of the oceans in his numerous collections of photographs, books, television shows, and movies, and to the sea itself through his invention of SCUBA gear and techniques for creating underwater photographs.

Many countries, notably industrialized countries with coastlines, have established schools and institutes for the study of marine science. Due to the very high economic costs of conducting marine scientific studies, there exists a disparity between developed and developing countries with respect to their scientific infrastructure and human resources. Such economic disparities focus attention on the need for international cooperation in marine scientific endeavors, which is further necessitated by the global nature of the marine environment itself,

The marine realm encompasses over 71 percent of the earth's surface, providing habitat for millions of species.

transcending spatial and temporal boundaries, as well as those imposed by nation-states.

Elisabeth Mann Borgese, an expert in marine policy and law who championed the legal idea that the oceans are "the common heritage of mankind," founded the International Ocean Institute with centers around the globe, and convened yearly Pacem in Maribus (literally, Peace in the Oceans) conferences, captured the essence of the field. She wrote, "The marine scientist is the prototype of a new interdisciplinary, international scholar, one who bridges the gap between theory and action. More often than not, the marine scientist is an explorer, a sailor, a diver, exposed to physical hardship and adventure, as well as a scholar, a theoretician, a philosopher of nature."

SEE ALSO: Coastal Zone; Fisheries; Law of the Sea; Marine Pollution; Oceans; Water.

BIBLIOGRAPHY. Katherine Cullen, *Marine Science: The People Behind the Science* (Chelsea House Publishers, 2006); Michael J. Kennish, *Practical Handbook of Marine Science,* 3rd ed. (CRC Press, 2000); Elisabeth Mann Borgese, ed., *Ocean Frontiers: Explorations by Oceanographers on Five Continents* (Harry N. Abrams Inc., 1992); P.S. Meadows and J.I. Campbell, *An Introduction to Marine Science* (John Wiley & Sons, 1978); Dorrick Stow, *Oceans: An Illustrated Reference* (University of Chicago Press, 2006).

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Marketable Permits

MARKETABLE PERMITS ARE instruments aimed at reducing pollution on an individual level. The permits represent a quota of pollutant that the permit-holding individual or organization is allowed legally to emit, and may also be bought or exchanged with other permit-holders for financial considerations. The laws of supply and demand apply to such exchanges, with a national or international regulatory scheme monitoring observance of permit limits and, when necessary, reducing the total number of permits in circulation to cut down on pollution. Many firms find this system a powerful incentive to make their operations cleaner and more efficient because they will not exceed their permitted levels of emissions, and because the unused permit or some portion of it becomes a commercially valuable asset.

This system combines two other approaches that have been tried but, in some circumstances, found wanting. The "command and control" system relies on strong governmental control of pollution and the imposition of penalties on perpetrators. This system can only be successful when state governments take pollution control issues seriously and have the capacity to monitor and police levels of pollution emitted. The U.S. George W. Bush administration has not taken pollution and its implications seriously, and has not signed the Kyoto Protocol aimed at pollution control.

The second approach is to rely on market-based transactions to limit pollution, but this is impractical because those suffering most from pollution are rarely those who cause it, and because market operations are prone to failure unless strongly regulated so that abuses are prevented. By issuing permits, governments can control the marketplace, but also permit some market transactions to take place. Consequently, attempts to create monopolies or in other ways rig the market should be spotted by regulators, although at the cost of additional expense in the system.

There have been complaints based on ethical grounds that it is inappropriate to give the ability and right to pollute to those who are the greatest offenders. However, this need not be problematic so long as the polluters are properly monitored. Even so, it is possible that those firms or states that have already taken steps to reduce their emissions will be disadvantaged if the assessment of total permissible levels is taken on current rather than historic measurements. Given the importance of the problem of pollution, this argument is trivial and it may even be that such states can obtain economic benefits by selling their technology to others struggling not to exceed their permitted targets.

Problems with the marketable permits scheme and similar arrangements include the difficulty in identifying accurately the total level of appropriate pollution, together with the issues surrounding transaction costs and uncertainty. Transaction costs are all those costs that are part of an economic transaction but are not central to it. Examples include insurance, verification costs, transportation, and legal fees. Since there is a measure of uncertainty attached to pollution and environmental issues, which are complex and often chaotic in nature, the transaction costs involved in trying to accurately price permit purchases can be high or can be ignored at the risk of making the purchase inefficient. Despite the problems inherent in the system, the marketable permits approach appears the most helpful one currently available to tackle pollution.

SEE ALSO: Permits, Tradable; Polluter Pays Concept; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. John O. Ledyard and Kristin Szakaly-Moore, "Designing Organizations for Trading Pollution Rights," *Journal of Economic Behavior and Organization* (v.25/2, 1994); Arik Levinson, "Why Oppose TDRs? Transferable Development Rights Can Increase Overall Development," *Regional Science and Urban Economics* (v.27/3, 1997); Juan-Pablo Montero, "Marketable Pollution Permits with Uncertainty and Transaction Costs," *Resource and Energy Economics* (v.20/1, 1998); *Putting Markets to Work: The Design and Use of Marketable Permits* (OECD, 1998).

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Markets

MARKETS ARE PHYSICAL or virtual spaces where people buy and sell commodities in exchange for money or for other commodities through barter. Markets can be local, national, or international in scale and exist within larger social and cultural contexts that affect the rules governing market transactions. Because markets can only deal with commodities, i.e., goods or services that are treated as somebody's property that can be sold, goods can only be made subject to market forces if they are first converted to a commodity form.

For example, humans can be made into a commodity if they are enslaved, but this form of commodification is now illegal. On the other hand, the Kyoto Protocol opens the possibility of internationally trading permits to emit carbon dioxide, treating carbon dioxide emissions as a tradable commodity. The rules determining which kinds of things are treated as commodities, and how they can be exchanged, as well as the market structures that emerge, all affect how people use natural resources, with profound environmental implications.

COMMODIFICATION TRENDS

The general thrust within the last two centuries has been to transform more and more things into commodity form, for example, by enclosing commonly owned resources as private property. Karl Polanyi referred to this process as the "Great Transformation," making the market the dominant social institution. This transformation is justified as promoting the more efficient allocation of scarce resources, using Adam Smith's "invisible hand" of the free market to ensure that each resource is used by the people capable of making the best use of it. However, Polanyi showed that a countermovement, led by unions and other oppositional forces, led to a partial reversal of the trend toward greater importance of markets in the course of the 1930s and 1940s (particularly in Britain, but elsewhere as well). Yet another "great transformation" occurred with the rise of neoliberalism in the latter part of the 20th century, as described by Blyth and Harvey. Hence, despite the general trend toward expansion, markets are constantly subject to opposing social forces.

FREE MARKET FORCES

According to most economic theorists, a market only yields favorable results if it is free. For a market to be free, there must be many buyers and many sellers of a commodity, ensuring that no buyer or seller can manipulate prices. If a market is dominated by only a few sellers, it is an oligopoly market; if it is dominated by only one seller, it is a monopoly. In both oligopoly and monopoly markets, sellers can raise prices in order to get extraordinary profits; in fact, many profitable companies in the world operate in oligopoly markets (e.g., pharmaceuticals, agrochemicals, petroleum, and hi-tech manufactures).

If only one or a few buyers dominate the market, they can depress prices, as typically occurs in markets for agricultural commodities, mineral resources, and mature (low-tech) manufactures such as textiles. These markets tend to be dominated by companies that act as middlemen between producers and consumers. If the producers of these commodities have no other viable economic alternatives, they are forced to cut corners in order to continue in business. In agriculture, this may include the neglect of long-term investments to maintain soil fertility; in mining, it may include the indiscriminate dumping of wastes (e.g., mine tailings); and in manufacturing, it may include excessive pollution. In all economic sectors, it includes depressed wages and disregard for workplace safety (e.g., exposure to toxic chemicals).

If entire countries depend on sales in buyers' markets, these strategies pervade their entire economy, and development must be financed from foreign sources (e.g., foreign aid and loans). This increases the danger of falling into severe debt and of dependency on institutions such as the World Bank and the International Monetary Fund.

The companies that dominate the markets use their political and economic clout in order to perpetuate their market dominance, making it very difficult for a free market to emerge. For example, barriers to entry of new firms may be raised by the strategic use of below-cost sales, or by patenting of minor innovations. Furthermore, the core industrialized nations have until recently been very successful in bargaining for the relatively unrestrained entry of their products into the rest of the world at World Trade Organization negotiations, while keeping their own markets relatively protected.

Environmental impacts of these trade inequities include the inability of many Third World producers to invest in more environmentally sustainable production methods because of low profit margins and the wasteful use of cheap imported commodities (ranging from natural resources to many manufactures) in the wealthy industrialized countries.

LABOR MARKETS

Labor markets also usually deviate far from the model of the free market (as emphasized by Karl Marx, and the political left in general). If workers do not own the means of production, do not have an independent source of livelihood (e.g., farming), and have little or no access to social welfare payments from the government, their only alternative to being employed is to starve.

They are then not free to withdraw from the labor market and must accept any wages employers may offer. Only a scarcity of labor can enable workers to negotiate a wage that exceeds bare subsistence levels; that is, if there are few workers with particular skills that are in high demand. The contradiction between labor and capital involves persistent efforts on the part of both workers and employers to try to shift the labor market in their own favor.

Capitalists frequently employ a "spatial fix" (in the words of David Harvey) to circumvent higher labor costs in one place by moving production to another place (e.g., from the northern to the southern United States or from high-wage to low-wage countries), a strategy also referred to as the "race to the bottom." It involves not only the search for lower wages, but also disregard for worker safety and other environmental concerns. Employers may also invest in more machinery in order to reduce labor costs; this strategy depends on sources of cheap energy in order to be able to run the machinery efficiently.

REGULATION

Many "market imperfections" that cause undesirable social or environmental outcomes can be addressed through government regulations and/or through pressures from civil society. While the need for regulation is often clear, the methods by which regulations may achieve desired objectives are often far more difficult to determine.

In addition to market regulation, some environmentalists seek to remedy the problems of existing markets by developing alternative forms of marketing. One example is fair trade, in which Latin American, African, or Asian producers of agricultural commodities and some crafts products are guaranteed a minimum price for their products, to enable them to make a sustainable living. Fair trade often includes provisions for environmentally sustainable production methods, such as organically grown coffee. Another example of alternative marketing is local currencies, which are intended to stimulate local exchange among individuals and small businesses, usually with environmental aims in mind as well. This illustrates that markets exist in many forms, capitalist as well as noncapitalist, and will continue to evolve with society.

SEE ALSO: Carbon Trading; Globalization; International Monetary Fund; Kyoto Protocol; Livelihood; Marx, Karl; Race-to-the-Bottom Hypothesis; Trade, Fair; Trade, Free; Undeveloped ("Third") World; World Bank; World Trade Organization (WTO).

BIBLIOGRAPHY. Mark Blyth, *Great Transformations: Economic Ideas and Institutional Change in the Twentieth Century* (Cambridge University Press, 2002); Peter Dicken, *Global Shift: Reshaping the Global Economic Map in the 21st Century* (Guilford Press, 2003); David Harvey, *A Brief History of Neoliberalism* (Oxford University Press, 2005); Andrew Leyshon, Roger Lee, and Colin C. Williams, eds., *Alternative Economic Spaces* (SAGE Publications, 2003); Karl Polanyi, *The Great Transformation* (Farrar and Reinhart, 1944); Philip W. Porter and Eric Sheppard, *A World of Difference: Society, Nature, Development* (Guilford Press, 1998); Jeroen C.J.M. van den Bergh, ed., *Handbook of Environmental and Resource Economics* (Edward Elgar, 1999).

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Marsh, George (1801–82)

GEORGE PERKINS MARSH was a lawyer, politician, diplomat, businessman, and farmer who studied a wide variety of subjects. Among his writings in favor of conservationism, his foremost influential book was *Man and Nature* (1864), which remains in print to this day. He was born in Woodstock, Vermont, on March 15, 1801, and died in Vallombrosa, Italy, on July 23, 1882. In 1820, he graduated from Dartmouth College, New Hampshire.

Marsh started his political career in Vermont, and from 1843 to 1849 he served as a Whig representative in the U.S. Congress. President Zachary Taylor appointed him minister resident in Turkey in 1849, where he served until 1853. He went to Greece temporarily as special minister in 1852. Later, President Abraham Lincoln appointed Marsh envoy extraordinary and minister plenipotentiary to Italy in 1861, a position that he held until his death.

From 1838 to 1862 he wrote on English and Scandinavian languages, and his work *Lectures on the English Language* (1859) was influential and contributed to the development of the linguistic study of English. His *The Origin and History of the English Language* (1862) offered a more historical approach.

Marsh was a pioneer in conservation studies and the movement that changed the perception of the relationship between man and environment. On September 30, 1847, he delivered a speech on agricultural conditions in New England to the Agricultural Society of Rutland County, Vermont. It draws on his early life interest in natural history, his farming activity, and his concern for the effects of deforestation. The American conservation movement was in its infancy. Henry David Thoreau's *Walden* was published in 1854. In 1857 Marsh wrote "Report on the Artificial Propagation of Fish," addressed to the Legislature of Vermont, in which he highlights the role of forests, river productivity, population restoration, and fish breeding.

In 1864 Marsh published *Man and Nature or, Physical Geography as Modified by Human Action,* the seminal work he revised in 1874 and published with the title *The Earth as Modified by Human Action: Man and Nature*. He brought a fresh, modern perspective to understanding the human capacity to be an agent of environmental change, and identified various environmental problems—deforestation, erosion, and pollution. Marsh called for sustainable resource management and anticipated the paradigm of the environment as a system. Marsh supported the establishment of the Smithsonian Institution by serving on the organizing committee and making donations of species obtained in his travels. His property eventually became part of Vermont's Marsh-Billings-Rockefeller National Historical Park.

SEE ALSO: Conservation; Movements, Environmental; Thoreau, Henry David; United States, Northeast.

BIBLIOGRAPHY. Jane Curtis, Will Curtis, and Frank Lieberman, *The World of George Perkins Marsh, America's First Conservationist and Environmentalist: An Illustrated Biography* (Countryman Press, 1982); David Lowenthal, *George Perkins Marsh, Versatile Vermonter* (Columbia University Press, 1958); David Lowenthal, *George Perkins Marsh: Prophet of Conservation* (University of Washington Press, 2000); Stephen C. Trombulak, ed., *So Great a Vision: The Conservation Writings of George Perkins Marsh* (University Press of New England, 2001).

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Martin vs. Waddell

MARTIN VS. WADDELL was a court case that helped to establish in the United States the lawful ownership of environmental resources, including living things. Martin held lands alongside the River Raritan in New Jersey and he claimed ownership of these lands back to a grant made by King Charles II during the second half of the 17th century. He brought a court case with a view to developing an oyster industry based on those that were present in the river, and he desired to have exclusive use of them and their economic exploitation.

The presiding judge, U.S. Supreme Court Justice Robert Taney, ruled that this claim was not valid because King Charles II's ability to make such a grant should have been curtailed by the Magna Carta. The Magna Carta—the Great Charter—was a treaty forced upon King John by rebellious barons, signed first in 1215, and reissued several times subsequently. The Magna Carta makes a few concessions to the barons and to the people of the land, but subsequently it was employed to increase rights of individuals that were not contained in the original. In the United States, the Magna Carta has been used to justify many innovations, not always contained within its remit. Justice Taney's decision rather followed this precedent.

The result has become a central part of environmental law in the United States by establishing a principle that no one can own wild animals or creatures. Originally applying only to the 13 states, its provisions were subsequently adopted by later signatories. A consequence is that wild animals and fish are considered to be held as part of the "public trust" by the greater public, through the arm of the state, and so individuals are empowered among other things to access them as they see fit, within the framework of other regulations. The alternative, in which private interests are believed to hold exclusive rights to wildlife on their land and in streams on their property, would have considerably restricted the ability of the state to regulate many forms of resource use. Subsequent court decisions and the Tenth Amendment of the constitution have strengthened these rights. The Tenth Amendment states that rights revert to the federal government when they are not explicitly controlled by the states. The federal government has the power to control interstate commerce and, consequently, acts as the protector of the interests of wildlife.

The provisions of the *Martin vs. Waddell* settlement have been challenged by what has been called the Wise Use movement, which instead favors the economic exploitation of nature by private interests, in a context in which the environment has become overprotected and is not working to efficient market means. However, many people identify followers of the Wise Use argument as people bent on recklessly endangering the environment as a whole.

SEE ALSO: Land Use; Public Trust Doctrine; Wildlife; Wise Use Movement.

BIBLIOGRAPHY. Michael J. Bean and Melanie J. Rowland, *The Evolution of National Wildlife Law* (Praeger, 1997); Richard L. Revesz, Philippe Sands, and Richard B. Stewart, *Environmental Law, the Economy, and Sustainable Development: The United States, The European Union, and the International Community* (Cambridge University Press, 2000).

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Marx, Karl (1818–83)

A WESTERN EUROPEAN social theorist and political activist, Karl Marx wrote voluminously, and his works rank among the most recognized contributions to social analysis. Best known for *Das Kapital* (1867), and for coauthoring *The Communist Manifesto* (1848) with his long-time collaborator Friedrich Engels, Marx's examination of the contradictions and crises entailed in social relations under capitalism has played a critical role in most "radical" political economic theory and politics since his death.

There are many ways in which Marx, and the various Marxisms that have followed, speak to the relation between society and environment. It is only since the last decades of the 20th century that the relevance of Marx's work to environmental politics has been widely recognized. Prior to the 1980s, many argued that Marx largely ignored nature—or even that he thought it unimportant. His "labor theory of value," for example, is frequently and erroneously brandished as proof that he believed nature contributes nothing of value to human production. Recent scholarship, however, has corrected this misinterpretation in two important ways: by demonstrating the relevance of Marx's concepts for the study of socio-environmental dynamics, and by bringing attention to the ways in which Marx's work reflects on the role of nature in the production and reproduction of human society.

First, beginning in the early 1980s, an increasing number of social scientists interested in ecological problems turned to Marx-inspired analytical tools to understand the ways in which environmental change is a product of political economic struggle between humans. Seminal contributions to the study of these dynamics in developing countries like Nepal and Nigeria looked at the political economic, that is, productive and distributional implications for natural resources of political conflict between classes, nations, and ethnic groups.

Marxian concepts like the "social relations of production" (the totality of human institutions that animate a particular "mode of production" like capitalism or feudalism) and "primitive accumulation" (the means through which subsistence producers are dispossessed of ways of providing for themselves without wage work) are essential to these studies. Much of the power of political ecology as an approach to understanding the "society-environment dialectic" is drawn from these explicitly Marxian roots, an analysis only made stronger by political ecology's marriage of political economy and cultural anthropology, which highlights important dynamics—religious beliefs and practices, for example—obscured by an emphasis on economic structures.

Second, the standard and grossly incorrect caricature of Marx as a dogmatic economic determinist who believed that labor was the sole source of anything meaningful is eroding, albeit very slowly. The work of writers like James O'Connor and John Bellamy Foster shows Marx's thinking on production as not only far more complicated than often thought, but as speaking, often directly, to environmental concerns. As Marx himself wrote in 1875, "Labour is not the source of all wealth. Nature is just as much the source of use values (and it is surely of such that material wealth consists!) as labour, which itself is only the manifestation of a force of nature, human labour power." These analyses, and

Highgate Cemetery

With the old church cemeteries in and around London becoming full by the late 18th century, plans were drawn up for large cemeteries in the new suburbs surrounding London. One of these "magnificent seven" cemeteries is Highgate Cemetery, which opened in 1839. It holds large Gothic tombs, vast mausoleums, and modest burial plots, and it also became an impressive garden in which many Victorians would promenade.

The cemetery fell into disrepair during the mid-20th century, but was saved by the Friends of Highgate Cemetery, who organize tours that point out interesting gravestones, including those of the many famous people buried there. Much wildlife, especially birds, live in the cemetery, and there are even some foxes. In recent years there have been studies of the flora and fauna at Highgate and in some of the other London cemeteries, such as Kensal Green.

One of the most famous people buried at Highgate Cemetery is Karl Marx. His modest grave was visited by many Communists and others interested in history and was later replaced by a massive monument with a large bust of Marx and the slogan "Workers of the World Unite." In Len Deighton's novel *SS-GB,* about a hypothetical German occupation of Britain in World War II, there is an assassination attempt on Josef Goebbels as he lays a wreath on the grave to commemorate the Nazi-Soviet Pact of 1939. Many Eastern European and Chinese politicians have visited the grave, and a number of other Communists have been buried in plots close to Marx, including members of Afghan and Iraqi Communist parties.

the work of many political ecologists, show the possibilities of a "green Marxism."

SEE ALSO: Capitalism; Mode of Production; Political Economy; Production of Nature.

BIBLIOGRAPHY. Piers Blaikie, *The Political Economy of Soil Erosion in Developing Countries* (Longman, 1986); John Bellamy Foster, *Marx's Ecology* (Monthly Review, 2000); Karl Marx, *Critique of the Gotha Program* (International Publishers, 1938); Karl Marx, *Capital* (Vintage, 1977); James O'Connor, *Natural Causes* (Guilford, 1997); Paul Robbins, *Political Ecology* (Blackwell, 2004); Michael Watts, *Silent Violence* (University of California, 1983).

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Mass Media

MASS MEDIA IS typically defined as a form of technology (including radio, film, and television, but also encompassing newspapers, magazines, and book publishing, as well as advertising, marketing, and public relations) or institutional organization (Time-Warner, RCA, BBC, AOL, Al-Jazeera, and so on). Beyond these narrow definitions, mass media also encompasses shifting cultural forms shaping human perception and possibilities for social change. Mass media therefore simultaneously includes technical, institutional, and cultural dimensions. This broad conception is required to understand how media shape contemporary human/environment conditions, including representations of nature, popular perceptions of environmental issues, and public opinion on phenomena ranging from swimming with dolphins to global warming.

MODERN ENVIRONMENTALISM AND MASS MEDIA COVERAGE

Many of the founding events of modern environmentalism were irrevocably shaped by mass media. Rachel Carson's 1962 book *Silent Spring* is a common touchstone for histories of environmentalism, but its initial serialization in a popular magazine (*The New Yorker*) and use in a CBS television exposé of the pesticide industry is crucial to a proper appraisal of its influence. Though it is hardly the first example of popular nature writing influencing attitudes and opinions regarding environmental advocacy, *Silent Spring* signaled the significance of mass media as a site for advancing environmental social change. Less than a decade later, subsequent events were not merely affected by media coverage but often *designed* as "media events" aiming to refigure human perceptions of nature and provoke action against the ill effects of industrialism. For example, Earth Day celebrations are public protest events designed to produce an agenda-setting effect, whereby prominent media coverage moves issues onto the public and political agenda. Prominent North American news coverage of the first Earth Day in 1970 was followed by increased public support for environmental protection, improved opinion polling on such issues, broad national environmental protection policies, and new political priorities, all of which underscored the importance of mass media as a tool for environmental change, while ensuring future conflict with antienvironmental institutions on its public terrain.

Greenpeace was probably the first environmental organization to explicitly design publicity strategies on the basis of mass media theory. Whereas the 1970 Earth Day was announced with a full-page newspaper advertisement, Greenpeace created dramatic coverage through direct confrontation with powerful industries. Finding inspiration in 1960s media guru Marshall McLuhan, images of environmental confrontation were released as a series of "mind bombs," or visual imagery triggering emotional response and support for issues usually obfuscated in abstruse regulatory language. These provocative conflicts were staged less to stop whalers, loggers, or nuclear testing than to create compelling images for mass media dissemination. As Kevin Deluca's important 1999 study made evident, these moments of radical confrontation were not romantically quixotic or irrational attacks on an impervious industrial system, but effectively measured tactics for conducting "image politics" in an increasingly televised or screened world.

More radical groups such as Earth First! and Earth Liberation Front (ELF) adopted new media as organization tools, finding in internet technology a medium well suited to their highly decentralized and antihierarchical style. Their direct action politics generally take the form of "monkey wrenching," a practice characterized across a wide continuum of frames ranging from harmless prank to ecoterrorism. Monkey wrenching is small-scale, low budget, nonviolent industrial and economic sabotage, including such activities as putting sand in gas tanks, billboard graffiti, tree spiking, and sport utility vehicle vandalism. Similar to the early radicalism of Greenpeace, the goal is mainstream media attention and public perception of natural destruction, not a belief that damage to property will suffice to halt industrial-scale exploitation. Edward Abbey's 1975 novel, *The Monkey Wrench Gang,* provided inspiration for the practice and gave expression to desires for new forms of environmental resistance, which proponents often conceive as an individualist or anarchist form of civil disobedience.

Critics associate monkey wrenching with forms of political terrorism, a view Michael Crichton extrapolates into a generalized state of paranoid anxiety in his 2004 novel, *State of Fear,* where well-funded, globally coordinated ecoterrorists stage a media-friendly tsunami in support of climate change activism. What remains clear in this broad range of characterizations is that, as Tim Lukes notes, "the whole design of monkey wrenching perhaps can be traced back to symbolic battles over environmentalism's image in the media."

As Greenpeace adopted a more conventional organizational structure in the 1990s, it came to rely less on McLuhanist principles than social marketing and fundraising techniques to the extent that it, like the World Wildlife Fund (WWF), is among the most recognized logos globally and a forerunner of what Naomi Klein has called "lifestyle branding." Lifestyle branding is the idea that identity, values, and lifestyle are sold more readily than actual commodities and that successful brands stretch across any number of actual products or issues, as the Canadian WWF recent brand-stretching into climate change issues indicates.

The use of attention-getting techniques employed in advertising and public relations to advance consumer ideologies has raised concerns regarding the appropriate means by which environmental goals should be achieved. Given that scientists, politicians, and activists must accommodate to prevailing media conventions in order to be heard at all, or "play by the rules of the game," does environmental crisis at times require or justify hyperbole and exaggeration? At what point do well-intentioned calls to recognize the urgency of environmental problems lapse into unwarranted fear appeals? As environmental organizations rely increasingly on fund-raising and publicity tactics typical of marketing industries, revelation of the use of such mainstream commercial techniques easily helps depict environmental groups as manipulative or propagandistic.

Controversial examples include a number of documentary-style films attacking Greenpeace, including *Survival in the High North,* which claim the organization utilizes propaganda methods, falsifications, and unseemly fund-raising in their campaigns. Bjorn Lomborg, in *The Skeptical Environmentalist,* echoes this antienvironmental refrain in linking proenvironmental public opinion to poor journalism and manipulative media.

As environmentalists claim that mass media express systemic antienvironmental bias, whether through outright exclusion, trivialization of issues, or "green washing," where consumerism is celebrated as the solution not the problem, questions about the role of mass media in shaping public opinion and environmental activism remain strenuously contested. Answers to these questions fall into three broad categories: (1) mass society and mass culture; (2) media reinforcement, dependency, and cultivation theory; and (3) framing and problem formulation distortions.

MASS SOCIETY AND MASS CULTURE

Mass society theory hypothesizes significant and direct effects for mass media content on public opinion, behavior, and culture. Largely a product of the 1920s–30s, with its innovations in mass media technology, propaganda technique, and the birth of modern advertising and public relations agencies, this line of thinking expresses concerns over mass media as tools for engineering consent and conformity. Modernization is often characterized as social transformation in which traditions dissolve, political and commercial power is centralized, and mass production stamps out a conformist, consumer society. As traditional community ties dissolve, alienated individuals become susceptible to control through mass mediated opinion management techniques, an indication that the instrumental intelligence evident in our technological domination of nature also seeks disciplinary control of human beings, though less through direct coercion than a debased popular culture.

Genuine insights in this tradition of thinking tend to get lost in the exaggerations of ironic skeptics and romantics alike. However, the connection between domination of nature and of humans, the opening rift between urban and rural sensibilities, and the provocative suggestion that environmental problems are simply intractable given the basic framework and institutions of industrial society admirably refuses easy accommodation to the truisms of consumer culture. The presence of some 75,000 significant dams in the United States as markers of progress and models for the world remains a visible reminder of the role of mass communication in equating progress with industrial and engineering development.

MEDIA REINFORCEMENT, DEPENDENCY, AND CULTIVATION THEORY

Reinforcement and dependency theories suggest media influence is expressed indirectly through the broader social system in which mass media find their role and is contingent on the extent to which we depend on them, such as in times of natural disaster. Media are contributory, not causal, factors reinforcing existing conditions along with other mainstream social institutions, such as the home, school, and church. Post-1960s evaluations tend to view this reinforcement function critically, as ideological or hegemonic, particularly as the popularity of television demands more weight be accorded its socializing or cultural influence. Cultivation theories have emphasized this point in arguing mass media provide a systemic source of socialization through storytelling that is thoroughly industrialized and bent to consumerist ends, while excluding representations of nature or "symbolically annihilating" environmental concerns. The main claim is that a small but pervasive, steady, directional, measurable, and independent contribution for television's influence on culture is observable and socially significant, in much the way a few degrees centigrade shift in mean temperature can severely impact local ecosystems. James Shanahan and his collaborators have built on this tradition to suggest heavy television viewers have less environmental knowledge, concern, and willingness to pay for protections, while directly challenging skeptics such as Lomborg on their claims about mass media effect.

FRAMING AND PROBLEM FORMULATION DISTORTIONS

Most research in this tradition focuses on the attention and framing given to specific environmental issues. One popular conceptualization of this process is Anthony Downs's (1972) "issue attention cycle," which suggests public perception of environmental crisis "does not reflect changes in real conditions as much as it reflects the operation of a systematic cycle of heightening public interest and then increasing boredom with major issues." Downs hypothesized a five-stage cycle through which environmental concern would pass: pre-problem, alarmed discovery and enthusiasm, realization of cost of resolution, gradual decline of intense public interest, and a post-problem stage, where issues reemerge only spasmodically.

Today, such conceptualization appears flawed in failing to acknowledge the specificity of environmental issues and too blunt given the results of more sustained study of mass media and public policy fields. Agenda-setting theory has proven important in finding that as media cover and attribute importance to an issue, through formal features such as story placement and amount of coverage, they alter public and political/policy agendas. Such theories strive to explain why some issues receive attention and, more importantly, how problems are defined and how possibilities for their solution often narrow to suit preexisting social institutions. Though there is considerable empirical support for such research, particularly regarding measurement and relationships of media and public agenda, the effect varies with respect to specific issues, the sorts of media employed, and the type of coverage, particularly the way concerns are framed. For example, vivid imagery tends to undercut agenda-setting power in focusing attention on people or unique characteristics rather than on underlying problems.

CONTINUING PROBLEMS

Those seeking to understand the relationship between mass media, public opinion, and environmental issues face two broad problems: (1) the nature of contemporary environmental problems, and (2) significant innovations in communication media.

First, contemporary formulations of environmental problems have expanded considerably in terms of their spatial-temporal scale, their complexity, and the diffuseness of their consequences, all of which make their adequate representation more difficult. The familiar symbols of environmental destruction in the 1960s and 1970s, such as burning rivers, dead lakes, razed forests, and mushroom clouds were easily represented and regionally delimited, with relatively clear causes for public opinion and policy regulation to address. Environmental problems today span the globe, stretch across generations, and remain largely invisible to common modes of perception. How does one effectively represent parts per billion of arsenic in drinking water, a gigaton of atmospheric carbon, or a critical oceanic desalinization point?

The problem formulation/resolution processes of mass media are particularly ill suited to mediating such environmental issues. Entertainment, educational, and news media alike tend toward dramatic representation and spectacle at the expense of ordinary, everyday engagement. Documentary films and tourist promotion tend to situate nature *as* spectacle, for spectators, which implies a stark dualism between humans and their natural world while routinely obliterating alternative and participatory engagements with nature from consideration. Such media continue belief in progressive technical domination and control of nature for human enjoyment, setting the stage for those converse instances of dramatic spectacle: natural disaster and catastrophe. Portrayals of disaster in Hollywood film and broadcast news are increasingly shaped by imperatives to capture attention and entertain, resulting in a vastly simplified framing of environmental crisis to the point these representations say more about narrative and journalistic production conventions than anything else.

In Hollywood film, environmental issues are portrayed as personalized conflicts between good and evil. This produces a simplified image of the complex and ambiguous process of claims making and responsibility attribution, while problem resolution takes place through heroic individual action, neatly tying up loose ends. In news media, problem formulation is similarly simplified. With the growth of 24-hour news and cable, news is now ever-present, continually casting events of the day into facile problem formats suiting television conventions like dramatic visualization, brevity, topicality, narrative coherence, blame, and action over criteria of multifaceted environmental appraisal.

The consequences of such distortion are most evident in coverage of natural disasters, where human/nature dualisms and "man versus nature" frames disguise the interaction of sociopolitical structures and natural processes. Failure to properly formulate the role of social policies in shaping structures of human vulnerability to disasters such as flood, fire, earthquake, and hurricane greatly impedes proper disaster policy analysis and the role of media therein.

Eric Klinenberg's 2002 book-length study of a single heat wave brilliantly elucidates the consequences of mass media failures to properly formulate and frame environmental crises. Heat waves are among the most consistently dangerous and well-understood environmental phenomena, easily predictable and ameliorated, yet, unlike flooding, they are difficult to visualize, affecting the most vulnerable in society without the widespread property damage images generally accompanying representation of disaster. As Klinenberg concluded in his analysis of the 1995 Chicago heat wave, which killed over 700 people, "several of the most probing and insightful accounts were overshadowed by prominent and sensational photographs, dramatic but misleading headlines, and false political debates that obscured the social aspects of the disaster."

The second set of problems concerns new information and communication technologies (ICTs), which have irrevocably changed the nature of mass media. Just as television altered the workings of print news and advertising, so digital media and internet access has transformed the relationship between mass media and society, creating new possibilities for perception and political organization. Optimistic proponents celebrate the interactive nature and participatory possibilities of new media, in providing near-instantaneous access to information on a vast array of issues and events, such as Scorecard, a regionalized pollution information site (www.scorecard.org) or Green Media Toolshed, which provides software and support for media components of environmental campaigns (www.greenmediatoolshed.org).

Other observers suggest answers to the problem of representing contemporary environmental problems might be found in the broad array of new visualization techniques ICTs offer, such as remote sensing, geographical information systems (GIS), and climate change modeling. At present, however, these gains are restricted largely to expert research tools. Their use in contemporary mass mediation tends to produce "chart junk" (visually appealing, scientific looking, but meaningless or misleading representations of data) and "data smog" (vastly increased production and distribution of unwanted and misunderstood information claiming our attention) as two consequences of decreasing costs and increasing availability of these media technologies.

More sober critics note a continuing Western bias to the global reach of news and advertising, as the same commodity orientation of mass media now characterizes the digital ones and zeros of these deregulated and privatized communication tools. As advertising-funded Western consumer media systems increasingly challenge subscription or tax-based public ones, observers remain genuinely concerned whether the digital extension of global advertising will contribute negatively to the magnitude and intensity of current environmental problems.

SEE ALSO: Abbey, Edward; Carson, Rachel; Earth First!; Ecotage; Greenpeace; Ideology; Sociology; World Wildlife Fund.

BIBLIOGRAPHY. John C. Besley and James Shanahan, "Skepticism about Media Effects Concerning the Environment: Examining Lomborg's Hypothesis," *Society and Natural Resources* (v.17, 2004); Graham Chapman et al., *Environmentalism and the Mass Media: The North–South Divide* (Routledge, 1997); Mike Davis, *Ecology of Fear* (Metropolitan Books, 1998); Kevin Deluca, *Image Politics: The New Rhetoric of Environmental Activism* (Guilford Press, 1999); Anthony Downs, "Up and Down with Ecology: The Issue-Attention Cycle," *Public Interest* (v.28, 1972); David Ingram, *Green Screen: Environmentalism and Hollywood Cinema* (University of Exeter Press, 2000); Eric Klinenberg, *Heat Wave: A Social Autopsy of Disaster in Chicago* (University of Chicago Press, 2002); Gary Kroll, "The 'Silent Springs' of Rachel Carson: Mass Media and the Origins of Modern Environmentalism," *Public Understanding of Science* (v.10/4, 2001); Tim Lukes, *Ecocritique* (University of Minneapolis Press, 1997); Dan Philippon, "Nature on Screen," *Review of Communication* (v.2/3, 2002).

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Mauritania

AFTER WINNING independence from France in 1969, the Islamic Republic of Mauritania annexed what is now Western Sahara, but was forced to cede the territory in response to repeated guerilla raids. After a coup in 1984 unseated the existing government, steps were taken to broaden political power. Although a free election was held in 2001, a bloodless coup in 2005 transferred power to a military government that pledged to move Mauritania toward democracy and away from the autocracy that still exists.

With a per capita income of $2,000, Mauritania is ranked 182nd in world incomes. Half of the workforce is engaged in agriculture, although less than one percent of land area is arable. One-fifth of Mauritanians are unemployed.

Forty percent of the people in Mauritania live below the official poverty line, and there is considerable income disparity. The richest 10 percent of Mauritanians share 30.2 percent of the wealth, while the poorest 10 percent claim only 2.5 percent of resources. The United Nations Development Programme's Human Development Reports rank Mauritania 152 of 232 countries on overall quality of life issues.

In addition to iron ore, which comprises 40 percent of export income, other natural resources include gypsum, copper, phosphate, diamonds, gold, and oil. Fishing has traditionally made up an essential element of the economy, but overexploitation by visitors to the country is threatening this important resource. Oil production is estimated at 75,000 barrels a day. Mauritania is still struggling with heavy debts and qualified for the Heavily Indebted Poor Countries Initiative in 2000.

Bordering on the North Atlantic Ocean, Mauritania has a 754 kilometer coastline. Land borders are shared with Algeria, Mali, Senegal, and Western Sahara. With the exception of a few hills in the central part of the county, Mauritania is generally comprised of the barren, flat plains of the Sahara Desert and the desert climate is hot and dry.

Drought may occur with devastating results in Mauritania at any time of the year. From March to April, the sirocco winds—which are hot, dry, and laden with dust—blow over Mauritania, creating major environmental damage. Elevations range from five meters at Sebkhet Te-n-Dghamcha to 915 meters at Kediet Ijill.

Environmental health is a major issue in Mauritania just as it is in other poor countries of Africa. Only 63 percent of urban residents and 45 percent of rural residents have sustained access to safe drinking water. While 64 percent of urban residents have access to improved sanitation, only nine percent of rural residents have similar access.

The population of 3,177,388 people is at very high risk for contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, typhoid fever, and the respiratory disease meningococcal meningitis. In some areas, the people also have a high risk of contracting malaria and Rift Valley fever. Women are particularly at risk from the fertility rate of six children each. The dissemination of birth control and other environmental health information is hampered by a literacy rate of 31.9 percent for females and 51.8 percent for males.

Deforestation, which occurs at a rate of 2.7 percent annually, is a result of the population's demand for fuel and construction materials and the traditional practice of clearing the land for agricultural use by slash-and-burn tactics. These methods have produced extensive soil erosion, and agricultural mismanagement has led to overgrazing.

When these processes are combined with frequent drought, increasing desertification is a foregone conclusion. The entire country is subject to locust infestation. Outside the area surrounding the Senegal River, fresh water resources are limited. For this reason, the population is concentrated around Nouakchott and Nouadhibou in southern Mauritania, resulting in a 61.7 percent rate of urbanization. Water pollution has been caused by dumping raw sewage into waterways, along with agricultural runoff and industrial effluents and oil spills. A project is in the works to build a dam on the Senegal River intended to deal with the shortage of water for human consumption and agricultural usage.

In 2006, scientists at Yale University ranked Mauritania second from the bottom of all countries scored on environmental performance, significantly below the relevant income and geographic groups. Particularly low scores were assigned in the categories of biodiversity and habitat, air quality, and environmental health. Between 1980 and 2002, levels of carbon dioxide emissions jumped from 0.4 to 1.1 per capita metric tons. The decrease in forested land is leading to major loss of biodiversity. Only 1.7 percent of all land area is protected by the government. Of 61 identified mammal species, 10 are endangered, as are two of 172 bird species.

In the late 1980s, the Mauritanian government began working toward developing a national program to deal with mounting environmental problems. Subsequently, the Ministry of Rural Development and Environment prepared the National Work Plan for the Environment, and policies were instituted to work toward achieving the goals of promoting sustainable development, achieving food self-sufficiency, rehabilitating problem areas, ensuring the rights of inhabitants to remain in their homes, checking rates of deforestation and desertification, and instituting water and power programs. The National Council for Environment and Development was also created to coordinate environmental issues. Mauritania participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Deforestation; Desertification; Dust; Sahara Desert.

BIBLIOGRAPHY. Central Intelligence Agency, "Mauritania," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Porgramme, "Human Development Report: Mauritania," hdr.undp.org (cited April 2006); World Bank, "Mauritania," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Mauritius

SINCE OBTAINING INDEPENDENCE from the British in 1968 after more than four centuries of colonial rule by a succession of counties, the island of Mauritius established itself as one of the most stable and prosperous countries in Africa. With a per capita income of $13,200, Mauritius is the 72nd richest nation in the world. The economy is diversified, and the industrial, financial, and tourist sectors are expanding. With more than 9,000 offshore entities, investments in the banking sector have passed the $1 billion mark. Even though arable land (49.02 percent) and fish are the island's only natural resources, only 14 percent of the workforce are engaged in these industries.

As the island has flourished economically, the standard of living has risen for most Mauritians. All of the people have sustained access to safe drinking water, and 99 percent have access to improved sanitation.

There has been some concern in recent years that the standard of living has decreased in the Creole community because of a slowed economy resulting from adverse weather conditions and a drop in sugar prices. Among the population of 1,240,827, this economic slowdown has also produced an unemployment rate of 10.5 percent and a poverty rate of 10 percent. The United Nations Development Programme's Human Development Reports rank Mauritius 65th in the world in overall quality of life issues.

Surrounded by the Indian Ocean, the Southern African nation of Mauritius has a coastline of 177 kilometers, encompassing the Agalega Islands, Cargados Carajos Shoals (Saint Brandon), and Rodrigues. The islands are comprised of a small coastal plain that gives way to discontinuous mountains around a central plateau. Elevations range from sea level to 828 meters at Mont Piton. The tropical climate of Mauritius is moderated by southeasterly trade winds. From May to November, winter temperatures are warm and dry, while the summer months from November to May are hot, wet, and humid. Cyclones occur every 15 years or so between November and April. The abundant reefs around the islands may present maritime hazards.

The waters surrounding the islands have become polluted, and coral reefs have begun to deteriorate. Around eight percent of the total land area is forested, and deforestation is occurring at a rate of 0.6 percent each year. Mauritius is not a land of great biodiversity, but three species of mammals are endangered. The nine species of endangered birds include the Mauritius kestrel, which was once identified as the rarest bird on the planet, and the still extremely rare echo parrot. The government has created a system of national and marine parks and protected other marine areas from further environmental damage. The Black River Gorges National Park is the largest nature reserve.

In 1989, the government of Mauritius created the Ministry of the Environment and the Department of Environment and charged them with implementing and enforcing environmental laws and regulations. Environmental policy was subsequently laid out in two National Environmental Action Plans that emphasized sustainable development by promoting the strengthening of existing institutions and improving management methods of land, marine, and coastal resources, water resources, and biodiversity. As industry has grown in Mauritius, there has been a greater demand for facilities to deal with expanded solid waste as well as basic sanitation and sewage. As a result, in 2000 the government instituted the National Solid Waste Management Strategy, and new regulations for handling hazardous waste were enacted the following year. A number of initiatives have been established to deal with the search for alternate energy sources and to minimize the impact of tourism on the environment.

Mauritius participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Coral Reefs; Endangered Species; Tourism.

BIBLIOGRAPHY. Central Intelligence Agency, "Mauritius," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *A Global Environmental Movements in Minority and Majority Worlds Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); S. Seegaluck et al, "National Priorities: Mauritius," www.sidsnet.org (cited April 2006); United Nations Development Programme, "Human Development Report: Mauritius," hdr.undp.org (cited April 2006); World Bank, "Mauritius," lnweb18.worldbank .org (cited April 2006).

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Maximum Sustained Yield

MAXIMUM SUSTAINED YIELD (MSY) is a central concept used in the management of renewable, biological resources, most prominently in forestry and wild fisheries. It is based on the deceptively simple notion that harvesting pressure should be limited or controlled such that aggregate harvests—

usually calculated on an annual basis—equal the rate of growth in the exploited population, and that in particular, harvest volume equilibrates with the maximum possible growth rate of the resource. This maximum in biological resources (again in theory) corresponds to the "culmination age," the point in the life cycle of individual members of the commercially exploited species when annual growth is maximized. Mathematically, this corresponds to the maximum marginal and average rates of growth calculated over the life span of the species. By harvesting all individuals in the target population at the point when their growth rate (not their actual size) is maximized, the aggregate harvest will correspond to the maximum sustainable yield over time.

Note, however, that this does not necessarily mean management for maximum economic profit. In fact, these are unlikely to coincide, and the MSY is a strictly biomass maximum, not an economic one. The notion also implies that management for the MSY should result in the "production" of regulated populations, be they trees or fish, such that no individuals exceed the age of culmination. In this respect, despite the apparently desirable connotation of "sustainable" here, management for the MSY based on idealized and simple mathematical equations between maximum growth and maximum harvest can result in dramatic and often unforeseen ecological effects.

FORESTRY

In forestry, this idea derives mainly from the German *Normalbaum*, literally "normal tree" or "normal forest," and more generally, from the development of scientific forestry in Europe during the 19th century (although with some antecedents in Asian forest management). A normal forest has been defined as "an ideally constituted forest with such volumes of trees of various ages so distributed and growing in such a way that they produce equal annual volumes of produce that can be removed continually without detrimental impacts to future production." The implementation of this idea in industrial forestry, wherein each tree is harvested at its culmination age, typically entails rationalizing forests by rotating harvesting pressure across a collection of discrete stands of commercially desirable trees, with each stand homogenous by age (if not species) and with different stands representing different age cohorts. As each stand reaches its culmination age, it is harvested. Subsequently, harvesting pressure moves to adjacent stands, while the harvested stand is allowed to grow back. The geography of implementing this principle requires not only shifting harvesting pressure from one stand to another, but also a total area often called a "working circle" can be derived from a given maximum harvest volume and known rates of growth per unit area.

Historically, adoption of MSY forestry arose in the context of increasingly science-based forest management, which was typically state-centered or coordinated and reflected and reinforced the conversion of "wild" (i.e., unmanaged by industry or science) forests into managed ones. Largely a 19th century development in Europe, the formalization of sustained yield policy in North American forestry is a product in certain respects of Progressive era championing of rationalized, state-led, and science-based resource management based on utilitarian principles, but oriented (à la Gifford Pinchot) to efficiency, order, legibility, and the production of "the greatest good for the greatest number" (again, in contrast with profit maximization).

The institutionalization of MSY forestry in the United States and Canada took place largely between 1937 and 1945. This timing followed important conceptual developments, including the work of E.J. Hanzlik who developed a formula for the "orderly" conversion of old-growth forests to normal forests based on the liquidation of accumulated, large volume and "overmature" stands, attended by harvesting rates that would, in the shorter term, exceed long-run sustainable levels. Initial adoption of the MSY as official forest policy on public lands in both the United States and Canada was precipitated not only by zealous Progressives such as Pinchot, but also by industry figures such as David T. Mason interested in conferring some predictability on harvest rates, and by more widely held social concerns with stabilizing and underwriting the future economic development of forest dependent communities with predictable, secure, and sustainable harvest volumes. This has largely failed because of the naïve equation of stable timber harvests with stable capitalist industrial employment and income.

FISHERIES

In fisheries, the adoption of MSY as orthodoxy is largely a post–World War II phenomenon. It followed the decline and collapse of numerous fisheries, and a concomitant shift from the perception of fisheries (particularly ocean fish stocks) as inexhaustible to recognition that the failure of many fisheries was tied to overharvesting, and regulation needed to rein in fishing effort.

Institutionalization of MSY in fisheries regulation was advanced by development of the Ricker model of stock and recruitment in the mid-1950s, which specified the culmination age given known species-specific dynamics of birth, growth, and mortality. However, unlike trees, fish move around and interact with other fish, including schooling with fish of the same species across multiple age and size cohorts. Moreover, some fish reproduce late in life, potentially after reaching their culmination age. Thus, successful MSY regulation in fisheries has had to target not only the amount of effort, but also the type of gear used (e.g., net mesh size) so as not to catch fish younger than their culmination age (with fish size used as a proxy), and in addition, models of MSY fisheries management have also had to account for the so-called recruitment problem, ensuring that harvesting pressure on reproductive age adults is controlled to allow sufficient recruitment of juveniles into the next generation.

Fishing regulations are maintained to avoid the catching of fish younger than their culmination age.

MSY REGULATION

Difficulties in fisheries management point more generally to some of the problems with MSY regulations. Neo-classical economists have been quick to point out that the MSY does not correspond to profit maximization of a fishery or in forestry except by chance, and thus is likely to dissipate rents. From this perspective, the emphasis is on privatization and market-led exploitation, a direction of reform that has garnered considerable momentum, particularly in fisheries, propelled not least by the ascendance of neoliberalism. This is despite the uncomfortable reality that, under the right conditions, economically "optimal" behavior for utility maximizing individual fishers may well be to drive fish to extinction.

There are other problems with MSY, too numerous to fully elaborate here. One is that the MSY approach to regulation tends to rely on idealized representations of abstract and single species population dynamics that can disguise how little is known about the basic biology of exploited species, including how they will actually respond to harvesting pressure. In forestry, unknown rates of soil depletion, responses to chemical fertilizers and herbicides, and to commercial thinning and pruning among forests whose history of regulated, commercial exploitation may still be only one or two generations (of trees) old all confound the ability to accurately predict future yields. As a result, "errors" have been introduced in MSY timber estimates based on persistently excessive optimism.

Similar problems have plagued fisheries science. In general, regulating wild fisheries for MSY or otherwise has proven extremely difficult largely because of commercial pressures to cheat, because of incomplete or uneven regulation of fishing territories (e.g., between domestic and international waters), because of the ecological effects of habitat destruction and by-catch, and because fisheries ecology has often been poorly understood. To some extent, these problems with MSY could be ameliorated with more precautionary models that emphasize unpredictable or nonlinear fluctuations in environmental conditions and population dynamics, and that set harvest limits below critical population thresholds.

But focus on single species in MSY regulation has also often failed to account for interactions of the commercially exploited species with their biotic and abiotic environment, not to mention with social behaviors and institutions. Simple population models and metrics, at least in their initial instantiations, tended to discursively erase other species and elements of ecosystems, helping to produce the abstraction, individuation, and ultimately alienation from ecological (and sometimes socio-ecological) context necessary for commodification. Yet this has proven problematic when other, ostensibly nondesirable elements of the ecosystems in question turned out to be important, even from a narrow instrumental standpoint, as well as from broader biodiversity conservation perspective.

It also becomes problematic when social sensibilities change. Increasing conflict over logging in old-growth forests of western North America, for instance, signifies the declining political legitimacy of MSY regulation, as the ecological impacts of forest simplification have become evident, and as these impacts have been politicized by changing sensibilities about forests. This points to the naïve or non-existent account of political economic context captured by simple MSY prescriptions for sustainable harvesting.

Responses to the shortcomings of the first generation of MSY regulation are myriad. They include not only the aforementioned emphasis on privatization and marketization, but also efforts to devolve governance and to involve resource user groups more directly in regulation, countering the generally top-down manner in which sustained yield has been implemented (and generally referred to under the rubric of community natural resource management). Alternatives also include efforts to regulate whole ecosystems in the form of ecosystem management, and to explore more adaptive forms of ecological management.

SEE ALSO: Fisheries; Forest Management; Forests; National Forest Management Act (NFMA); National Marine Fisheries Service (U.S.).

BIBLIOGRAPHY. N. Castree, “Commodifying What Nature?” *Progress in Human Geography* (v.27/3, 2003); C.W. Clark, *Mathematical Bioeconomics: The Optimal Management of Renewable Resources*, 2nd ed. (John Wiley & Sons, 1990); D. Demeritt, “Scientific Forest Conservation and the Statistical Picturing of Nature’s Limits in the Progressive-Era United States,” *Environment and Planning* (v.19, 2001); E.J. Hanzlik, “Determination of the Annual Cut on a Sustained Yield Basis for Virgin American Forests,” *Journal of Forestry* (v.20/10, 1922); S.P. Hays, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920* (Atheneum, 1980); R. Lande, B.-E. Saether, and S. Engen “Threshold Harvesting for Fluctuating Resources,” *Ecology* (v.78/5, 1997); P.A. Larkin, “Fisheries Management—an Essay for Ecologists,” *Annual Review of Ecology and Systematics* (v.9, 1978); B. Mansfield, “Neoliberalism in the Oceans: ‘Rationalization,’ Property Rights, and the Commons Question,” *Geoforum* (v.35, 2004); B. Mansfield, “Rules of Privatization: Contradictions in Neoliberal Regulation of North Pacific Fisheries,” *Annals of the Association of American Geographers* (v.94/3, 2004); J. McCarthy, “Devolution in the Woods: Community Forestry as Hybrid Neoliberalism,” *Environment and Planning A* (v.37/6, 2005); T.D. Perry, H.J. Vaux, and N. Dennis, “Changing Conceptions of Sustained-Yield Policy on the National Forests,” *Journal of Forestry* (v.81, 1983); W.S. Prudham, *Knock on Wood: Nature as Commodity in Douglas-Fir Country* (Routledge, 2005); W.G. Robbins, *Lumberjacks and Legislators: Political Economy of the U.S. Lumber Industry, 1890–1941* (Texas A&M University Press, 1982); K. St. Martin, “Making Space for Community Resource Management in Fisheries,” *Annals of the Association of American Geographers* (v.91/1, 2001).

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Measurement and Assessment

ALL DISCIPLINES USE some form of measurement for planning, performing, developing, and other purposes. They also seek to assign values or measures of quality and quantity to their objects of study, which can then be used as assessments of the subject. Much of modern measurement is performed as some form of descriptive statistics.

In the military, for example, the measurement may be the amount of ground captured, bridges wrecked, enemy units destroyed, or miles advanced into enemy territory. Similar goals are usually set in sports: a game is won by the team with the highest score, and this is usually achieved by the team with the longest possession time of the ball or puck, the most times at bat, or most ground advances toward a goal. In these and all other activities of life, measurement is an important task for determining what has been done and then assessing what needs to be done.

In the life sciences, measurements are most basically performed as a counting of the number of particular features of a representative member of a species; anomalies are also noted accordingly. For example, birds have two wings, fish have two primary fins, and dogs, cats, and horses have four legs. This form of measurement is very basic but is still done to describe a newly discovered species.

Other forms of measurement are those used to count the population of a species as well as its range. Some species such as dogs have large populations. Other species such as panda bears are confined to a small area and have small populations.

Counting the populations and the carrying capacity of an area is important to land and animal management. For example, an assessment of the size of a deer herd after a severe winter could be an important measure that could help forestry officials decide what extent of hunting should be allowed in the autumn. Or a survey of the size of the nesting habitat of migratory birds in the northern United States and in Canada (or in Europe and Siberia) could be an important study of the future prospects of the ability of species to survive, let alone flourish.

Many organizations working in the area of environmental protection or poverty reduction are seeking new instruments of measurement and assessment to use in setting goals. Key to the development of strategies for sustainable development that will help reduce poverty is the invention of measurement scales or tools that will aid decision making in public policy formulation.

In the case of those working with the poor in various areas of the world, the issue of defining poverty and the question of how to define levels of power is a subject of significant controversy. Because the resources available to people in the Philippines, for example, differ from the resources and needs of people in Brazil, Israel, or even in Japan, it is difficult to come to a single way of measuring the poverty of people in these countries.

In the Philippines, coconut palm trees grow readily. Any family with a small plot of land can easily grow coconuts trees, which provide food, fuel (the leaves and branches), and materials for other uses. However, in other countries, coconut trees may not grow easily, if at all. Therefore, to measure the impact and the absence of this resource and many other differences is difficult.

In Europe, the United States, and elsewhere, there have been debates for decades about the definition of poverty. However, there has been no universal agreement on the definition, nor has there been agreement about the approaches best used to define poverty. The struggle to define poverty in a scientific manner has been ongoing since the Industrial Revolution when impoverished workers inspired intellectuals to seek solutions to the problem of poverty.

Other ways in which measurements are made are of the factors of weather: temperature, wind, moisture, and clouds. These measurements provide data about the atmosphere, which become the weather of the day or hour. However, over a long period of time they become the climate and indicators used to assess whether the climate is warming or cooling.

Measurements in medicine are crucial to both individual patients and the physicians who treat them. For example, measurements of a patient's vital signs, blood sugar levels, cholesterol levels, white blood cell counts, and other factors are important measurements in determining the health of a particular body.

Some medical measurements and appropriate assessments are vital to the public at large. Public health officials keep watch on the number of cases of certain types of diseases. Significant increases may require major interventions to stop the advance of a disease. For example, a rapid rise in the number of E. coli cases may mean that restaurants or their suppliers of green onions, lettuce, carrots, or other vegetables may have to be shut down. Decisions in these kinds of cases may affect the financial success of individuals and companies, but they vitally affect the immediate health of people.

Statistical measurements of diseases are important to public health officials. The annual estimates of the number of influenza cases and the estimates of the likely mortality that will occur in population groups that are most vulnerable are a major health concern. It is because of measurements in the differences between serious and fatal reactions to taking vaccines compared with debilitation and fatality rates from the actual disease that decisions are usually made for urging large scale vaccinations. For example, if there is a sudden rise in the number of cases of tuberculosis or an outbreak of hemorrhagic fever, rapid responses can be made if the proper measurements are made in a timely manner.

Pharmaceutical companies aggressively develop new drugs by assessing the responses of drugs to viruses, bacteria, fungi, or parasites. However, they also engage in high throughput to assess chemicals in varied doses to various receptor sites in proteins, or in cells so that new leads for drug development can be identified.

Measurements of humans may be the most controversial of all measurements. From time to time the life sciences have provided material that has brought about political theory used to justify discrimination on the basis of race or to justify treating humans in an inhumane way. All people differ and those differences can often be easily recognized. However, establishing criteria for treating people unequally is often done by means of pseudo-measurements. In the case of natural differences, such as those of youth or age, different patterns of treatment are usually justified because of ancient tradition rather than by sound ethical reasoning.

All measurements of infants will show that they lack a number of capacities and that this justifies treating them differently from adults. For example, pharmaceutical companies spend great sums of money developing medicines and other drugs. These drugs have to be carefully tested and the results of the test assessed before they can be safely prescribed. It is a fact of biology that infants and children cannot absorb or utilize the same quantities of medicine as adults, and different doses must be prescribed.

Perhaps the most common forms of measurement and assessment are found in educational institutions. Teachers use many instruments to measure learning. However, test results also need to be weighed against other factors. Mere memorization will carry students to a certain point, but more important than mastery of the facts of a body of knowledge are the insights that come from applying information to a set of problems or to a set of facts. When this is accomplished, analysis can provide deeper types of information.

The use of biological ideas as a measure for assessing worth has a long history. Almost immediately after the publication of Charles Darwin's *Origin of the Species* in 1859, Herbert Spencer wrote *Social Statics,* from which developed the sociopolitical philosophy of Social Darwinism. The claim of Spencer, of his follower William Graham Sumner, and others was that humans compete for the resources of life. The unsuccessful and the unfit die off. The successful, it turned out, were the rich and the unfit were the poor. Using this measure of success, public policy advocates in the later 1800s argued against helping the poor. A similar politico-philosophic argument had been made in England in the early 1800s following the publication of Thomas Malthus's *An Essay on the Principle of Population*. Supporters of Malthus argued that because population increased geometrically and food supplies increased arithmetically, it was illogical to aid the poor with poverty programs. The Utilitarian doctrines of Jeremy Bentham, James Mill, and John Stuart Mill were developed and applied in opposition. The measure of sound policy, said Bentham, was its ability to deliver the greatest amount of good to the greatest number of people.

One of the most controversial forms of measurement is that found in intelligence studies. IQ tests measure the intelligence quotient of a person.

A person's IQ is their mental age divided by their chronological age. A child of eight with a mental age of 12 years will have an IQ of 1.5. If this were applied to a scale in which the statistical norm for the general population was 100, this child would have an IQ of 150. If this figure were more than two standard deviations away from the norm, the child would rank in the category of genius.

Intelligence tests, such as those developed by Alfred Binet at Stanford University and others, have been used to measure people and then to categorize them for jobs or other institutional situations. In the case of those falling at the bottom of the scale, they have sometimes been assigned to mental institutions as being mentally unfit for independent living in society.

Critics have, in many cases, claimed that IQ testing used as a criterion for admission to colleges or universities is unjust and discriminatory. One frequent argument is that these types of tests are culturally loaded. For example, immigrant children may be very bright, but their language skills are weak in the language in which the measurement and assessment is being made.

It may also be that children from underprivileged homes perform less well because they are undernourished or simply unexposed to the wider world. Another issue is the meaning of intelligence that IQ tests are supposed to measure. The term *intelligence* has never been precisely defined, which means that there is an open question as to what exactly an IQ test is measuring.

Economic measurements usually appear easily stated in terms of money. However, in many countries wealth is not measured in terms of cash or money; other resources may be used. While it is easy to appear to be using a scientific definition in terms of resources such as goats, sheep, services, or other values that are not readily stated in cash terms, these apparently operational measures of wealth may create false assessments. It is easy to raise a great number of rabbits; however, if a market for rabbits is significantly lacking, then this will not provide an equivalent mechanism for assessing value as cash does. Efforts at using scientific definitions to permit measurements that can be correlated between income and standards of living changes have proved to be difficult.

SEE ALSO: Malthus, Thomas Robert; Population; Poverty; Social Darwinism; Vaccination.

BIBLIOGRAPHY. Ian J. Deary, *Intelligence: A Very Short Introduction* (Oxford University Press, 2001); Jay Gould, *The Mismeasure of Man* (W.W. Norton, 1996); Robert L.L. Linn and M. David Miller, *Measurement and Assessment in Teaching* (Prentice-Hall, 2004); Cynthia C.C. Norkin and D. Joyce White, *Measurement of Joint Motions: A Guide to Goniometry* (F.A. Davis, 2003).

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Meat

MEAT IS THE edible, fleshy parts of animals used as food. It is an important component of the human diet because it is rich in protein, iron, selenium, and zinc, as well as being a good source of vitamins, notably vitamins B_1 to B_5. It constitutes a major link between society and environment because environmental resources are necessary to produce it and society is partially sustained by it.

Throughout prehistory and history, meat acquisition, consumption, and trade have contributed to the development of society and been responsible for environmental change as hunting/gathering has given way to organized animal husbandry. In general meat is classified as red, white, or game. Red meat derives from sheep, cattle, and pig while white meat derives from poultry, and game is the flesh of wild animals or birds. Meat production and consumption are also controversial issues not only because of the fundamental issue of eating animal flesh but also because of the treatment and butchery of animals in agricultural systems. The production, processing, and selling of meat and meat products are sources of employment and wealth generation worldwide.

A BRIEF HISTORY OF MEAT

There are several thresholds that can be recognized in the context of meat eating in prehistory. First, there is the onset of meat consumption by the ancestors of modern humans about 2.5 million years ago. This practice is characteristic of the early hominids, specifically *Homo erectus,* and is one feature that distinguishes the hominids from their australopithecine, apelike ancestors. The evidence for meat eating derives from cut marks on animal bones and the patterns of wear on the teeth of hominid skeletons found in archaeological sites. Some archaeologists subscribe to the hypothesis that meat acquisition and sharing contributed to social, linguistic, and brain development. The earliest meat acquisition was probably through opportunistic scavenging.

Second, hunting developed about 2 million years ago as an active food procurement strategy that required cooperation, planning, and group activity. This is linked with the control of fire and tool making. Third, further control was exerted by modern humans (*Homo sapiens*) beginning around 12,000 years ago with the first animal domestications and the initiation of the first agricultural systems. The main center of origin was the Near East, where goats, cattle, sheep, and pigs, the mainstays of modern pastoral agricultural systems, were domesticated. Other animals, for example, chicken, turkey, goose, duck, ox (yak), and rabbit, were domesticated subsequently. The dog was the first animal to be domesticated, possibly around 20,000 years ago, mostly for assistance with hunting and guarding but dog is eaten by some societies in the Far East.

Most modern meat consumption involves these animals but other animals are also consumed, notably those referred to as game, such as deer and game birds, for example, quail and pheasant. Moreover, bush meat, comprising any type of hunted or trapped wild animal, is consumed in many countries, especially those of low income or where famine and/or war render food scarce.

Once domesticated, livestock were introduced into Europe, Africa, and Asia and in some cases, notably cattle, additional domestication may have occurred independently in Africa and Asia. Animal herding, along with the spread of crops, resulted in deforestation as woodlands were converted to agricultural land. It has thus been a major agent of environmental change during the last 10,000 years. The impact of livestock rearing has also been significant in the Americas and Oceania, notably in Australia and New Zealand. This impact has been more recent than in the rest of the world because it was not until the discovery and annexation of these lands by Europe that cattle, sheep, and other livestock spread to these continents. This began in the Americas following the voyages of Columbus, which began in 1492, but later in Oceania following annexation by the British of Australia in the 1770s and New Zealand in 1840. All of these regions are major livestock producers today.

Most livestock species are herbivores; this means that they obtain energy for survival and reproduction from plant material, which in turn derives energy from the sun through photosynthesis. Consequently livestock are described as primary consumers, insofar as they consume the plants that are the primary producers, and as secondary producers because they are second in the food chain. Human consumers are secondary consumers. In terms of energy transfers within the system, the sun is the ultimate source of energy, but only organisms that can photosynthesize can harvest the light energy. Thus plants as forage are vital to livestock production and ultimately to human sustenance, which requires an intake of protein. This can be obtained directly from plants but occurs in a concentrated form in meat.

Over the centuries, livestock have been bred for specific characteristics including food value. Meat production can be classified into three types. First, intensive animal rearing as it occurs in Europe and North America involves the use of animal health products such as vaccines and antibiotics, and possibly pasture produced using artificial fertilizers, along with "finishing," that is, indoor fattening prior to processing in a slaughterhouse. Second is small-scale animal rearing, in which animals such as poultry and pigs are raised for the needs of an individual household or farm to provide protein for the family and are fed from farm and household waste.

Third is the rearing of animals on much of the earth's surface that is unsuitable for growing crops but that can produce animal protein due to the capacity of ruminants to convert low-quality forage into protein as milk or meat. Such areas include the continental interiors of Asia, Africa, Australia, and the Americas. In Eurasia and Africa, millions of

World livestock production in 2002 amounted to 242 million metric tons of meat—five times that of 1950.

people are supported by this extensive type of pastoral system in lands where plant productivity, and, hence, animal productivity, is constrained by environmental characteristics, especially annual temperature and rainfall regimes and soil type. Here, grasslands and shrublands support herds of grazing animals at low density; the animals are managed by nomadic peoples whose animal herds represent their wealth. Examples include the Saami people of northern Scandinavia (Lapland) and the Nenet people of northern Eurasia, who herd reindeer; these animals graze lichen-rich pastures in far northern continental regions in summer and retreat to the boreal forest zone in winter. In contrast, the Fulani people of West Africa and their neighbors, the Tuareg, follow the rains in semiarid and savanna regions to seek green pastures for their herds of cattle, sheep, goats, and camels.

Over time, many socioeconomic factors have influenced the quality and quantity of meat consumed. These include proximity to production, wealth, costs of other foods, transport availability, religious constraints, and health considerations. Technological factors are also important, notably the development of large-scale meat processing; the establishment of rapid transport systems via land, sea, and eventually air; as well as the development of refrigeration, which altered meat production and consumption patterns at all scales from the international to the domestic. Large-scale meat processing requiring industrial-scale slaughterhouses developed in response to the rapid urbanization that accompanied the Industrial Revolution, which began in the 1750s.

The emergence of large concentrations of people in Europe and North America in particular provided a ready market for all types of animal products as well as fresh meat. Cities like Chicago came to preeminence for their meat packing capability. Consequently, livestock was transported to cities and towns and then slaughtered, in contrast to the former practice of on-farm processing. Initially, the animals were themselves herded from the pastures to the slaughterhouses, but this changed as rail and, later, road transport systems were developed.

The invention of refrigeration in the first half of the 18th century made enormous differences to meat transport, its market price, and availability. Moreover, it encouraged meat production in countries distant from the main markets, especially in South America, Australia, and New Zealand, where large-scale ranching of cattle and sheep in semiarid regions began to produce meat for the voracious European market to which it was transported via refrigerated ships. Exports of meat continue to be significant earners of foreign currencies for these countries, though the markets now include the rapidly developing nations of Southeast Asia. Additional technologies that have influenced meat consumption include canning, vacuum sealing, the advent of supermarket ready meals containing meat, fast-food outlets, and pet-food production.

PATTERNS OF MEAT CONSUMPTION

Table 1 gives global livestock data for 2004, though, of course, not all animal parts are consumed as meat. In some countries, such as India, which has the second highest number of cattle at 185 million, the animals are kept mainly for their milk; similarly sheep are kept for wool production as well as meat. Many countries export meat and meat products, which constitute an important source of revenue as is the case for Brazil which, at 192 million head, has the highest numbers of cattle in the world, and

Argentina, which has almost 51 million. The United States has almost 95 million head, but most of the meat produced is consumed at home.

	Number of Animals
Cattle	1,339,295,570
Goats	782,947,553
Sheep	1,058,600,770
Pigs	947,801,201
Chickens	16,351,860,000

Table 1. World livestock data for 2004 (FAO, 2005).

The Food and Agriculture Organization (FAO) also collects information on meat consumption. In 2002 almost 40 kilograms (or 88 pounds; 1 kilogram equals 2.2 pounds) of meat were consumed on average per person worldwide. However, there are marked differences between world regions, which mainly reflect patterns of income. Meat consumption in the richest nations of North America is almost 10 times higher than that in the poorest nations of sub-Saharan Africa. Moreover, meat production and consumption worldwide has been gradually increasing. In 2002 livestock production amounted to 242 million metric tons of meat; this was five times the production in 1950 and double that of 1977. The growth has occurred mainly in newly industrializing countries such as China and India.

ENVIRONMENTAL COST OF MEAT

In terms of the environment, there are concerns about this trend. First, grains, which could be consumed directly by humans in a more energy-efficient food chain, are being diverted into animal feed. Second, additional land is required to sustain meat production either through the increased production of grain or the creation of pasture. Such an increase in agricultural land occurs at the expense of remaining natural ecosystems resulting in the loss of forests and savannas and their store of carbon.

SEE ALSO: Animal Rights; Animals; Cattle; Consumers, Ecological; Deer; Global Warming; Hunting; Land Degradation; Livestock; Overgrazing; Sheep; Vegetarianism.

BIBLIOGRAPHY. Carrick Devine and Michael Dikeman, eds., *Encyclopedia of Meat Sciences* (Elsevier, 2004); Food and Agriculture Organization, FAOSTAT database, faostat.fao.org (cited July 2006); James Gillespie, *Modern Livestock and Poultry Production*, 6th ed. (Delmar, 2002); Craig Stanford and Henry Bunn, eds., *Meat Eating and Human Evolution* (Oxford University Press, 2001); Peter Ungar and Mark Teaford, eds., *Human Diet: Its Origin and Evolution* (Bergin and Garvey, 2002); Paul Warriss, *Meat Science: An Introductory Text* (CABI Publishing, 2000).

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Mediterranean Sea

THE MEDITERRANEAN SEA is a sea of the temperate zone located between Europe to the north and west, Africa to the south, and Asia to the east. It represents approximately 0.8 percent of the total marine waters of the earth but contains 7 percent of global marine flora and fauna.

The region surrounding the sea and the numerous islands also contain one of the richest natural and cultural heritages of the earth, now threatened by phenomena such as pollution by agricultural and industrial discharges as well as that derived from oil tankers (25 percent of world traffic); urbanization linked to mass tourism; loss of natural and agricultural land; and possibly also sea level rise linked to climate change. The Mediterranean also presents one of the main socioeconomic fractures of the globe, with income differences of 1 to 5 between the northern and richer shore versus the southern and poorer shore. Hence the legal and, above all, illegal tide of immigrants from the south to the north.

The physical environment of the Mediterranean reflects the great complexity of an extremely dynamic natural setting. With over 28,520 miles (46,000 kilometers) of coasts, the sea is surrounded by high mountains, hills, and coastal plains and fragmented into several smaller water bodies separated by large land masses (peninsulas such as Iberia, Italy, and Greece and large islands such as Corsica,

Malta Burials

In Malta, with much of the island covered in rock, burials have always been a problem because of the difficulties in digging graves. In ancient times, people were buried in graves carved with great difficulty from the rock. The Romans forbade the burial of corpses in towns and cremation was used until 60 C.E., when Christianity reached Malta, and burials became preferred. This led to the construction of catacombs. The most famous surviving catacombs in Malta is the Hypogeum of Hal Saflieni, located in Burials Street, Paola. It was rediscovered in 1902 when workmen were building a water storage system, and is now a popular tourist site.

Gradually it became more popular to bury the dead inside churches and this continued up until a ban was placed on this in 1703 by the church, largely over worries about diseases and the disposal of bodies during epidemics. With the deaths caused by the plague of 1675–76, many bodies had to be buried in special graveyards in the countryside—prior to that the only cemeteries were for Turkish slaves and other Muslims whose bodies were not interred in Christian churches.

Another outbreak of the plague in 1813, a smallpox epidemic in 1830, and many deaths from cholera in 1837, 1865, and 1887 saw an enlargement of cemeteries throughout the island with many such as Ta Braixa becoming very large. A few burials in churches continued in country areas, especially when other members of the family were already interred in the church. By the mid-19th century civil authorities grew worried about the proximity of graves to the underground storage areas at Floriana, and even more new cemeteries were opened.

Sardinia, and Sicily). Climatically the most relevant characteristic is the presence of a distinctive summer drought, which historically has conditioned agricultural production, making irrigation necessary. Together with thermal conditions, however, it has also prompted the consolidation of mass tourism (228 million tourists in 2003 or more than 30 percent of the world total).

The combination of an active physiography (earthquakes, landslides, and volcanic eruptions) and climate (dominated by the hydrological extremes of floods and droughts)—plus a long history of human settlement—has produced one of the highest biodiversity rates of the planet. The Mediterranean is the home of 10 percent of the world's higher plants and ranks second only to tropical rain forests in the diversity of its many other plant and animal species.

In 2003 the 22 countries bordering the Mediterranean had an estimated population of 427 million (about 7 percent of the world total). Because of agricultural and tourist demand, water, which traditionally has been a limited resource in this region, has become critical, especially in the southern and eastern parts. Access to water and adequate wastewater systems represents perhaps the most important environmental challenge of the region. Most of the water is used for irrigation, and in many countries, available resources are unable to compensate for a growing demand. Thus it is estimated that about 108 million people in Mediterranean countries live with less than 264,172 gallons (1,000 cubic meters) per year available, and that about 45 million do with less than 132,086 gallons (500 cubic meters) per year (this figure is considered the "extreme scarcity" threshold). By 2025, the number of people with less than this threshold amount per year will rise to 63 million.

Alternative plans to correct growing water scarcities have tended to focus on the supply side through the building of dams and long-distance water transfers. Because of economic, social, and environmental reasons, however, these alternatives are being abandoned for demand management, and above all for new sources such as desalinized water.

In Spain in 2004, the socialist government commissioned the construction of some 18 desalinization plants with an estimated capacity of 35 billion cubic feet (1,000 cubic hectometers) per year. In some islands (such as Majorca and Malta) desalinization is already a regular source of water supply, and some oil-rich North African countries (Algeria and Libya) are also stimulating the development of this resource.

Land management, and particularly agricultural land management, is also a source of important environmental problems, although these assume different forms depending on the area. In the north, the rural population decreased 74 percent between 1960 and 2000. Abandonment has been particularly acute in the mountainous hinterlands where soil erosion, forest fires, and desertification are becoming serious environmental threats. In the south, despite migration, rural population still increased during the same period. However, intensive agriculture in some cases leads to soil salinization (affecting some 3.7 million acres [1.5 million hectares] in Turkey alone).

Urbanization and the related infrastructures are also destroying prime agricultural land. About 65 percent of the Mediterranean population lived in cities in 2002, but the patterns of settlement are again very different depending on the shore. In the north, the traditionally "compact" urbanization is changing to urban sprawl based on single-family houses (many of them with gardens and swimming pools) and the proliferation of the private car. Besides the loss of agricultural land and increase in energy consumption and emissions, an important effect of urbanization in the north is the production of waste (up to a ton per person per year in Monaco). In the south, cities are growing much faster, but 30 to 60 percent of their dwellers live in informal settlements. In 2025, 75 percent of the population will live in cities, especially those of the south.

In 1975, the Mediterranean countries and the European Community (EC) signed the Mediterranean Action Plan in Barcelona under the auspices of the United Nations Environment Programme (UNEP). The main objectives of this plan (later to be known as "The Blue Plan") were to protect the sea from pollution and to ensure development consistent with environmental protection. In the Monaco meeting of 2001, it was agreed to prepare a Mediterranean Strategy of Sustainable Development, which was presented in June 2005 in Athens and officially ratified by all member states in Slovenia in November 2005. Peace, political and social stability, and economic prosperity are seen as key factors in achieving sustainability, especially after the Balkan wars of the 1990s and continuing conflicts on the eastern shores.

SEE ALSO: Biodiversity; Oil Spills; Pollution, Water; Salinization; Tourism; United Nations Environment Programme; Urbanization; Waste, Solid; Wastewater.

BIBLIOGRAPHY. Russell King, Lindsay Proudfoot, and Bernard Smith, *The Mediterranean: Environment and Society* (Halsted Press, 1997); John D. Milliman et al., eds., *Climatic Change and the Mediterranean: Environmental and Societal Impacts of Climatic Change and Sea-Level Rise in the Mediterranean Region* (Edward Arnold, 1993); M.L. Nicolaou and A.D. Andreadakis, eds., *Pollution of the Mediterranean Sea* (Elsevier Science & Technology, 1996).

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Megalopolis

THE TERM *MEGALOPOLIS* combines *mega* (Greek for "big") and *polis* (Greek for "city") and has been used both to connote any very large city or city region and as a place name for particular large cities. The emergence in 19th- and 20th-century capitalist economies of cities that were both large and very rapidly growing led to a considerable literature on the opportunities and particularly the dangers that those cities presented. The coining of new terms to describe these cities reflected the feeling that they were unprecedented in scale, character, and significance.

EARLIEST USES OF THE TERM

The 1828 edition of Webster's *American Dictionary of the English Language* records the earliest known use of megalopolis, which it defined in terms of size and importance as "a chief city; a metropolis." This use is atypically neutral, but confirms that the term has always had most currency in North America. In *The Interpreter Geddes* (1927), the geographer and visionary Patrick Geddes (1854–1932) used megalopolis in a stage model of city growth and decay that was characteristic of his use in the social sciences of the concept of evolution. Geddes's "Polis" (city) grew successively into "Metro-polis" (the capital), "Megalo-polis" (the city overgrown), "Parasito-polis" (the degenerate city), "Pathalo-polis" (the diseased city), and finally "Necro-polis" (the city of the dead).

Geddes's pupil Lewis Mumford (1895–1990) extended the model. In *The Culture of Cities* (1938), he identifies six stages of evolution from "eopolis" (village) to "polis" (association of villages) to "metropolis" (capital city emerges) to "megalopolis" ("the beginning of the decline") to "tyrannopolis" (the overexpansion of the urban system based on economic exploitation), and finally to "nekropolis" (war and famine, city abandoned).

Mumford's use of the term and his gloomy prophesies continued in *The City in History* (1961) and in the double volume *The Myth of the Machine I: Technics and Human Development* (1967) and *The Myth of the Machine II: The Pentagon of Power* (1970), the latter of which uses images of New York's World Trade Center twin towers as exemplars of the "purposeless giantism" and "technological exhibitionism" of megalopolitan culture.

In 1961 the urban geographer Jean Gottmann (1915–94) published *Megalopolis,* which used the term "as a geographical place name for the unique cluster of metropolitan areas of the Northeastern seaboard of the United States." Gottmann's use of *megalopolis* consciously echoed its history as a place name in antiquity (Megalopolis was a city in the Peloponnese, Greece, founded in 371–368 B.C.E.) and, probably unconsciously, challenged the work of Geddes, who in *Cities in Evolution* (1915) had coined the term *conurbation* for the more or less continuous urban development characteristic of the same region, which he found to be "depressing life…[with] disease and folly…vice and apathy…indolence and crime." Gottmann describes Megalopolis neutrally as "an extraordinarily interesting laboratory *in vivo,*" but he admired it for the material and cultural opportunities it offered its inhabitants.

CONCEIT OR CONCEPT?

Whether "megalopolis" is an empty conceit or an unjustifiably neglected concept rests on whether the term has explanatory force. When Geddes and Mumford used the term, they were arguing by analogy from biology: organisms develop and decay, so too will cities because they are "organic." To Geddes's argument by analogy from nature, Mumford added an argument by extrapolation: because cities had fallen in the past, so would they in the future.

None of this identified a causal mechanism for cities' evident growth and posited decline, though the rhetoric, sharpened by use of neologisms such as *megalopolis*, was undoubtedly powerful in winning converts to the idea that uncontrolled capitalist city growth must be replaced with a rationally planned humane alternative. Mumford did attempt a causal explanation for his stage model, which included "megalopolis": in a mixture of classical economics and Marxist reading, he analyzed the economies and technologies that underlay the development of cities, suggesting that overconcentration in cities involved huge diseconomies and at the stage of "tyrannopolis" involved strategies of exploitation pursued over a wide geographical area to ward off the relentless fall in the rate of profit.

Despite having taken great pains over his choice of the word, Gottmann never explicitly claimed any explanatory power for it, and he was criticized in geographical circles from an early date for his refusal to define clearly what he meant by it. Gottmann's term was rooted in the rhetoric of classical erudition, internationalism, and scientific value freedom, but rhetoric could not compensate for the ambiguity of the term.

Gottmann defines Megalopolis as a place, a particular city region, and conceived of his study as a description of a unique region in classic French style, and an end in itself, although he stated that because the region was skillfully chosen it might also aid the study and the planning of similar regions. However, urban geographer Peter Hall asserts that in fact Gottmann had in mind not a physical definition, but a functional definition of urbanization and urban growth. Gottmann's ambiguity meant that megalopolis was not widely taken up by geographers as an analytical tool, but became simply a label bestowed by various authors on various very large city regions, a bestowal, however, which gave Gottmann great satisfaction.

The term megalopolis *has always had the most currency among North Americans.*

NEW INTERPRETATIONS

Contributors to a 2003 volume celebrating Gottmann's work, *Ekistics*, try to get beyond labeling by articulating what Gottmann apparently intended by "Megalopolis." They suggest "megalopolis" is a particular regional structure epitomizing Gottmann's general "geographical theory" of the relationships of man with space: geographical structures reflect the operation of both centralizing and circulatory trends, and analysis of those trends and the geographical entities they produce suggest a method for geography. They suggest that Gottmann was not simply a prophet of a new urban form, but rather that he clearly linked his case for the emergence of an American Megalopolis and possible ones elsewhere to a particular model of historical-geographical change. This model is based on the tension between pressures toward openness and closedness in territorial systems such as modern states.

They suggest that neither the possibility for linking the "megalopolis" to recent ideas about global city regions nor the fundamental insight about the political geographical underpinnings of urbanization has received much attention, and that instead megalopolis has misleadingly been associated simply with descriptions of urban sprawl and taken up in a literature that fallaciously considers city systems as separable from the particular economic systems of which they are a part. This is a valid criticism of urban studies, but the criticism is not new: neither is a new understanding or use of the term *megalopolis* necessary or sufficient for its solution.

Robert E. Lang and Dawn Dhavale also argue in favor of the term *megalopolis* to connote a functional, trans-metropolitan urban region. They suggest it is of value both in aiding description of a new geography, in which regional economies clearly extend beyond metropolitan areas, and as a basis for regional planning in an increasingly globalized economy. Perhaps most pertinently they argue that the U.S. Census Bureau is actively considering using "megalopolis" as a category in its work. Such an adoption would ensure the longevity of the term, but if, as seems likely, it would be based on size alone, it would probably ensure that the term remained a physical, not a functional term. (Interestingly *Ekistics* also uses the term as a simple measurement of settlement size.) Its adoption would, however, ensure that the term would increasingly be used following Gottmann's example, rather than Geddes's and Mumford's. The term continues to be used in pejorative, neutral, and approbatory ways outside the scholarly literature.

SEE ALSO: Cities; Geography; Industrial Revolution; Marx, Karl; Mumford, Lewis; Urbanization.

BIBLIOGRAPHY. Elizabeth Baigent, "Patrick Geddes, Lewis Mumford and Jean Gottmann: Divisions over 'Megalopolis,'" *Progress in Human Geography* (v.28, 2004); Robert E. Lang and Dawn Dhavale, "Beyond Megalopolis: Exploring America's New 'Megalopolitan' Geography," Metropolitan Institute Census Report Series, #05:01 (July 2005), www.mi.vt.edu (cited July 2006); Calogero Muscarà, ed., "In the Steps of Jean Gottmann," *Ekistics* (v.70, 2003).

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Mekong River

THE MEKONG RIVER is a major transboundary river with origins 5,000 meters above sea level in the Tibetan Plateau. The river's course runs through Yunnan Province, China (where it is known as the Lancang Jiang) and five Southeast Asian nations—Myanmar, the Lao People's Democratic Republic (Laos), Thailand, Cambodia, and Vietnam. The Mekong forms part of the borders of Cambodia, Laos, and Thailand. It drains an area of 795,000 square kilometers. Its annual discharge of 475 square kilometers and length of 4,180 kilometers makes the Mekong the longest and largest (by volume) river in mainland Southeast Asia, and the 12th longest and 10th largest in the world.

The population of the Mekong basin is estimated at 60 million, 50 million of whom reside in the Lower Mekong, the part of the river that flows through Southeast Asia. Approximately 25 percent of this Lower Mekong population lives in the Mekong Delta region, the most densely populated and agriculturally productive part of the basin. More than 70 ethnic groups live in the Lower Mekong basin. Human settlement in the basin dates back 6,000 years, and the Angkor civilization flourished on its banks (9th–15th centuries).

The Mekong is a vital livelihood resource for the people living on the banks of its tributaries and main stem, notably for irrigating some of the world's most productive rice fields, as well as the thriving fish catches. Mekong river ecosystems are some of the most diverse in the world. An estimated 400 fish species live in the Mekong and its tributaries, including the giant catfish (*Pangasianodon gigas*) and Irrawady dolphin.

Another unique environmental feature is the Tonle Sap, a lake in Cambodia that naturally regulates the extremities of seasonal flooding and low water levels in the main river. There is concern that dam construction on the river will impair the Tonle Sap's future ability to act as a "bladder" for the Mekong.

The Mekong has long held the imagination of institutions and administrations that have sought to exploit its potential. For the French seeking to expand colonial possessions in the late 19th century, the Mekong was purported to hold the key route to China. Although an 1866 expedition to chart this route failed to accomplish this, it succeeded in producing a number of mapping and qualitative surveys that were instrumental in guiding future French expansion in the region. Today, the river remains navigable only in sections.

Contemporary aspirations turned away from the river's navigability to the harnessing of its hydropower potential. In 1957, the Mekong Committee was formed with the aim of coordinating intercountry cooperation on flood control, irrigation, and hydropower. The first dams built were the Nam Pong and Nam Pung (1965–66) in Thailand's northeast, and the Nam Ngum (1971) in Laos. Other than these, activities of the committee came to a halt as the Indochinese (Vietnam) war escalated, and later, as Cambodia came under the control of the Khmer Rouge.

Cooperation was revived in 1995 with Cambodia's renewed participation in the newly reformed Mekong River Commission (MRC), which heralded a new era of regional cooperation, a move "from battlefield to marketplace." The commission revived scientific studies of the Mekong River, aiming at the sustainable development of the river's resources, although its true influence remains questionable, largely because two riparian countries—Burma and China—are not MRC members.

Although the Lower Mekong countries have agreed to avoid hydropower projects on the main stem, China has completed two main stem dams and has plans for more, with possible downstream impacts on the Lower Mekong. Dam-building on the Lower Mekong tributaries, however, gained momentum in the 21st century. The environmental and social costs of such projects have so far been secondary to the push for economic development in countries like Laos, where hydropower for export contributes a quarter of the annual Gross Domestic Product.

SEE ALSO: Cambodia; Dams; Hydropower; Laos; Myanmar; Rivers; Thailand; Vietnam.

BIBLIOGRAPHY. Hiroshi Hori, *The Mekong: Environment and Development* (United Nations University Press, 2000); Mekong River Commission, www.mrcmekong.org (cited August 2006); Milton Osborne,

The Mekong: Turbulent Past, Uncertain Future (Allen & Unwin, 2000).

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Mendes, Chico (1944–88)

FRANCISCO "CHICO" MENDES was a Brazilian rubber tapper, union organizer, and environmental activist who became an international symbol of the struggle to preserve livelihoods and the environment in the world's rapidly diminishing rain forests. Chico Mendes was born in Brazil's western Amazonian state of Acre to a rubber tapping family. He began working in the forest at a young age, combining small-scale subsistence farming with the harvest of rubber and Brazil nuts.

As the surrounding forests became increasingly threatened by deforestation by ranchers expanding their pasture holdings, often illegally, Chico Mendes became involved in local labor union and land rights issues. Elected secretary of his local rural workers union in 1975, Chico Mendes began organizing resistance to deforestation through a series of stand-offs (*empates*) in which local rubber tappers blocked ranch employees from clearing disputed forest areas.

In 1985 Mendes presided over the First National Rubber Tappers Conference in Brasília, resulting in the creation of the National Council of Rubber Tappers (Conselho Nacional dos Seringueiros). The formation of this entity propelled the rubber tappers' struggle to preserve their working and natural environment onto the national and international stage. The rubber tappers produced a declaration at the 1985 meeting entitled "Unity Among Forest Peoples" which consolidated the demands of indigenous and other local communities for the creation of extractive reserves that would combine forest protection with community economic survival. A key element of the declaration was the linkage between preservation of the natural environment and the protection of human rights, as evidenced in the opening statement of the declaration: "We demand a development policy for Amazonia that meets the interests of rubber tappers and respects our rights. We do not accept an Amazon development policy that favors large enterprises which exploit and massacre rural workers and destroy nature."

Chico Mendes also worked to publicize how international development projects including roads, ranching, mining, and other large infrastructure activities were linked to landscape conversion and deforestation within the Brazilian rain forest. In 1987, after traveling to Washington, D.C., Mendes worked with international environmental organizations to successfully pressure the Inter-American Development Bank to withdraw funding for a controversial road project that would have bisected his region.

Subsequently, legislation was passed in 1988 by the Brazilian federal government that would lead to the first extractive reserve in Brazil, officially demarcated in 1990 on land expropriated from ranchers in the municipality of Xapuri, Chico Mendes's organizing base and home. Named in his honor, the reserve today covers almost 2,500,000 acres and provides a forest-based livelihood for more than 6,000 families. By 2000, Brazil had created 12 extractive reserves on more than 8,000,000 acres. Economic activities on the reserves include rubber tapping, fishing, and the harvest of Brazil nuts, palm and other essential oils, and other forest products. Over 22,000 families live and work on the reserves.

For Brazilian and international audiences, the Chico Mendes story humanized the struggle to preserve the world's rain forests. Global discourse around forest preservation came to mean more than protecting biodiversity and addressing the problem of global warming by reducing deforestation, and to include discussion of the rights and roles of local peoples in combining conservation with social and economic development. Issues of social justice and political and economic empowerment became increasingly incorporated into international environmentalist discourse about ecological protection.

The story of Chico Mendes and the rubber tappers in Acre also highlights the evolving alliances between international nongovernmental and environmental organizations and grassroots groups around the world. Through such alliances local groups such as the rubber tappers of Acre learned the art and politics of international negotiation and the power of fostering a global discourse of solidarity that could bolster their local struggles. International environmental organizations learned the importance of valuing local knowledge about forest preservation and to recognize and protect the right of local peoples to sustainably utilize their local environments.

Local ranchers who felt threatened by the increasing political success of the rubber tappers' movement orchestrated the assassination of Chico Mendes in his home in Xapuri, Acre, Brazil on December 22, 1988. Darli Alves da Silva and Darci Alves Pereira were convicted of the crime in 1990 and sentenced to 19 years in prison. He was survived by his wife and two young children.

SEE ALSO: Amazon River Basin; Brazil; Deforestation; Nontimber Forest Products (NTFPs); Rain Forests; Rubber.

BIBLIOGRAPHY. Katrina Brown and Sergio Rosendo, "Environmentalists, Rubber Tappers, and Empowerment: The Politics and Economics of Extractive Reserves," *Development and Change* (v.31/3, 2000); Margaret E. Keck, "Social Equity and Environmental Politics in Brazil: Lessons from the Rubber Tappers of Acre," *Comparative Politics* (v.27/4, 1995); Chico Mendes, *Fight for the Forest: Chico Mendes in His Own Words* (Latin American Bureau, 1989).

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DR. CAROLYN MERCHANT is a leading U.S. expert in the fields of environmental history, ecological feminism, and the history of science. Dr. Merchant is Chancellor's Professor of Environmental History, Philosophy, and Ethics in the Department of Environmental Science, Policy, and Management at the University of California, Berkeley where she has served as faculty since 1979. Merchant was born in Rochester New York and received a B.S. in Chemistry from Vassar College at a time when few women studied the subject. For graduate work she transferred her focus to the history of science, earning a Ph.D. at the University of Wisconsin at Madison. Dr. Merchant also holds an honorary doctorate from Umeå University in Sweden.

In addition to numerous articles on the history of science, women and environment, and philosophy, Merchant is the author of half a dozen books. Merchant's writings have expanded understanding of symbols of nature, the interaction between productive and reproductive forces in history, and the importance of ecological change in understanding social and economic history. Her seminal first book, *The Death of Nature: Women, Ecology and the Scientific Revolution* (1980), brought women and nature front and center in the history of science and established her as a pioneer in the field of environmental history. In *The Death of Nature* Merchant details major changes in the perception of the earth, science, and of the role of women in society as a result of the scientific revolution. This book was a founding text for the field of ecological feminism. Her *Major Problems in Environmental History* is widely viewed as the most extensive textbook in the field. In 1998 the American Society for Environmental History held a symposium on *The Death of Nature,* during which it was called one of the most influential books in environmental history, philosophy, and feminism.

As a founding member and past president of the American Society for Environmental History, she has been instrumental in bringing issues of race, class, and gender into the forefront of historical analysis of human interaction with nature. Carolyn Merchant's more recent work has centered around an earth ethic, advocating bringing nature to the table as an actor in environmental decisionmaking. She currently teaches courses in American History, Philosophy, and Ethics at the University of California at Berkeley.

SEE ALSO: Ecofeminism; Gender; History, Environmental.

BIBLIOGRAPHY. Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (HarperCollins, 1980); Carolyn Merchant, *Radical Ecology: The Search for a Livable World* (Routledge, 1992; 2nd ed., 2005); Carolyn Merchant, ed., *Major Problems in American Environmental History* (D.C.

Heath, 1993; 2nd ed., 2005); Carolyn Merchant, *The Columbia Guide to American Environmental History* (Columbia University Press, 2002); Carolyn Merchant, *Reinventing Eden: The Fate of Nature in Western Culture* (Routledge, 2003).

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Mercury

MERCURY, OR QUICKSILVER, is a dense, silvery chemical element named after the Roman god of commerce and trading. It has fascinated humans for centuries, in part because it is something of an oddity—it is the only metal that remains a liquid at body temperature. Its abbreviation in the periodic table, Hg, is derived from its Greek name, *hydrargyrum,* which means "water silver." In German, mercury is called *Quecksilber,* while in French it is known as *mercure,* from which the English word is derived.

Mercury is most commonly found in a reddish ore called cinnabar. When the ore is heated, the mercury liquefies and oozes out of the crevices of the cinnabar. The world's largest deposit of cinnabar was located in southwestern Spain in a mine named the Almaden, which is Arabic for "the mine." Another large deposit, the Idria in Slovenia, has been mined for the last 2,000 years. There are other smaller deposits of cinnabar in China and Latin America. The New Almaden and New Idria Mines in California are the largest deposits of cinnabar in the United States, though it has also been mined in Oregon, Nevada, and Texas. Mercury mining has decreased, due in part to depleting sources of cinnabar, but also to an increased awareness of its toxicity. Today, most of the world's mercury comes from mines in China, Kyrgyzstan, Spain, and Tajikistan.

For centuries humans used mercury for a variety of cosmetic, medicinal, and technological purposes. The Chinese used mercury as early as 2000 B.C.E. and evidence suggests the Egyptians used it about 500 years later. Native Americans in California decorated their bodies with red cinnabar pigment, but because it often burned their skin, they claimed the mines from which it came contained evil spirits. During the Middle Ages, alchemists thought quicksilver had the ability to turn objects into gold, while medical doctors believed mercury could cure humans of a variety of maladies. The ancient Greeks used mercury in ointments, while England's Dr. Thomas Dover (1660–1743) was known as the Quicksilver Doctor because he commonly prescribed mercury to patients suffering from everything from "apoplexy to worms." By the 19th century, doctors commonly mixed calomel and "blue mass pills" using mercury to treat diverse maladies from syphilis to tuberculosis and gastrointestinal disorders.

Today, medicines containing mercury are typically considered poisonous; however, mercury can still be found in some over-the-counter medications such as antiseptics, eye drops, and nose spray. In recent years, legislative efforts in both the United States and the European Union (EU) have tried to reduce the amount of mercury in such medications, though mercury amalgams are commonly used in modern dentistry.

Mercury was once an indispensable element in gold and silver mining operations. In 1557 the Patio process was devised to separate silver from ore. Later a more involved stamping and amalgamation process was invented to separate gold and silver from quartz. When gold was discovered in California in 1848, the demand for mercury greatly increased.

Scientists experimented with mercury and by 1643 Evangelista Torricelli invented the barometer; Gabriel Fahrenheit invented the thermometer in 1714. Edward Charles Howard found a military use for mercury in 1799. Howard dissolved mercury in nitric acid and alcohol, forming a crystallized substance called mercury fulminate. When he struck the crystals, it caused a small explosion. Mercury fulminate was used as a primer to detonate gunpowder in cartridges and shells. At the outset of the American Civil War, mercury fulminate was an essential ingredient in warfare.

Mercuric nitrate was used in the 18th and 19th centuries to make felt hats. The "carroting process" released toxic vapors into the air. As craftsmen inhaled the fumes, they exhibited symptoms such as shaking, irritability, insomnia, and in some cases, dementia and hallucinations. The term "mad as a hatter" refers to craftsman suffering from mercury poisoning. As a result, mercuric nitrate was banned in the hat industry by the U.S. Public Health Service in 1941.

After the Industrial Revolution, mercury commonly entered the environment as a pollutant from a number of sources, including coal-fired power plants and industrial waste, and through the improper disposal of products containing mercury, such as car batteries and thermometers. Perhaps the most infamous incident occurred in Minamata Bay, Japan. When fishermen and families around the bay began to exhibit troubling symptoms, scientists found that the fish and shellfish of the bay contained inordinate levels of mercury. Researchers traced the high levels of mercury back to a local fertilizer company that had been dumping hazardous waste into the bay for more than 30 years. Over 3,000 people suffered from a particularly virulent form of mercury poisoning that locals referred to as Minamata Disease. As a serious health risk, therefore, mercury levels in tap water are limited by U.S. law. Even so, the element persists throughout the country, sometimes at dangerous levels. Between 1998 and 2003, 18.5 million people in the United States drank tap water contaminated with mercury and in 37 communities water was contaminated at levels above health-based thresholds.

SEE ALSO: Drinking Water; Minimata; Mining.

BIBLIOGRAPHY. Environmental Working Group, National Tap Water Quality Database, www.ewg.org/tapwater (cited July 2006); Leonard Goldwater, *Mercury: A History of Quicksilver* (York Press, 1972); Norbert Hurschhorn, Robert Feldman, and Ian Greaves, "Abraham Lincoln's Blue Pills: Did Our 16th President Suffer from Mercury Poisoning?" *Perspectives in Biology and Medicine* (v.44/3, 2001); Kenneth Johnson, *The New Almaden Quicksilver Mine: With an Account of the Land Claims Involving the Mine and Its Role in California History* (Talisman Press, 1963); Kenneth Ragsdale, *Quicksilver: Terlingua and the Chisos Mining Company* (Texas A&M University Press, 1976); Jimmie Schneider, *Quicksilver: The Complete History of Santa Clara County's New Almaden Mine* (Zella Schneider, 1992).

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Methane

METHANE (CH_4) IS a colorless and odorless gas that is produced naturally and as a result of industrial processes. It is present in natural gas and in firedamp, which is associated with coal mining, as well as in marsh gas, which is a product of the anaerobic decomposition of animal or plant matter. Decomposition under water is the most common form of anaerobic decomposition. Methane is produced when bituminous coal is burnt in the production of other substances.

Its main use is as a fuel. Its burning with oxygen produces carbon dioxide and water in a highly exothermic process. Methane may be harnessed as an alternative source of power to oil. Animal guts, such as from cows, also produce methane. Commercial methane gas does have a strong odor as a result of sulfur additives introduced to allow detection of potentially dangerous gas leaks. The total amount of methane in the atmosphere is increasing because of intensive agricultural processes and this is contributing to global warming.

The digestive processes of animals, notably farm animals, contribute up to 14 percent of the global total of methane. Several state governments for which agricultural production is a significant industry have attempted to tax such emissions. However, powerful farming interests have managed to thwart these efforts.

Agricultural scientists have achieved more success with chemical solutions to the problem, achieving reductions in emissions of up to 70 percent, although these results have not yet been tested on a large scale. For countries such as Australia and Canada, such a reduction in greenhouse gas emissions would make a significant contribution to the Kyoto Treaty or other international commitments to total emissions reductions.

Methane is considered a greenhouse gas because its absorbs terrestrial infrared energy that would otherwise escape into space. The current level of methane in the atmosphere is at its highest recorded modern level. Ice core analysis indicates not only a rapid increase in the amount of methane since 1750, but also acceleration in its increase since the 1980s. Methane has now reached an average of 1,745 parts per billion of the earth's atmosphere. Earth's early atmosphere had a much higher amount of methane, resulting from volcanic activity; however, such conditions are not conducive to human life.

In addition to animal digestion, landfill sites represent another major contributor to methane emissions. In the United States, the Environmental Protection Agency (EPA) has organized a number of projects aimed at harnessing the value of methane from landfills and sites of natural production and converting it into an economically viable resource. Many hundreds of such sites have been identified as suitable for this kind of development. Production of energy from this methane has significant social and economic benefits.

The most common source of methane, nevertheless, remains the presence of natural gas in deposits associated with oil and hydrocarbons in the ground. The presence of such gas remains of considerable geopolitical importance owing to its role as a stable source of energy production.

The gas fields available to Russia, for example, have enabled it to further several international political goals. The withholding of gas at low cost to Georgia precipitated political change in that country, while negotiations with European Union leaders for continued supplies of the gas enabled the Russian leadership to achieve a higher profile and more respected position. The world's largest known gas field is located between Iran and Qatar at the South Pars field.

SEE ALSO: Alternative Energy; Garbage; Global Warming; Greenhouse Gases; Landfills; Livestock; Natural Gas.

BIBLIOGRAPHY. Paulina Jaramillo and Scott H. Matthews, "Landfill-Gas-to-Energy Projects: Analysis of New Private and Social Benefits," *Environmental Science and Technology* (v.39/19, 2005); M. Mastalerz, M.V. Glikson, and Suzanne D. Golding, eds., *Coalbed Methane: Scientific, Environmental and Economic Evaluation* (Springer, 1999); National Academy of Sciences, *Methane Generation from Human, Animal, and Agricultural Wastes* (Books for Business, 2001).

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Methyl Tertiary Butyl Ether (MTBE)

METHYL TERTIARY BUTYL ETHER (MTBE) is a volatile, oxygen-containing hydrocarbon primarily used worldwide as an oxygenated fuel additive. Oxygenates are added to motor vehicle fuels to make them burn more cleanly, thereby reducing toxic tailpipe pollution, particularly carbon monoxide and volatile organic ozone precursors. Oxygenates are favored not only for their role in reducing combustion engine vehicle emissions, but also as octane boosters and volume extenders. The primary oxygenates are alcohols and ethers, including: fuel ethanol, MTBE, ethyl tertiary butyl ether (ETBE), and tertiary amyl methyl ether (TAME).

Following the U.S. Environmental Protection Agency's (EPA's) approval of MTBE as a fuel additive in 1981, it became the oil refiner's oxygenate of choice because its blending attributes include a high octane rating and gasoline miscibility, and it dilutes undesirable gasoline components such as benzene, a known human carcinogen, and sulfur. In 1988 the EPA extended the blending limit of MTBE in gasoline to 15 percent by volume (from 11 percent in 1981).

Worldwide MTBE usage grew in the early 1980s in response to octane demand resulting initially from the phaseout of lead from gasoline, and later from rising demand for premium gasoline. In the United States, the Federal Reformulated Gasoline (RFG) Program, established in the Clean Air Act Amendments of 1990 and implemented in 1995, required the use of RFG in cities with high levels of ground level ozone.

About 30 percent of gasoline sold in the United States is RFG, and it is currently used in 17 states and the District of Columbia. The RFG program stimulated a threefold increase in MTBE production from 83,000 barrels a day in 1990 to 269,000 barrels a day by 1997.

Worldwide, the United States is easily the largest consumer of MTBE at 12 million tons per year (Mtpy); followed by Europe and the former Soviet Union at 4 Mtpy; Asia Pacific at 3 Mtpy; South America at 1 Mtpy; and Africa and the Middle East at under 0.5 Mtpy.

Although MTBE has provided important health benefits in terms of reduced hazardous air pollutants, the increasing detection of MTBE in ground waters and reservoirs due to leaking underground storage tanks and pipelines, spills, and recreational water craft is cause for concern. MTBE is highly soluble in water and does not biodegrade easily. There is no human data on the health effects of drinking MTBE, although data have been collected to provide the risk assessment process with pharmacokinetic information relevant to the most common human exposures—through air and drinking water.

Studies with rats and mice suggest that drinking MTBE may cause gastrointestinal irritation, liver and kidney damage, and nervous system effects. There is no evidence that MTBE causes cancer in humans.

Two studies with rats found that breathing high levels of MTBE for long periods may cause kidney and liver cancer. The U.S. Department of Health and Human Services, the International Agency for Research on Cancer, and the EPA have not yet classified MTBE as to its carcinogenicity.

Because of the widespread presence of MTBE in water supplies, the EPA formed the Blue Ribbon Panel on Oxygenates in Gasoline. In 1999 the Panel recommended the following: (1) Reduce the use of MTBE substantially, (2) have Congress clarify federal and state authority to regulate and/or eliminate the use of gasoline additives that threaten drinking water supplies, and (3) eliminate the current Clean Air Act requirement of 2 percent oxygen, by weight, in RFG.

Several U.S. states have enacted bans on using MTBE in gasoline, including California, New York, Illinois, and Ohio; many others have limited the content of MTBE in gasoline to less than 1.0 percent by volume. Ethanol is projected as the likely oxygenate alternative, although its higher volatility makes it more difficult for refiners to meet emissions standards. However, the same volume of ethanol contains almost twice as much oxygen as MTBE, so only about half as much is needed to meet the RFG requirements.

SEE ALSO: Automobiles; Clean Air Act; Environmental Protection Agency (EPA); Fossil Fuels; Pollution, Air.

BIBLIOGRAPHY. Environmental Protection Agency, *The Blue Ribbon Panel on Oxygenates in Gasoline, Executive Summary and Recommendations*, July 27, 1999; J. Prah et al., "Dermal, Oral, and Inhalation Pharmacokinetics of Methyl Tertiary Butyl Ether (MTBE) in Human Volunteers," *Toxicological Sciences* (v. 77/2, 2004).

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Mexico

MEXICO IS A nation-state made up of 31 states and one federal district lying in the Western Hemisphere, south of the United States, north of Belize and Guatemala, and surrounded by the Gulf of Mexico and the Caribbean Sea on the east and the Pacific Ocean on the west. As of 2005, Mexico had a population of 107,000,000 and experienced a 1.16 percent growth rate.

Climatic, geological, and locational characteristics provide Mexico with a variety of biomes ranging from alpine paramo vegetation, highland pine forests, inter-montane grasslands, northern deserts and southern tropical wet and dry forests. This habitat diversity reflects the high levels of biological diversity in terms of both flora and fauna. A number of endemic and endangered species have focused worldwide conservation on Mexico in recent years.

EARLY AND PRECOLONIAL HISTORY

Although subject to debate, it appears that human beings arrived at what is today's area of Mexico approximately 20,000 years B.C.E. via the Bering Land Bridge in Alaska. While early inhabitants undoubtedly survived by hunting and gathering, it is now thought that agriculture began in Mexico around 10,000 years B.C.E., paralleling the development of agriculture in the Eastern Hemisphere.

One of the earliest crops cultivated was maize (*Zea mays* sp.), now the world's third most important grain. Other notable crops domesticated in Mexico include tomato (*Solanum lycopersicum* L.), chili peppers (*Capsicum annuum* L.), cacao

(*Theobroma cacao,* possibly domesticated in South America), vanilla (*Vanilla planifolia*), and tobacco (*Nicotiana spp*., L.). Other than the dog (*Canis lupus familiaris* L.) and turkey (*Meleagris ocellata*), very little evidence exists for domesticated animal species in Mexico.

Some have suggested that the brocket deer (*Mazama pandora*) was at least partially domesticated, but this species is no longer kept domestically. During this period, archaeological evidence indicates that house gardens began to be kept and some would indicate that these are the sites of earliest domestication.

Great civilizations arose in Mexico starting approximately 4000 years B.C.E., with early societies arising in the Izama, Olmec, and Teotihuacan cultures. These and the societies that followed—Maya, Mexica, and others—engaged in extensive and intensive agriculture. Religious practices reflected this tie to climatic and agriculture livelihoods with many deities associated with precipitation, seasons, and other production factors. Also, pre-Hispanic Mexican civilizations developed complex mathematical and calendrical understanding that allowed them to time cultivation and harvest activities based on seasonal variations.

Long thought to be an exceptionalist society—one that did not engage in intensive water management—studies in the 1970s and 1980s demonstrated that Mexican pre-Hispanic civilizations managed water intensively. Indeed, these early civilizations altered land cover dramatically with agricultural landscapes overtaking forests, grasslands, and other natural vegetation.

When present, soft metals, especially gold, and semiprecious gems were mined for decorative arts. While some groups changed production habits and the location of production throughout history due to socioeconomic and ecological factors, others maintained their close relationship with the land until the arrival of European colonizers in the late 15th and early 16th centuries.

COLONIAL AND POSTCOLONIAL TIMES

The arrival of Europeans represented a radical reorganizing of relationships between society and the environment in the Western Hemisphere in general

Smallpox in Mexico

In May 1520, Panfilo de Narvaez, a Spanish conquistador, left Cuba for Mexico. He planned to form an alliance with Montezuma, the Aztec king, and seize power from Hernando Cortez, who had arrived at the Aztec capital of Tenochtitlan (Mexico City) six months earlier. Panfilo de Narvaez brought with him a number of African slaves, one of whom was extremely ill when the force landed in Mexico.

It seems likely that this slave, along with others who may have been showing symptoms, was suffering from smallpox. The disease was transmitted to the Tlascalans, a tribe living around what is now Vera Cruz, and then it spread to Tenochtitlan. This seems to have taken place while Cortez was busy defeating the forces of Panfilo de Narvaez.

Cortez himself had already reached Tenochtitlan in November 1519, and was holding Montezuma, but had to leave when news came that Panfilo de Narvaez had arrived. He defeated the forces of his rival only to hear of a general uprising in Tenochtitlan. He rushed back to the capital, but was forced to evacuate his men. Allying himself with nearby tribes, he returned in April 1521 and lay siege to the city, but when he did take it, his men were surprised to learn of the number of Aztecs who had died of disease.

It is estimated that nearly half the population of Tenochtitlan had died in the smallpox epidemic, with large numbers of others dying throughout the region. In 1531 a second epidemic, also probably smallpox, hit Mexico. Again, it was introduced from Spanish ships.

Known as the "small leprosy," it resulted in a smaller number of casualties than the first wave. There was another outbreak in 1545, which led to the deaths of 150,000 in Tlascala near the coast, and 100,000 in Cholula. Two more outbreaks followed in 1564 and 1576. In all, it is estimated that 18.5 million out of an entire population of 25 million were lost to smallpox.

and Mexico specifically. Old World diseases decimated native populations in Mexico—some estimate place the loss as high as 95 percent in the first 150 years after contact. Disease coupled with new power relationships altered land use and land cover through disintensification, new crop introduction, and new production priorities. Mining, especially for silver and gold, increased, as did the production of animal and other commodity crops.

Lands thought to be little used were exploited, although recent efforts by geographers and others have concluded that Europeans frequently did not recognize Mexican land-use patterns and that depopulation due to disease decreased land use. Lands were expropriated from native owners and users by colonizers during the colonial period, a pattern that continued after the removal of the Spanish in 1821. Creole and wealthy mestizos assumed the roles of the previous colonial rulers of Mexico and similar land use and mineral exploitation patterns remained.

During the era of the Porfiriato—the rule of Porfirio Diaz—from 1876 until 1911, resource exploitation, including the harvesting of timber and other forest products continued. Much of that exploitation and purchase flowed to the United States and the United Kingdom, resulting in little reinvestment in Mexican infrastructure. While the majority of Mexico's population faced impoverishment in the countryside during this period, working as peons on large plantations, cities, most notably Mexico City, began to grow with the introduction of foreign-based industry.

The second Mexican Revolution began in 1910 and resulted in a transition to a socialist constitution intent on righting the wrongs of the colonial and early postcolonial period, especially in terms of land distribution and resource exploitation. Mineral resources—copper, petroleum, and others—were nationalized and the Mexican government distributed plantation and hacienda lands to landless farmers using communal forms of land tenure, most notably the *ejido*. Lazaro Cardenas was the father of the mineral nationalization and *ejido* reform programs. He hoped to engender a system of land tenure and land use based on small family farms that would produce commodities for Mexico's growing cities and enrich the countryside as well.

SOCIETY AND ENVIRONMENT TODAY

Riding the wave of the petroleum boom, Mexico's economy grew progressively through the 1970s. As industrialization intensified and Mexico was able to subsidize foodstuffs, the country experienced rapid urbanization. In the early 1980s the strength of the petroleum economy, coupled with other factors, led to a decade-long economic crisis in Mexico.

As part of national economic restructuring imposed by international lending and credit agencies, Mexico began to disinvest in subsidies for agriculture, forcing many poor farmers to abandon farming for urban centers or abroad. A series of constitutional reforms, including the potential dismantling of the *ejido* system, culminated in the signing of the North American Free Trade Agreement (NAFTA) with the United States and Canada. Decried by some as the death knell of Mexico's independence and economy, NAFTA intensified preexisting relationships, although it enabled freer trade in agricultural foodstuffs. To protect Mexican farmers, new subsidies were distributed with total phase-outs planned for 2009.

Accompanying the rural impacts of NAFTA, foreign industrialization in Mexico has sped up because of the country's proximity to the United States, the high skill levels of the workforce, and the federal government encouragement of industrialization. In industrial areas, environmental regulations are poorly enforced and numerous chronic and extreme environmental hazards threaten residents in Mexico.

The 1980s and 1990s also witnessed a sustained drive to protect Mexico's environment. Unilateral and multilateral agreements encouraged the establishment of national parks, biosphere reserves, and new environmental legislation. These programs represent an improvement from efforts earlier in the century to populate the countryside and utilize it for national economic interests.

FUTURE TRENDS

Despite encouraging signs of increased environmental protection and awareness, Mexico's future society-environment relationships remain murky. Overexploited fisheries, decreasing watersheds, and tired soils portend slow or fast acting environmental problems. At the same time, Mexico's balance of trade has improved, pointing to possibly wealthier economic and environmental horizons. Population growth rates continue to slow but cities, especially Mexico City, are already pushed to the ecological breaking point.

SEE ALSO: Cacao; Disease; Gold; Industrialization; Maize; Markets; Race-to-the-Bottom Hypothesis; Tomatoes; Urbanization.

BIBLIOGRAPHY. T.D. Dillehay, *The Settlement of the Americas: A New Prehistory* (Basic Books, 2000); A. Sluyter, "Colonialism and Landscape in the Americas: Material/Conceptual Transformations and Continuing Consequences," *Annals of the Association of American Geographers* (v.9, 2001); T.M. Whitmore and B.L. Turner, *Cultivated Landscapes of Native Middle America on the Eve of Conquest: Oxford Geographical and Environmental Studies* (Oxford University Press, 2001).

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Microbes

MICROBES ARE A large, diverse group of organisms that exist as single cells or as colonies (clusters of cells of the same species) that are able to grow, generate energy, and reproduce independently of other cells. Microbes may be eukaryotic or prokaryotic. The eukaryotic microbes include algae, fungi, slime molds, and protozoa, and the prokaryotic microbes are the bacteria, archaebacteria, and cyanobacteria. (Because viruses cannot metabolize and reproduce without hijacking the metabolic processes of a host cell, viruses are not true cells. Thus, debate exists about whether viruses are living organisms and thus technically "microbes.")

Microbes colonize virtually all terrestrial and aquatic habitats on Earth, from polar glaciers to deep-ocean hydrothermal vents. Microbes contain the greatest species diversity of any group of organisms on Earth. Bacteria have particularly high species diversity, and their tremendous metabolic flexibility allows them to inhabit the extremely unfavorable environments of deep sea hydrothermal vents, polar ice, and deep buried sediments.

The first organisms to evolve on Earth, microbes have played a key role in altering the gaseous makeup of the Earth's atmosphere, and in the evolution of higher life forms. For example, early in the history of life, enormous colonies of aquatic cyanobacteria grew as pincushion-shaped organisms termed *stromatolites*. Over hundreds of millions of years, oxygen emitted by *stromatolites* as a by-product of their prolific photosynthesis progressively oxygenated the atmosphere. Scientists believe that the cyanobacteria-mediated oxygenation of the atmosphere facilitated the evolution of new organisms that rely upon oxygen. Soil fungi may have also facilitated the evolution of higher life forms. Root imprints of the earliest land plants fossilized in sedimentary rock show evidence of fungal symbionts present in root cortical cells. This suggests that the movement of plants onto land was aided by a mutualism with mycorrhizal fungi, specialized fungal microbes that today colonize the roots of most terrestrial vascular plants to aid in nutrient uptake.

People most commonly associate microbes ("germs") with human illness, and indeed microbes act as pathogens or parasites on a great number of humans and other animals. The effects of microbial colonization of animal tissue, however, may be positive, negative, or neutral. Hair follicles are inhabited by an array of bacteria, yeasts, and filamentous fungi. Various pathogenic bacteria cause diseases such as *Stapholococcus* and *Streptococcus* infections, diphtheria, Legionnaires' disease, tuberculosis, and sexually-transmitted diseases. The bacterium *Yersinia pestis*, transmitted to humans through bites from fleas that have fed on infected rodents, caused the bubonic plague, which killed 25 million people around the world over five years during the Middle Ages. Protozoan diseases such as leishmaniasis, African sleeping sickness, malaria, and amoebic dysentery cause serious illness and death to millions of people worldwide each year. The same bacteria that can cause illness when present in the mammalian stomach, however, are essential for nutrient transformation and uptake in the large intestine.

Ecological communities are also strongly affected by microbes. Pathogenic organisms, especially fungi, can have such broad-ranging effects that the composition of entire ecosystems can be changed indefinitely. For example, an Asian fungal pathogen *Cryphonectria parasitica* caused a widespread chestnut blight that virtually eliminated the stately American chestnut tree (*Castenea dentata*) from eastern deciduous forests in the mid-1900s. Other microbial plant pathogens cause significant plant and crop damage every year, and scientists are continually studying ways to mitigate damage to desirable plant species.

By no means are all microbes pathogenic. Microbes also have enormous positive impacts on agriculture, ecology, human welfare, and global economics. The discovery of the antibiotic properties of the soil fungus *Penicillium* was one of the most important microbial contributions to human health in recent history. Enzymes produced by microbial processes are used commercially to produce sweeteners such as glucose and fructose, and microbial enzymes and secondary metabolites are used industrially to produce various antibiotics and other pharmaceutical products. Chemical food additives such as amino acids, riboflavin, B_{12}, and ascorbic acid (vitamin C) are also produced industrially from microbial by-products. Selected species of the single-celled yeast fungus, *Saccharomyces*, are used as baker's yeast for raising bread and for beer and wine manufacturing. Beneficial mutualisms between microbes and plants, animals, and other microbes are common in nature. And, in all natural and agricultural ecosystems, soil bacteria and fungi decompose and mineralize soil organic matter, which recycles carbon, nutrients, and minerals through the biosphere.

Recent biotechnological developments have expanded the possibilities—and risks—of the industrial use of microbes. Genetic engineering of microbial cells is used to modify antibiotic-producing microbes, to produce vaccines against deadly viruses, and to isolate and produce mammalian proteins for medical research. Microbes that degrade pollutants are used in bioremediation of polluted soil and water. Scientists in the field of gene therapy who treat genetic diseases are currently experimenting with microbes that can control the expression of particular deleterious genes. Microbial transgenes inserted into whole plants and animals may also increase agricultural productivity and the nutritional value of food. It is important to note, however, that although genetic engineering holds promise for improving the quality of life for many people, the field is still highly controversial because many possible negative consequences remain unknown. Risks of genetic engineering include the escape of crop transgenes into wild weedy relatives, and risks to human health of ingesting transgenes from allergenic organisms. Long-term research will shed light on both the opportunities for and risks of using microbes in genetic engineering.

SEE ALSO: Antibiotics; Biotechnology; Disease; Genetics and Genetic Engineering.

BIBLIOGRAPHY. T.D. Brock, M.T. Madigan, J.M. Martinko, and J. Parker, *Biology of Microorganisms* (Prentice Hall Publishers, 1994); B.D. Dyer, *A Field Guide to Bacteria 2003* (Cornell University Press, 2003).

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Microclimates

MICROCLIMATES OCCUR IN localities where the atmosphere is different from the general climate of the surrounding area. They affect the fauna and flora of the small area enough to create a unique little ecology. Usually they cover a small forest, garden, or town.

Microclimates can be caused by nature or by human activities. They exist in many places. Some are near bodies of water that can cool the local atmosphere. Or some may be in sheltered glens or mountain coves where the atmosphere allows plants to grow that would not survive if exposed to the general atmosphere.

In some localities volcanic activity creates warm conditions that allow fauna or flora to grow where they would not otherwise survive. There are places such as remote, isolated valleys among high desert mountains where fauna and flora thrive sheltered from sun and drought. The Ahaggar Mountains (Hoggar) in the Algerian Sahara have verdant microclimates even though most of the Ahaggar Mountains are waterless regions. Occasional snows supply water to deep ravines in which vegetation grows.

Human activities can create microclimates. When dams are built, land is farmed, forests are logged, or afforestation is implemented, the local climate is sometimes significantly affected. Cities also affect the hydrology of an area because the absence of vegetation and loss of ground area for absorbing run off leads to localized flooding. Also, skyscrapers can create wind changes and a tunnel effect as winds are forced to flow between tall buildings in cities.

Humans also utilize microclimates. Planting gardens on urban rooftops can reduce ambient heat, and gardeners also often position certain plants were the sunshine will favor them. In the American South, fig trees are planted by the sheltered southern corners houses where they will be better sheltered from in winter. Farmers use local microclimatic features to grown crops in small areas when they cannot flourish in the surrounding climate. For example, xeriscaping uses knowledge of drought and desert conditions to promote the growth of decorative gardens. Using the sun-favored southern slopes in the Northern Hemisphere and the sun-favored northern slopes in the Southern Hemisphere plants or homes can take advantage of a local microclimate.

Slopes can also protect frost sensitive plants when they are placed nearer to the top of the slope—colder air sinks toward the bottom of slopes. Cherry trees are planted on the sides of slopes to keep them from standing in water. Gardens that are surrounded by walls are afforded protection from winds that can destroy fruit blossoms or tender leaves; fruit trees grown next to walls can use the heat absorbed by the wall as a radiator to promote ripening.

Some museums create artificial microclimates, such as hot jungles, rain forests, and cold climate rooms that permit storage or exhibition of plants and animals that would not normally thrive in the local atmosphere. Greenhouses, hothouses, or sheltered houses are artificial environments as well as artificial microclimates. By using trapped solar heat plants can be germinated earlier or grown to maturity sooner.

One of the most well-known microclimates is the summertime "urban heat island." Microclimates occur in urban areas because asphalt and concrete streets combine with tall buildings of brick, stone, concrete, or other materials to absorb heat from the sun's rays.

The absorbed energy is radiated as heat that adds to the air in the ambient atmosphere. The effect is to create a heat dome that makes the city locality hotter. Another example often seen is a natural park adjacent to a shopping mall that covers the same area as the natural park. The natural park will be cooler than the adjacent area. Each of these would be separate microclimates: The vegetation in the natural park will absorb the sun's rays in its leaves; the grooves of the mall buildings and parking lot reflect the heat of the sun's rays back into the ambient atmosphere. If solar energy striking urban areas were collected in a systematic fashion it could be harnessed as energy.

SEE ALSO: Forests; Urban Ecology; Urban Gardening and Agriculture; Urban Parks Movement; Xeriscaping.

BIBLIOGRAPHY. Dario Camuffo, *Microclimate for Cultural Heritage* (Elsevier Science & Technology Books, 1994); Hamlyn G. Jones, *Plants and Microclimate: A Quantitative Approach to Plant Physiology* (Cambridge University Press, 1992); Norman J. Rosenberg, Blaine L. Blad, and Shashi B. Verma, *Microclimate: The Biological Environment* (John Wiley & Sons, 1983); David Leslie Spittlehouse, R.S. Adams, and R.D. Winkler, *Forest, Edge and Opening: Microclimate at Sicamous Creek* (BPR Publishers, 2004).

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Micronesia

AS A UNITED Nations Trust Territory, the Federated States of Micronesia was placed under the administration of the United States after World War II. In 1986, Micronesia attained independence through a Compact of Free Association. In addition to marine products and deep-seabed minerals, Micronesia's natural resources include forests and high-grade phosphate. The Micronesian economy suffers from a 16 percent unemployment rate. Less than 6 percent of the land is arable; however, most people survive by subsistence farming and fishing. Less than one-third of the population lives in urban areas even though two-thirds of Micronesians work for the government.

With a population of 108,105, Micronesia has a fertility rate of 4.4 children per woman. The per capita annual income of $2,000 means that Micronesia ranks 180th of 232 nations in world incomes. Almost 27 percent of the population lives below the poverty line. Without subsidies from the United States, which are scheduled to end in 2023, and other grants, Micronesians would find life even more difficult. While 96 percent of the residents do have access to safe drinking water, 72 percent have no access to improved sanitation. Many people have no knowledge of basic environmental protection measures. Due to lack of data, Micronesia is not ranked by the United Nations Development Programme Human Development Reports.

Made up of only 271 square miles (702 square kilometers) of land area with no freshwater resources, Micronesia comprises four major island groups: Pohnpei, Chuuk, Yap, and Kosrae, totaling 607 islands. Bordered entirely by the North Pacific Ocean, Micronesia has 3,789 miles (6,112 kilometers) of coastline. The tropical climate leads to heavy rainfall throughout the year, particularly in the eastern islands. The typhoon belt in the southern edge of the federation occasionally suffers serious ecological and property damage. The terrain of the islands varies from mountainous to low coral atolls. Volcanic outcroppings are present on Pohnpei, Kosrae, and Chuuk.

The largest of the 607 Micronesian islands is home to 100 species that live nowhere else on the planet.

In addition to creating economic problems for Micronesia, overfishing has damaged ecosystems, as have pollution and global warming. Military activities of the past have left legacies that include contamination of marine food supplies; hot spots have been identified in Micronesia where hazardous chemicals such as transformer oils and pesticides have been stored, used, or discarded.

There are more rare, endangered, threatened, and endemic species per unit of land in Micronesia than anywhere else in the world. Consequently, some Micronesians have banded together in the Nature Conservancy to promote environmental protection and biodiversity. The focus of this work is on Pohnpei, the largest of the Micronesian islands. Pohnpei, which is home to 100 endemic species that live nowhere else on the planet, contains the largest intact upland rain forest in Micronesia and is one of the greenest wetlands in the world.

In order to promote sustainable development, the Environmental Protection Board and the Department of Human Resources are given authority under the Environmental Protection Act to promote environmental responsibility in Micronesia. Yap and Kosrae have also passed state environmental legislation. The U.S. Department of the Interior also works with Micronesian officials on the Micronesia Water and Wastewater Training Project to promote the operation, maintenance, and management of local water and wastewater utilities. In addition to government programs, the University of Oregon established the Micronesia and South Pacific Program in 1988 to work with the University of the South Pacific and the College of Micronesia-FSM to further promote sustainable development on the islands. Micronesia's commitment to the global environment is basically limited to participation in the following economic agreements: Biodiversity, Climate Change, Desertification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Endangered Species; Overfishing; Poverty; Rain Forests; Subsistence; Wetlands.

BIBLIOGRAPHY. Central Intelligence Agency, "Micronesia," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Australia, Oceania, and Antarctica: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); K.R. Howe, *Nature, Culture, and History: The "Knowing" of Oceania* (University of Hawai'i Press, 2000); Nature Conservancy, "Federated States of Micronesia," www.nature.org (cited April 2006); United Nations Development Programme, "Human Development Reports: Micronesia," hdr.undp.org (cited April 2006); United Nations Environment Programme, *Pacific Island Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Micronesia, Federated States," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006).

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Migration

THE RELATIONSHIP BETWEEN the environment and migration is most often addressed through two major issues: the ways in which environmental change relates to decisions to move, and the ways in which migrants either leaving or arriving in a particular place affect the environment. Recent literature addressing both of these issues, while building upon long-standing debates on migration and the relationship between population and the environment, now focuses on case-specific understandings of the local social relations that give the environment and natural resources value and meaning in particular places.

MAXIMALIST VERSUS MINIMALIST

Historically, the study of the relationship between the environment and the decision to migrate has taken shape through debates about the definition and legal standing of environmental migrants and environmental refugees. The debate about what constitutes an environmental refugee is largely divided into two camps. The first of these takes a maximalist point of view to the role of environmental change in migration decision making, in which environmental degradation is a cause of insecurity that "displaces" people by causing them to seek out settings of greater safety and certainty. This approach to understanding the relationship between migration and the environment works best in situations of sudden, dramatic change, such as coastal inundation or volcanic eruption. In cases of gradual environmental change, however, the decision to move is often considered alongside of, or in combination with, other factors such as the economic and social situation of the decision maker. Writers who recognize this complexity follow a second, "minimalist" approach to the relationship between environment and migration, arguing that one cannot separate the political and the economic from the environmental when considering migration decision making. This argument arises most clearly when researchers question what constitutes a "legitimate" push for migration, but while they point out the complex links among environment, economy, and politics in migration decision making, very little of this work systematically engages how the environment, as one of a suite of drivers in a specific context, becomes integrated with economic and political concerns.

While the minimalist and maximalist literatures continue to inform scholarly and legal debates over the definition and status of those who move, at least in part, due to reasons of environmental change, this discussion limits the ways in which this relationship is conceptualized and therefore does not speak to the intersection of larger political ecological and migration issues that will better inform our understanding of the environmental change/migration nexus. Recent work in migration, however, runs closely parallel to contemporary interests in political ecology, suggesting new paths for the consideration of the migration and environment nexus.

NEOCLASSICAL VERSUS POLITICAL ECONOMY

The broader migration literature has been dominated by two conceptual camps: neoclassical/rational choice and political economy/Marxist. While seemingly opposed approaches to understanding migration decision making, with the neoclassical/rational choice emphasis on individual maximization and the political economy/Marxist focus on structural shifts in the economy, a number of authors have pointed out their shared shortcomings. Vinat Gidwani and Kalyanakrishnan Sivaramakrishnan offer the broadest critique of both schools, arguing that neither offers any interrogation of a modernist rationality that reduces the migrant and migration to a "necessary, if sometimes unfortunate, subplot in the unfolding of history."

The problems that neoclassical/rational choice and political economy/Marxist approaches to migration share have prompted a number of critics to offer their own alternatives to these dominant schools. Many of these critiques aim to understand, as Gidwani and Sivaramakrishnan put it, "how migrants apprehend, negotiate, and transform the social structures that impinge on their lives." The diverse approaches that result from these critiques range from efforts to explore the transformative power of consumption to exploration of the voices of migrants.

These alternative migration approaches are important parallels to contemporary work in political ecology, especially feminist political ecology, that focuses on uneven access to and control over resources. Specifically, these literatures share an understanding of the importance of local social relations in human perception and decision making. These social relations, therefore, serve as a point of contact between the migration literature, which attempts to understand migrant subjectivity, and the political ecological literature, which attempts to understand the social construction of natural/environmental resources and their use. This point of contact creates the potential for a link between environmental change and migrant subjectivities.

ENVIRONMENTAL DEGRADATION

The other major area of concern with migration and the environment is the relationship between migration and environmental degradation. Historically, little attention was paid to this issue within population and refugee studies, with organizations such as the office of the United Nations High Commissioner for Refugees (UNHCR), the Red Cross, and the World Food Program conducting environmental assessments of potential refugee camps only since the early 1990s. Due to the paucity of data on the subject, there is no definitive understanding of the relative environmental impact of forced migrants versus those who elect to move, as case studies arguing both sides have been generated. For example, while circular migration has long been recognized as an important strategy for adding resilience to livelihoods, it may also serve as a means by which local land uses remain sustainable if farmers do not have to overexploit soils to make a living. However, the migration of labor to work in new areas, such as in the expansion of cocoa plantations in West Africa across the 20th century, may contribute to rapid environmental transformations as new land is brought under cultivation, enabled by the new supply of labor. In more extreme cases, the sudden arrival of large numbers of migrants or refugees into new areas, especially in the context of natural disaster or armed conflict, may overtax various local environmental functions and contribute to environmental degradation.

The contemporary focus on the relationship between environment and migration, regardless of whether one's concerns are for environmental pushes or pulls, or for the environmental impact of migrants, is on making sense of the social relations through which the environment is understood in particular cases. For example, in the context of environmental migration, Edward R. Carr has constructed a minimalist framework focused not on the study of environmental conditions that drive migration, but on local intersections of power and knowledge in which environment, ecology, and politics are understood. In this framework, the ways migrants negotiate and transform their context, and the objectives behind such negotiation and transformation, are the condition and result of this understanding.

Sara R. Curran, in examining migrant impact on coastal ecosystems, focuses on the ways in which these migrants' resource use and access is a function of the ways in which they are incorporated into social relations that define resource value and access in the new setting. These and other studies are part of a rethinking of the relationship between environment and migration that uses comprehensive understandings of complex local situations to build a foundation for future efforts at generalization.

SEE ALSO: Feminist Political Ecology; Livelihood; Political Ecology; Population.

BIBLIOGRAPHY. Diane C. Bates, "Environmental Refugees? Classifying Human Migrations Caused by Environmental Change," *Population and Environment* (v.23/5, 2002); Edward R. Carr, "Placing the Environment in Migration: Economy, Environment, and Power in Ghana's Central Region," *Environment and Planning A* (v.37/5, 2005); Sara R. Curran, "Migration, Social Capital, and the Environment: Considering Migrant Selectivity and Networks in Relation to Coastal Ecosystems," in W. Lutz, A. Prskawetz, and W.C. Sanderson, eds., *Population and Environment: Methods of Analysis* (Population Council, 2002); Vinat Gidwani and Kalyanakrishnan Sivaramakrishnan, "Circular Migration and the Spaces of Cultural Assertion," *Annals of the Association of American Geographers* (v.93/1, 2003); Gaim Kibreab, "Environmental Causes and Impact of Refugee Movements: A Critique of the Current Debate," *Disasters* (v.21/1, 1997); Steven Lonergan, "The Role of Environmental Degradation in Population Displacement," *Environmental Change and Human Security Project Research Report I* (University of Victoria, 1998); Norman Myers, "Environmental Refugees: A Growing Phenomenon of the 21st Century," *Philosophical Transactions: Biological Sciences* (v.357/1420, 2002); Rachel Silvey and Victoria A. Lawson, "Placing the Migrant," *Annals of the Association of American Geographers* (v.89/1, 1999); Astri Suhrke, "Environmental Degradation and Population Flows," *Journal of International Affairs* (v.47/2, 1994).

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Minamata

MINAMATA IS THE name of a neurological disease that closely resembles cerebral palsy. It develops from poisoning by methyl mercury that enters the food chain from industrial wastewater. It was first identified at Minamata, Japan. The expression "mad as a hatter" derives from the use of mercury compounds that affect the human brain that were absorbed by tanners who made top hats from rabbit fur using mercurous nitrate. Somewhat similar symptoms developed in the people of Minamata from the seafood they ate, which was drawn from Minamata Bay.

Minamata Bay is located on the western side of Kyushu, the southernmost of the four main Japanese islands. The bay is part of the Shiranui Sea, which is abundant in fish, clams, crabs, and other sea creatures. Fish has long been the main protein source of the people of the area. The Chisso factory was located between Hyakken Harbor and the Minamata River. Chisso ("nitrogen") was originally a fertilizer company. The factory had opened in 1907 at the request of the townspeople who were farmers and fishermen. By the middle of the 1920s Chisso was dumping its industrial wastes into Hyakken Harbor and Minamata Bay. To compensate for the damage, it paid off the people who were opposed to the polluting.

The practice of dumping was acceptable to the town because in Japanese culture solidarity is an important value. The townspeople who worked at the factory accepted Jun Noguchi, the owner, as a paternal protector, which was a common attitude toward elites in prewar Japanese culture. During the prewar and wartime eras Chisso was making acetaldehyde and using mercury as a compound in the manufacture of drugs. However, after World War II it moved into petrochemicals related to the manufacture of plastics. It prospered and expanded operations, and its polluted wastewater discharges into Minamata Bay increased. The new products led to the discharge of methyl mercury, which is an organic compound that carries the heavy metal mercury.

Minamata disease was first noticed in the area when cats, fed fish from the bay, began to exhibit strange symptoms: They would dance and then die. So bizarre were the symptoms that the idea spread that the dying cats were engaging in "cat suicides." No one was aware that the deaths were being caused by mercury retained in the body from locally caught fish, and that the cats were victims of mercury poisoning. The mercury was causing an encephalopathy. Symptoms in humans included numbness, blurred vision, slurred speech, involuntary movements, and other abnormal neural behaviors. Some people thought that they were going crazy and would shout in an uncontrollable manner. Some lapsed into a coma. Others committed suicide, in part because the Japanese view of medicine held that illness was due to a personal defect that warranted ostracism. Some people suffered brain damage.

The number of babies born with congenital defects increased dramatically. In addition, because mercury settles in the nerves of the human body, it affected children between the ages of five and 11 severely. In all, at least 3,000 people were severely affected by Minamata disease. The last straw came when birds that had also been poisoned from eating the contaminated fish began to fall from the sky.

For years Chisso refused to acknowledge that a problem existed, or that they were the cause of it. By 1963 the Japanese public health service had traced the disease to Chisso's mercury discharges. Payments were made, but the settlements were slim compared to the suffering endured. In the late 1950s, the people of the area organized a "Mutual Help Society." They engaged in grassroots politics, but with little success. Minamata Bay remains polluted with sediment riddled with mercury.

SEE ALSO: Fisheries; Heavy Metals; Japan; Mercury; Wastewater.

BIBLIOGRAPHY. Timothy S. George, *Minamata: Pollution and the Struggle for Democracy in Postwar Japan* (Harvard University Press, 2001); Akio Mishima, *Bitter Sea: The Human Cost of Minamata Disease* (Kosei Publishing Company, 1992); W. Eugene Smith, *Minamata* (Holt, Rinehart, and Winston, 1975); Tadao Tsubaki and Katsuro Irukayama, *Minamata Disease: Methylmercury Poisoning in Minamata and Niigata, Japan* (Elsevier Scientific Publishing Company, 1977).

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Minerals

THERE ARE SEVERAL thousand minerals in the world, but only about 100 are common. Minerals are inorganic, homogeneous, crystalline solids with definite physical properties and chemical composition. They are commonly defined by their chemical composition. Elements are minerals such as gold or copper that are composed of a single kind of atom. All other minerals are compounds of two or more elements. Minerals are chemically bonded in their atomic structure by the sharing of electrons. They are commonly classified by the negative part of their chemical bond (negative ion) into groups such as: sulfides, halides, oxides, borates, silicates, carbonates, sulfates, phosphates, and chromates.

Minerals are crystalline and can be classified by their crystallographic characteristics. The atoms in minerals have properties that organize them into geometrical forms (crystals) such as cubes like halide (common table salt) or sheets (mica). Mineral crystals are classified into seven systems: isometric, tetragonal, hexagonal, trigonal, orthorhombic, monoclinic, and triclinic.

The physical characteristics of minerals used to identify a specimen include luster, cleavage, hardness, and color. The luster of a mineral is the manner in which its surface reflects light. The luster may be either metallic or nonmetallic. Minerals like gold nuggets or lumps of "fool's gold" (iron sulfides or pyrites) have a shiny metallic luster. Minerals have a nonmetallic luster if the surface looks vitreous (glassy like quartz), pearly (talc), resinous, silky, or is dull and clay-like. The Mohs hardness scale classifies minerals by their hardness on a scale from 1 to 10. The color of minerals depends on their chemical composition. Mineral colors range from white to black with the colors of the rainbow in between. However, the color of a mineral may have been affected by chemical impurities in the formation process.

Some minerals may be recognized by their habit (general appearance). Streak tests are used to identify minerals. After a mineral is rubbed across a rough porcelain plate, the streak it produced is examined for its color. Flame tests to identify minerals use a bit of the mineral specimen ground into a powder. When the mineral powder is burned the color will aid in identification. Chemical tests are used to identify minerals, even in the field.

Minerals are usually formed in various kinds of solutions. The core of the earth is molten magma. As magma wells up from the center of the earth it fractures the crust, melts the rock in its vicinity, and superheats water. As the liquid rock solutions cool, crystals form. Crystals also form when they precipitate out of solutions of hot gases or hot water in fracture veins. Crystals also form from sublimation in cooling volcanic vapors, by chemical reactions to air, water, or other minerals, and by the evaporation of salt lakes or seas.

Mineral deposits are classified by their manner of formation. Igneous actions produce magmatic and pegmatic minerals such as diamonds or corundum. Mineral deposits can form by metamorphic contact (metasomatism), or from magmatic gases (pneumatolysis). Sedimentary action can produce iron ores. Evaporites, such as gypsum, salt, and potash, are solid remains from evaporation. Some deposits are the residue of erosion or other forces. Miners and others seek mineral deposits to work for commercial gain; for them, these include some substances such as granite, oil, gas, opal, and amber that are not true minerals.

SEE ALSO: Geology; Heavy Metals; Mining.

BIBLIOGRAPHY. A.C. Bishop et al., *Cambridge Guide to Minerals, Rocks and Fossils* (Cambridge University Press, 2001); Walter Borchardt-Ott, *Crystallography* (Springer-Verlag, 1995); Ole Johnsen, *Photographic Guide to Minerals of the World* (Oxford University Press, 2002); Kennie Lyman, ed., *Simon & Schuster's Guide to Gems and Precious Stones* (Simon & Schuster, 1986); Frederick Pough, *A Field Guide to Rocks and Minerals* (Houghton Mifflin, 1997); A. Putnis, *Introduction to Mineral Sciences* (Cambridge University Press, 1992); Donald E. Sands, *Introduction to Crystallography* (Dover Publications, 1975); Walter Schumann, *Minerals of the World* (Sterling Publishing Co., 1992).

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Mining

MINING IS THE removal or extraction of rocks, minerals, ores, gemstones, or other geological materials from the earth, typically from an ore body, seam, or vein. Mined materials include diamond, iron, tin, bauxite (aluminum), precious metals (gold, platinum, silver), lead, nickel, and rocks like coal, limestone, marble, salt, and uranium. Mining can also include the extraction of petroleum, natural gas, and water.

The earliest known mine operated 43,000 years ago in Swaziland, Africa, where iron ore (hematite) was removed and ground into a red pigment called ochre. Other early operations mined turquoise in ancient Egypt and in pre-Columbian America in Cerrillos, New Mexico. The first mining operation to use gunpowder was in Slovakia in 1627.

SURFACE MINING

Mining techniques can be divided into two basic extraction types: surface and subsurface. Surface mining removes or extracts deposits of rocks and minerals that are near the surface. First, the land is prospected to locate rock, minerals, and ores. The extent and value of ore is determined and the quality of the material is estimated. A feasibility study is conducted to valuate the proposed mining project. Access to the ore is established to extract and remove the important rock. In large commercial operations, heavy equipment like backhoes and earthmovers first remove the overburden (the soil, gravel, or rock above the valuable deposits). Next, huge backhoes called tower or dragline excavators extract the mineral and redeposit the materials into trucks or onto conveyer belts. Then it is taken away to be crushed further and/or to be extracted from attached rock (gangue). Finally, the land is reclaimed to make the mined environment suitable for use again.

Surface mining results in the production of large piles of waste rock called spoil banks, until the area is recovered through mandatory mitigation policies. Because surface mining techniques remove overlying material, large portions of the countryside may be altered, and the mining operation often destroys the local ecosystem.

There are five techniques for surface mining. Open-pit mining removes rocks or minerals from an open pit because the material is close to the surface and the overburden is thin or the earth is unstable for tunnels. Strip-mining is similar to open-pit mining and extracts ore by removing all overburden. It is a practical technique when the ore is near the surface. Strip-mining generally leaves spoil banks until the area is reclaimed. This technique can have enormous negative environmental effects. Quarrying uses shallow open pits for removing building materials, such as limestone, marble or granite.

Placer mining is accomplished using water pressure (hydraulic mining) or surface excavating equipment to separate and remove materials in alluvial or loose deposits of sand and gravel in stream beds where the material is typically unconsolidated and cannot be tunneled.

Natural processes have separated the valuable materials from the original veins or deposits through stream action, weathering, or erosion and they can then be extracted from stream beds where their greater density permits separation using running water in sluices or pans. This technique was particularly effective during the California Gold Rush in the 1850s and is used today for gem mining in Southeast Asia and gold mining in the Yukon, Alaska, and British Columbia. Because of the large amounts of sediments that are disturbed, placer mining is considered environmentally destructive, so many placer mines now use settling ponds to capture these silts.

Mountaintop removal is a relatively new form of mining in which the earth is destroyed or restructured to reach deep rocks and minerals (less than 1,000 feet [305 meters]). It often requires the complete removal of all timber (clear-cutting) to level the mountain with explosives. In many cases in the United States, this destructive practice has been ruled illegal by the Clean Water Act (1972).

SUBSURFACE MINING

Underground or subsurface mining uses techniques to remove or extract valuable minerals, ores, or other geological materials from beneath the surface, involving equipment and/or miners that work underground. Greater risks are involved with underground mining because the overburden is not removed but lies above. Subsurface coal mines, for instance, are commonly at risk to fires smoldering for years since they can be nearly impossible to control or extinguish.

There are four types of underground mining. Shaft mining uses shafts or tunnels that are vertical or inclined. On the surface above the shaft lies the pithead or hoist and winding apparatus that raises and lowers the cage within the shaft. This cage carries minerals, miners, and equipment. Drift or slope mining cuts into the side of the earth, rather than tunneling downwards. This technique creates access to the material (e.g., coal seams) at slanted or horizontal angles. Hard-rock mining techniques are used to mine ore bodies by digging underground rooms or stopes that are supported by timbers or pillars of standing rock. Hard rock mining is used to extract ores that include gold, zinc, copper, and diamonds. Borehole mining remotely extracts minerals through the use of boreholes and high pressure water and can be used in hillsides, open pits, underground mines, or from floating platforms. Currently the world's deepest mines are for gold extraction and exceed 12,000 feet (3,658 meters).

In 2005, there were nearly three million jobs in the American mining industry and extracted materials were valued at about $30 billion per year or nearly 4 percent of the U.S. Gross Domestic Product.

SEE ALSO: Clean Water Act; Coal; Gold; Minerals; Natural Gas; Petroleum; Uranium.

BIBLIOGRAPHY. Alena Mudroch et al., *Remediation of Abandoned Surface Coal Mining Sites: A NATO-Project* (Springer, 2002); Earle A. Ripley and Robert E. Redmann, *Environmental Effects of Mining* (CRC, 1995).

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Mississippi River

ITS TRIBUTARIES SPANNING Montana to New York and its main channel from Minnesota to Louisiana, the Mississippi River is the biggest in North America and the second largest in the Americas behind the Amazon. The river drains much of the interior of North America and shapes the land through sediment erosion and deposition, building an al-

Barge traffic is increasing, but some argue the Mississippi is already overburdened by navigation demands.

luvial landmass from Cairo, Illinois down to the marshes of South Louisiana. At its mouth, where thousands of square miles of land owe their tenuous existence to the whims of the river's choice of outlet, the river builds up and abandons deltaic lobes every few centuries. Every day hundreds of thousands of tons of sediment are moved by the river off the continent and into the Gulf.

The Mississippi valley was the site of the largest urban populations in pre-Columbian America, the Cahokian mound-building states. The river was a crucial transportation link connecting the middle United States to the rest of the world in the 19th century. New Orleans became the hub of this vast commercial system made possible by the introduction of steamboats that could move against the river's current. This "destruction of space by time" greatly accelerated travel throughout the region and connected forestry and farming across a vast expanse to markets.

The steamboat revolution also resulted in hazardous travel on the Mississippi, as the large number of trees pulled into the river by erosion formed many snags that were hard to detect and readily sank boats that ran into them. In the 1830s the entrepreneur Henry Shreve operated a fleet that pulled up many of these snags and directed crews of loggers who cleared riverside trees. This widespread deforestation made steamboat navigation much safer while it accelerated the rate of soil erosion along the river, already increased by expanding agriculture and land clearing throughout the river's eastern reaches. Thus by the 1840s the river was already greatly shaped by human action, but was certainly not tamed.

Levees along the river were constructed from the time of French colonization of Louisiana in the 18th century, and gradually expanded in length and height. Periodic severe floods overwhelmed levees, leading to increasing federal involvement. In 1849 and 1850, the Swamp Land Acts gave federal land to the states for the purpose of funding levee improvements to reclaim the vast swamps in the river valley and protect existing development.

Proponents of a "levees only policy" won a long and sometimes bitter engineering argument on the proper means of controlling flooding. Levees-only proponents argued against the maintenance of multiple outlets for river overflow because keeping the river in a narrow channel would keep the river scoured of obstructions and deepen it to accommodate floodwaters. The levees-only approach also served to maximize the area that could be reclaimed from swamps for plantation agriculture and coincided with the confidence proponents felt that science and technology could make the river do their bidding.

Such confidence in engineering was bolstered by the success of James Eads in 1876 opening up the sandbars that blocked deep draft ship access to the mouth of the river. By means of a jetty that constricted the river's flow at its mouth, the river pushed away the bars and opened the channel without costly dredging, allowing for an explosion of shipping tonnage at the port of New Orleans that placed that city on par with the largest ports in the world.

On the upper Mississippi, as railroad trusts expanded into the Midwest and plains from Chicago, farmers sought relief from their monopolistic practices and turned to river transport. Making the river channel at least four-and-a-half feet to handle barges was key to this strategy. The Army Corps of Engineers built wing and closing dams to constrict the channel and thus deepen it. By 1906 rising rail fees and declining river traffic led to a push for a six-foot channel. Agricultural crisis and problems of soil erosion caused by excessive constriction of the river led to a movement for a nine-foot channel. The channel was later created by locks and dams that raised the entire river level, and was completed by 1940.

Throughout this time, growing conservationist interests lobbied for protecting the river's water quality and wildlife, sponsoring the creation of wildlife refuges and working against channel deepening. The nine-foot river did not create the ecological disaster some opponents predicted, but the upper Mississippi's compartmentalization into reservoirs greatly reduced sediment loads going downstream, blocked the migration of fish, and reduced the seasonal expansion and contraction of the river by keeping water levels constant. Barge traffic on the upper river carrying coal, soybeans, and corn down river has expanded so much that traffic backups are increasing costs for farmers competing in world markets. This has led to a new showdown between proponents of expanding the lock and dam structures for more traffic and environmentalists who argue the river is already too burdened by the demands of navigation.

The security afforded by levees against flooding was always fragile, as crevasses again and again broke through levees in the years after the Civil War. Flood heights increased as levees continued to climb and constrain the channel, but after 1900 people seemed to be getting the river under control. In 1927 the river showed this was not the case. Heavy rains upstream led to record flood heights and massive levee breaks that marched southward as millions of acres of land and homes were flooded out from Kentucky down to the Arkansas and Mississippi delta and huge stretches of Louisiana.

The callousness, brutality, and inadequacy of local and federal response led to the resurgence of populist politics in the country, from Huey Long's gubernatorial victory the following year in Louisiana to the activist New Deal replacing Hoover's lukewarm response to the flood and the Depression. This political upheaval was motivated by actions like the New Orleans city fathers' decision to dynamite a levee east of the city and flood out rural St. Bernard parish and the holding of black sharecroppers on the tops of levees without supplies or clean water, surrounded by flood waters, instead of evacuating them to higher ground, for fear they might leave Mississippi altogether if given the chance.

The 1927 flood forced the Army Corps to build outlets into its flood control strategy even as the 1928 Flood Control Act gave the Corps more power to intensify control over the river. Presently, the lower Mississippi has several outlets such as the Bonne Carré and Atchafalaya spillways.

The Atchafalaya, a distributary of the Mississippi, now threatens to take the main flow of the river away from New Orleans and is only prevented from doing so by the Old River Control Structure, a massive dam complex that almost failed in a 1973 flood.

The industrialization of the river has led to serious problems of water quality as complexes like the chemical corridor in Louisiana have located on the river's shores. Since the 1930s, Louisiana's coastal wetlands have declined in size by some 1,900 square miles, in part due to the loss of upstream sediments and their diversion into the open gulf by the channelizing of the delta, as well as the effects of oil and gas development and wetlands reclamation in the region.

A "dead zone" of hypoxic water averaging 4,800 square miles caused by nitrogen and phosphorous enrichment from fertilizer use in the upper valley forms each year offshore of the Mississippi's outfall. Despite efforts to compartmentalize the Mississippi river system, it continues to be a linked system, and solutions to the problems facing the river and the people who depend on it require the scaling up of efforts to match the interconnectedness of all the river's parts.

SEE ALSO: Floodplains; Floods and Flood Control; Levees; Locks and Dams; Water Quality; Wetlands.

BIBLIOGRAPHY. J. Anfinson, *The River We Have Wrought: A History of the Upper Mississippi* (University of Minnesota Press, 2003); J. Barry, *Rising Tide: The Great Mississippi Flood of 1927 and How It Changed America* (Simon and Schuster, 1997); C. Colten, ed., *Transforming New Orleans and Its Environs* (University of Pittsburgh Press, 2000).

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Modernity

MODERNITY, IN ITS sociological usage, generally refers to the social and cultural characteristics describing the period of history in the West since the 17th and 18th centuries. Typically, modernity is described in terms of contrast between the modern period and the feudal era that preceded it, especially in terms of changing capacity for understanding, harnessing, and transforming the nonhuman world.

Although there have been dramatic improvements since the feudal era, most sociological discussion and analysis has focused on the negative aspects of modernity. Scholars have raised many issues in their attempts to characterize modernity. Some of the more common characteristics of modernity include: the replacement of religion by science as the major social institution establishing truth; rapid social, economic, and political change; the nation state; global commerce, capitalism, and industrialization; totalizing political ideologies; a highly specialized and mobile workforce; the breakdown of community and increasing individualization; uncertainty and reflexivity; normlessness; the ascendancy of instrumental reason in all social arenas; centralized administration and bureaucracy; the idea of progress; and the domination of nature.

These various, but interlinked, characteristics of modernity could be roughly grouped into those seen by some to be progressive, such as the replacement of superstition with rationality and science; while others seem more problematic, such as the loss of community and increasing normlessness. Social progress is a concept that forms a central aspect of modernity. But grave doubts began to arise in the 19th century among existentialist philosophers such as Friedrich Nietzsche, which intensified in the 20th century. After two world wars, the Holocaust, increasing social estrangement, and the increasing awareness of what the application of science and engineering was doing to the environment, radical doubt increasingly developed regarding the progressive ideal of modernity.

This later period, especially since World War II and extending to the present, is sometimes categorized as "high," "late," or "reflexive" modernity. The spirit of open inquiry and questioning of traditional institutions that form a major aspect of modern social change have increasingly been directed at the institutions of modernity itself. This period is characterized by chronic and pervasive doubt and uncertainty, which has replaced the sometimes brash confidence in social progress that was the zeitgeist of earlier "classical" modernity. Sociologist Anthony Giddens states "modernity effectively involves the institutionalization of doubt."

However, critique of the institutions of modernity has been around from the beginning. The Romantic movement of the 18th and 19th centuries rebelled against many of the changes, and 19th and early 20th century sociologists made in-depth analysis of the negative aspects of social change that had occurred since the feudal period. Much of the focus of this analysis was on the disruption of traditional communities and the commodification of labor. German sociologists such as Ferdinand Tönnies, Max Weber, and Karl Marx are particularly noted for analyzing and describing these changes.

Postmodernists (those arguing that modernity has ended and a new historical period has begun) and neomodernists (who see the current social problematic as only an acceleration of social schemas characteristic of modernity) both maintain that it is an age of radical uncertainty and doubt, including the questioning of the very institutions associated with modernity, such as science, reason, and the possibility of human progress through the application of efficiency and scientific knowledge. The neomodernist perspective expressed by sociologist Ulrich Beck argues that the rise of new social movements and the critique of modernist institutions such as science and technology, "does not stand in contradiction to modernity, but is rather an expression of reflexive modernization."

This radical doubt coupled with the lack of any ultimate source of truth and the hyper-individualization of modern society, where individuals are cut loose from the moorings of community and traditional norms, raises the anxiety-producing responsibility of each individual to figure out how they should live. This heavy responsibility on the individual to construct his or her identity occurs within a social context of unlimited choice, which creates a problem. On the one hand, one of the manifestations of Ulrich Becks's "risk society" was the spawning of the contemporary environmental movement where pollution and other perceived assaults on nature by modern industry and the application of science were questioned. It is characteristic of the risk society attitude that change is no longer viewed as inevitable, but the product of human agency (intentional human action), thereby creating the perception that individuals and institutions are responsible for perceived risks.

On the other hand, environmentalists have evoked a modernist view of science as representing a true and inerrant picture of reality, and use science to argue against perceived environmental insults against some scientifically determined standard for what nature should be. This perspective is in contradiction to the doubt about the modern project among some scholars. For example, even putting aside the epistemological issues of claims to scientific certainties about the environment, the science of ecology now posits nature as highly context specific, driven by chance, and subject to continual and dramatic change, not a perpetual "balance" that can be determined by scientific research and then maintained.

Late modernity's realization of the dramatic limitations to human knowledge and ability problematizes the project of controlling or restoring human caused change in nature, much less resolving the perennial conflict among human groups over which "nature" is the right one. In a brilliant essay addressing this issue, sociologist Bronislaw Szerszynski states that "the world-picture at the heart of the modern problematic [is] that of a lonely humanity faced with the task of pure self-assertion in a meaningless world which no longer tells them/us what to do." As such, according to Szerszynski, there is no absolute referent regarding the goals of environmental stewardship or nature preservation, and "ecology, while seeming to promise a re-embedding of human choices and judgments within a framework which transcends mere human wishes, fails to do so, and always leads us back into the nihilistic condition of groundless self-assertion in a world without purpose and meaning." This condition of late modernity exposes the pretense of using science to justify some absolute standard for the environment that should be imposed on others who disagree, and leaves the debate on environmental protection and restoration where it belongs—in the political arena. With no absolute standard for nature, and given the wide discrepancies among individuals in the power to influence political decision making, the most socially just process for decision making is paramount.

Given the ever-changing nature of revealed reality due to technological, social, and scientific change, it renders impossible any absolute standard of how nature should be. Much as Nietzsche dramatically pointed out the existential (and terrifying) freedom of modern man in the social and moral realm by the metaphor "God is dead," the same problem of radical freedom is faced in attempts to manage or maintain natural systems in a particular way. There is no absolute standard to be found in nature for any objective, absolute criteria to direct our natural resource or environmental policy. As modernity relativized personal moral and religious beliefs, so it has with the use and character of the natural world.

SEE ALSO: Balance-of-Nature Paradigm; Capitalism; Ecological Modernization; Modernization Theory; Religion; Social Ecology.

BIBLIOGRAPHY. Ulrich Beck, *Risk Society: Towards a New Modernity* (SAGE Publications, 1992); Anthony Giddens, *The Consequences of Modernity* (Stanford University Press, 1990); Anthony Giddens, *Modernity and Self-Identity: Self and Society in the Late Modern Age* (Stanford University Press, 1991); David Harvey, *The Condition of Postmodernity: An Enquiry into the Origins of Cultural Change* (Basil Blackwell, 1989); Scott Lash, Bronislaw Szerszynski, and Brian Wynne, eds., *Risk, Environment and Modernity: Towards a New Ecology* (SAGE Publications, 1996).

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Modernization Theory

THEORIES OF MODERNIZATION define and position "modern" societies at the positive end of a linear development spectrum. Contemporary modernization theories draw on 19th and early 20th century European and U.S. sociology, including social Darwinism and theories of social order in the shift from community to society associated with urbanization and industrialization. Writing during the optimistic boom of the 1950s and emergent Cold War, economic historian Walter Rostow famously formalized modernization theory as stages of economic growth in a book subtitled *A Non-Communist Manifesto*. The stages span from traditional society through "takeoff" industrialization to a mass consumer society. The change from one stage to the next, in linear succession, was argued to be based on both an inherent societal tendency toward optimal paths of growth and a naturalistic concept of diffusion. Optimal paths would be determined by consumer demand, entrepreneurship, and technical knowledge, while diffusion would take place from high-growth Europe and North America to the global South.

Modernization has been most widely developed and deployed in sociology, rooted in Max Weber's idea of the rational individual and Talcott Parsons's concept of structural-functionalism. Parsons constructed a general model of society based on systems theory and biology. He argued that society existed in equilibrium with its environment and should be understood through the ways it adjusted to external pressures. The relative stability of society was achieved through "pattern variables" that created the context for individual rational action, theorized by Weber to be consistent with the reproduction of the "modern" social system. Although put forth as a general theory, Parsons determined the set of phenomena necessary to reproduce society primarily based on his observations of the United States.

In essence, the "blueprint" of modernization is a Euro- and U.S.-centric one that pervades contemporary thinking. Widespread use of phrases like "backward societies" (prevalent in the heyday of modernization theory) and "less developed countries" (still in use today) reflect and re-inscribe the West as the model of society. By dividing the world into categories of traditional, transitional, and modern, this way of thinking characterizes widely distinct societies as the same type and inhibits an understanding of relations between societies. By assuming that all societies follow a similar path to the same destination, modernization theory also implies that societies are infinitely pliable and devoid of their own histories and cultures.

Modernization theory has been highly influential in postwar development policy and is a precursor to structural adjustment policies developed in the 1980s. In the 1990s theories of modernization reasserted themselves in environmental terms in the closely related fields of environmental economics and ecological modernization. Theories in these fields were developed in response to environmental movements' demands for alternatives to the modernization paradigm and the associated process of industrialization. These fields respond by arguing that the solution to environmental damage as a result of modernization is more modernization. In economics, this argument is often tied to the Environmental Kuznets Curve (see Industrialization).

Ecological modernization, a growing literature primarily in sociology, argues that modernization causes industry to be more "ecologically rational," that is, to take into account environmental damage and to minimize it. According to this school of thought, this process is driven by institutional restructuring, greener technologies, market forces (like consumer demand for green products), and environmental movements. Ecological modernization theories are largely oriented toward responses to environmental pressures in urban contexts in the United States and Europe.

SEE ALSO: Ecological Modernization; Industrialization; Movements, Environmental.

BIBLIOGRAPHY. Roger Lee, "Modernization," in R.J. Johnston et al., *The Dictionary of Human Geography* (Blackwell, 2000); Philip W. Porter and Eric Sheppard, *A World of Difference: Society, Nature, Development* (Guilford Press, 1998); Eric R. Wolf, *Europe and the People Without History* (University of California Press, 1982); Richard York, Eugene A. Rosa, and Thomas Dietz, "Footprints on the Earth: Environmental Consequences of Modernity," *American Sociological Review* (v.68, 2003).

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Modes of Production

KARL MARX DEFINED modes of production in *Das Kapital* (1867) as the means (e.g., labor and materials) and relations (e.g., property and power) that when combined enable people to change their environment into useful objects (e.g., food and transportation). Marx defined several modes of production (kin-ordered, Asiatic, slave, tributary, capitalist, socialist, and communist). Of these modes of production, three (kin-ordered, tributary, and capitalist production) have been most useful in understanding the political economy of current cultures around the world.

In kin-ordered production, kinship relations are the basis of labor, which is categorized by marriage and/or other kinship relationships between individuals. For example, husbands may hunt with other men of their patriline while wives work in gardens with their sisters. Use is the basis of production rather than exchange. In these classless societies, there is a reutilization of social control. Sharing is a norm and surpluses are not stored, but consumed. Eric Wolf identified two subtypes of kin-ordered production. The first is the equivalent of a band society, which does not modify the landscape, but gathers resources and consumes them. The second subtype is where the environment is subject to transformation through social labor; the environment itself becomes a means of production, an instrument on which there is expenditure of labor.

Tributary production occurs when peasants produce their own food, but rulers extract tribute politically or militarily. The state usually owns the property and the peasants have little, if any, political power. Rulers maintained their elite status by exploiting the peasants, accumulating wealth, controlling the exchange systems and using force to keep peasants in their subordinate position.

The tributary mode of production most often occurs in societies with chiefdom political organization. There are two subsets of the tributary mode: civilizations and mercantile wealth. Civilizations use politics to provide a mode of production within a hegemonic society based on supernatural origins and validation. Mercantile wealth uses merchants to control the profit from the trade of products and goods.

In the capitalist mode of production the means of production (e.g., land and factories) is owned by capitalists (elite class/bourgeoisie). This type of production occurs in modern industrial states. The proletariats (working class) cannot own the means of production and must sell their labor to the capitalists. Capitalists use the sale of surplus commodities to increase their means of production, which increases the divide between the classes.

Of kin-ordered, tributary, and capitalist modes of production, the latter has been most useful in understanding how large states affect indigenous peoples around the world. According to Marx, the continuing repression of the proletariats (people who work but do not own the means of production) occurs when the capitalists control government and make the rules of the society (laws). Members of the capitalist class select representatives who pass laws that serve their own interests. For example, societies such as the United Kingdom and the United States have enacted laws that required people who are not property owners (proletariats) to work for wages and prohibited workers from organizing into labor unions. The police protected the capitalists and suppressed any protest of unfair working conditions.

By controlling the distribution of information, the capitalists can create, for their own benefit, an ideology of their superiority. According to Marx, if the capitalists control institutions that transmit information and ideas, they influence how proletariats view the world. Through institutions such as churches, schools, and newspapers, the capitalists promote the view that the capitalist dominance of society is in the best interests of all. The church, for example, encourages the proletariat to accept its fate because it is "God's will," and/or it teaches proletariats that their poverty is not the fault of the capitalists but is due to the proletariats' "fall from grace."

Similarly, through control of educational institutions and mass communications media, the capitalists convince proletariats that the capitalists use their power to the net benefit of everyone in society. The capitalists use the media to popularize the view that the society would perish without them. In short, the aim of an ideology of class is to convince the proletariat that its position in society is as it should be.

SEE ALSO: Capitalism; Colonialism; Communism; First Nations; Indigenous Peoples; Industrialization; Livelihood; Marx, Karl; Mass Media; Subsistence.

BIBLIOGRAPHY. Maurice Bloch, *Marxism and Anthropology: The History of a Relationship* (Clarendon Press, 1983); Karl Marx, *Das Kapital* (1867); Eric R. Wolf, *Europe and the People without History* (University of California Press, 1997).

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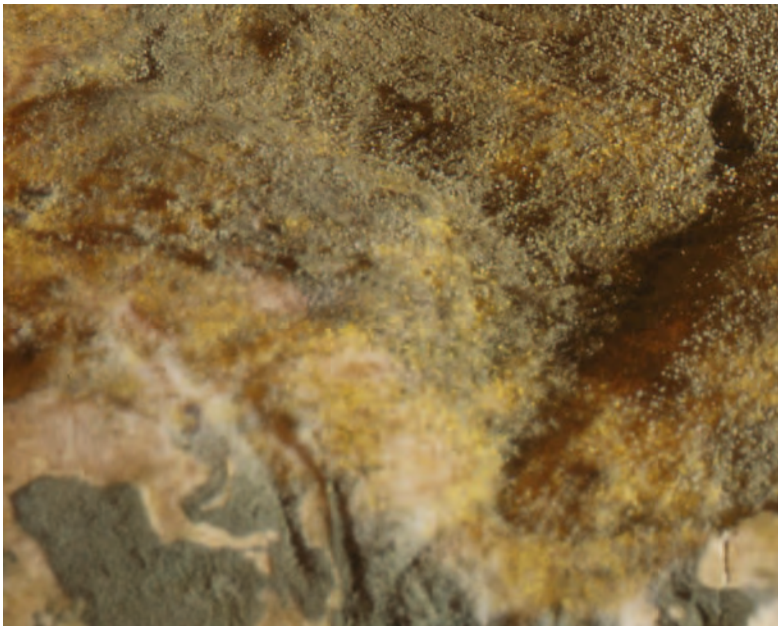
Mold

MOLD BELONGS TO the fungi group and is closely related to mildew, rusts, and mushrooms. As it does not produce chlorophyll, it does not conduct photosynthesis, and so lives on matter made by other plants, by animals, or on decaying matter, as do bacteria and other fungi. Mold develops from a spore, which is a tiny particle broadcast as its seeds. Mold requires a damp or wet organic surface upon which it can feed and grow. When a mold spore lands on a surface, such as a piece of bread in a damp climate, it begins to grow by producing tiny fibers (hyphae). The roots of the mold are the hyphae that become rhizoids. Stolons are the hyphae threads that spread on the surface of the organic material that is host to the mold. If the mold is able to grow to maturity, it will grow hyphae that stand upright and become spore casings. Spores are released from the hyphae that can be carried off by air currents or water to new locations.

Mold can be helpful to human beings. Blue mold, which often appears greenish in color, is familiar to humans as the mold on French Roquefort cheese, Stilton cheese, and many other natural blue cheeses. These cheeses are aged in places where the mold is allowed to grow on the cheese rounds or blocks so that it can give the cheese its flavor naturally. Blue cheese is made artificially by injecting the cheese in a manufacturing process so that the mold grows on the cheese more rapidly. The mold of blue cheese produces a chemical that aided the development of antibiotics. Sir Alexander Fleming (1881–1955) developed penicillin from the mold *Penicillium notatum*.



Toxic mold is a major problem in buildings that have been flooded and has been the subject of growing litigation.

Mold can be harmful to humans or their possessions. In areas of high humidity mold can grow on shoes, clothes, or other surfaces causing damage. It can grow in closed containers where there is no light, such as in the near freezing damp of a refrigerator. Mold can also destroy food. Green mold is familiar to most people as the mold that grows on bread; humans cannot eat this mold. The great Irish Famine (1845–49) was caused by the water mold *Phytophthora infestans*. It produced a late blight of potatoes, destroying the crop and causing millions of the Irish to starve to death or emigrate.

Breathing mold spores may harm human health. If mold can grow in the respiratory tract it can cause allergies. Or powerful toxins may be released and a weakening of the immune system or other major health problems may result. Air conditioning systems may develop mold that causes illnesses. The presence of toxic mold is a major problem in buildings or houses that have been flooded. It has also been the subject of growing litigation against owners who sold houses or buildings to buyers without disclosing the presence of a toxic mold problem.

SEE ALSO: Air Conditioning; Famine; Fungi; Microbes.

BIBLIOGRAPHY. Eric Lax, *The Mold in Dr. Florey's Coat: The Story of the Penicillin Miracle* (Henry Holt & Company, 2005); Nicholas P. Money, *Carpet Monsters and Killer Spores: A Natural History of Toxic Mold* (Oxford University Press, 2004); Carmel Streater, *Mold and Real Estate: A Handbook for Buyers and Sellers* (South-Western Educational & Professional, 2003).

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Moldova

THE EAST EUROPEAN republic of Moldova gained its independence after the collapse of the Soviet Union and is one of the poorest countries in Europe. Since the early 2000s Moldova has been recovering from a long economic recession and completed a successful privatization by the mid-2000s. A significant proportion of the population is living on agriculture; issues related to land use and farming are crucial in the country. The policy framework of Moldova has greatly improved since the early 1990s, however, improvements are still slow and there are a number areas in which the country has been trying to meet European Union practices.

Environmental assessment in Moldova has become transparent, but it is still inefficient and complicated. Therefore it is hard to enforce regulation from the country's limited economic resources. Pollution fines usually go through a long court procedure, which decreases the efficiency of enforcing environmental regulations. Pollution fines are generally low, and violators often ignore penalties. At the same time environmental monitoring has improved but it does not provide full coverage for all waters and lacks a comprehensive nationwide program. Similarly some institutes have increased their activities, but they lack modern techniques to share information with the public.

Around 20 percent of the total labor force earns their living from agriculture; it contributes over 19 percent to the Gross Domestic Product. Increasing soil erosion and decreasing soil fertility affect a significant proportion of the country. During the years of economic crisis followed by the collapse of the Soviet Union, environmental problems concerning agriculture lessened, because the economic crisis led to the reduction of fertilizer use and overgrazing. However, in the near future those problems will probably occur again because of the recent reactivation of the economy and more intensive agricultural production. Inexperienced farmers and the shift to private ownership of land may lead to overgrazing and erosion once more. In addition, environmental protection laws are not legislated and not properly enforced yet. Solutions will have to be developed by farmers, municipalities, and authorities working together.

After independence, industry emissions reduced rapidly due to the economic crisis, but since 1998 industrial output has grown over 30 percent in five years. However, overall emissions seem to have decreased. One must note that this is not the result of the current system of environmental standards—most of these date back to the Soviet era and are inadequate for Moldova's future.

SEE ALSO: Pollution, Air; Pollution, Water; Russia (and Soviet Union); Soil Erosion.

BIBLIOGRAPHY. Nicholas Dima, *Moldova and the Transdnestr Republic* (East European Monographs, 2001); *Environmental Performance Reviews: Republic of Moldova* (United Nations, 1998); Rebecca Haynes, *Moldova, Bessarabia, Transnistria* (University College, 2003).

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Mongolia

DESCENDED FROM A line of 13th-century conquerors, modern-day Mongolia won independence from China in 1921 and adopted communism three years later under Soviet pressure. Democratic rule was restored in the early 1990s. Surrounded by China and Russia, Mongolia is landlocked with limited freshwater resources in some areas. The climate varies from desert to continental with large daily and seasonal temperature variations. The terrain ranges from semidesert and desert plains to grassy steppe in the mountains of the west and southwest. The well-known Gobi Desert is located in south-central Mongolia. The country is subject to natural hazards that include dust storms, grassland and forest fires, drought, and harsh winter conditions known as *zud*. Extensive natural resources include oil, coal, copper, molybdenum, tungsten, phosphates, tin, nickel, zinc, fluorspar, gold, silver, and iron. Less than 1 percent of the land is arable.

When the Soviet Union dissolved in the early 1990s, Mongolia lost one-third of its Gross Domestic Product (GDP). This economic shock was followed by deep recession and natural disasters in the first years of the 21st century. Three harsh winters were followed by summer droughts that led to extensive loss of livestock. With a per capita income of $2,200, Mongolia is ranked 174th of 232 countries on income levels. The economy is heavily dependent on remittances from Mongolians who work abroad. Considerable income disparity exists with the wealthiest 10 percent of the population holding 37 percent of resources while the bottom 10 percent possesses only 2.1 percent. Forty-four percent of Mongolia's 2,791,272 people are engaged in herding and agriculture, and 36.1 percent of the population live below the national poverty line. Around 28 percent of the people are malnourished. The United Nations Development Programme Human Development Reports rank Mongolia 114th of 232 nations on overall quality-of-life issues.

Like most former Communist countries, Mongolia is experiencing the aftereffects of rapid industrialization and rapid growth unaccompanied by environmental responsibility. Nearly 57 percent of the population live in urban areas where air quality is poor, partially because of coal-burning power plants. Rates of respiratory illnesses among children are increasing. Overgrazing and deforestation in conjunction with the clearing of virgin land for agricultural use has increased the pace of soil erosion beyond what is normal for Mongolia. The country loses an estimated 148,266 acres (60,000 hectares) of forest each year, and only 11.5 percent of the land is protected.

Other environmental issues include desertification and the aftermath of intensive mining. Some 38 percent of Mongolians do not have access to safe drinking water, and 41 percent lack access to improved sanitation. Mongolia has one of the worst waste management systems in Asia, resulting in extensive surface and groundwater pollution. Of 133 endemic mammal species, 14 are endangered, as are 16 of 274 endemic bird species. In 2006, a study by scientists at Yale University ranked Mongolia 115th of 132 countries on environmental performance, below the relevant income and geographic groups. Particularly low rankings were received in the categories of sustainable energy, air quality, water resources, and environmental health.

In the 1980s the Soviets pressured Mongolia to take action in Hovsgol Nuur, where a wool-scouring plant was releasing industrial waste that eventually made its way to Lake Baikal in the Soviet Union. As a result, Mongolia began paying more attention to the environment, closing the plant, banning truck traffic on winter ice, and halting the transportation of oil in barges on area lakes. Government officials were also forced to deal with deforestation in the Hangayn Nuruu, where toxic agricultural runoff, industrial waste, and untreated sewage had polluted the waters and reduced the flow of northern rivers. The desert area of the Gobi had expanded, encroaching on pasturelands.

In 1987, Mongolia created the Ministry of Environmental Protection and began a conscious effort to raise public awareness. Currently, some 4,000 employees work under the Ministry of Nature and Environment, but there is little coordination among agencies, and all agencies are underfunded. Furthermore, environmental laws are not uniformly enforced. Mongolia participates in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Baikal, Lake; Deforestation; Desert; Gobi Desert; Malnutrition; Mining; Pollution, Air; Pollution, Water; Poverty; Soil Erosion; Steppe.

BIBLIOGRAPHY. Central Intelligence Agency, "Mongolia," *The World Factbook,* www.cia.gov (cited April 2006); Country Studies, "Mongolia: Environmental Concerns," www.country-studies.com (cited April 2006);

Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin H. Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993); United Nations Development Programme, "Mongolia," hdr.undp.org (cited April 2006); World Bank, "Mongolia," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); World Bank, "Mongolia Environment," web.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Monitored Retrievable Storage

MONITORED RETRIEVABLE STORAGE (MRS) is a temporary facility used to store radioactive materials. MRS installations are for holding High Level Waste (HLW) radioactive materials that are very "hot," or radioactive, because they are usually spent fuel rods from a nuclear power plant. The term *Monitored Retrievable Storage Installation* was defined by Congress in the Nuclear Waste Policy Act (NWPA) in 1987 (as amended). The Nuclear Regulatory Commission was given authority to monitor all MRS installations and the Department of Energy (DOE) is responsible for operating MRS installations.

The Code of Federal Regulations uses the term MRS to mean an installation with a complex designed, constructed, and operated by the DOE "for the receipt, transfer, handling, packaging, possession, safeguarding, and storage of spent nuclear fuel aged for at least one year, solidified high-level radioactive waste resulting from civilian nuclear activities, and solid reactor-related GTCC [Greater than Class C] waste, pending shipment to a HLW repository or other disposal."

A Monitored Retrievable Storage installation includes any installation that meets this definition. GTCC waste is "low-level radioactive waste that exceeds the concentration limits of radionuclides established for Class C waste." The regulations also establish requirements, procedures, and criteria for the issuance of Certificates of Compliance approving spent fuel storage cask designs. Current law requires all federal agencies to fully support the DOE's efforts to site and license MRS facilities. In addition, they are charged with fully supporting the Nuclear Waste Negotiator's effort to locate sites for MRS facilities.

Current law also restrains endless litigation efforts that would attempt to block timely locating and development of MRS facilities. Because HLW nuclear waste will be dangerous for centuries to come, the political phenomenon of NIMBY ("Not In My Back Yard") has hampered attempts to build MRS facilities. Governors of states and antinuclear interest groups routinely oppose efforts to transport waste, citing dangers from possible accidents that could permanently damage the natural environment.

Proposals to locate sites on Native American reservations have raised issues of sovereignty because of the status of tribal lands. A proposal by the Mescalero Apache Indians that their lands could host MRS facilities raised issues regarding political sovereignty, democratic consent, and environmental justice.

SEE ALSO: NIMBY; Nuclear Power; Nuclear Regulatory Commission (NRC); Radioactivity.

BIBLIOGRAPHY. *Monitored Retrievable Storage of High Level Radioactive Waste: Routing Implications and Emergency Response to Transportation Accidents* (National Conference of State Legislatures, 1990); National Research Council, *End Points for Spent Nuclear Fuel and High-Level Radioactive Waste in Russia and the United States* (National Academies Press, 2003); National Research Council, *Improving the Scientific Basis for Managing DOE's Excess Nuclear Materials and Spent Nuclear Fuel* (National Academies Press, 2003); *Nuclear Waste: Is There a Need for Federal Interim Storage?* (The Monitored Retrievable Storage Review Commission, 1989).

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Monoculture

A MONOCULTURE REFERS to the repeated cultivation of a single crop on an area of land and describes the practice of relying on a population of plants or animals derived from a single genotype or a very narrow genetic base. This implies an agricultural practice without any crop rotation or mixed intercropping. In forestry it refers to planting of single species tree crops instead of encouraging a diverse canopy of trees, so that biodiversity that would provide a suitable habitat for a number of different species cannot be provided. Monoculture is characterized by the absence of diversity and can occur on various scales: a plot of ground, a natural community, a landscape, or a large geographic region. Its correlative, polyculture, indicates that two are more crops or herds are part of the system, which is also scale dependent. For instance, a peanut field might be regarded as a monoculture, but fruit trees planted as wind breaks make the system a polyculture, as does any system that grazes animals on field stubble to refertilize the soil.

Monocultures in agriculture have been introduced to maximize the productivity of a single crop. Monocultures perpetuate and even exacerbate the general impacts of agriculture on ecosystems, such as narrowing the genetic base of the system by replacing the natural vegetation, destroying habitats for the natural fauna, increasing vulnerability to erosion by the decline of humus content, aggregating stabilities of soils as a consequence of soil tillage and conversion of virgin land, interrupting and simplifying the natural food web, and underutilizing the variety of niches of an ecosystem with subsequent loss of homeostasis and self regulation mechanisms of the system.

The practice of replanting the same species over years leads to additional yield declines that are due to autotoxity and monoculture injury. Explanations for this include: growing the same crop species in the same soil year after year leads selectively to a deficiency in one or more plant nutrients that would not be limiting to other crop species; the crop plant builds up a toxicity to itself, leading to self-inhibition; or, growing the same crop species in the same soil in subsequent years enriches the soilborne pathogens of the roots of those crops. This helps lead to complete crop failures. The most well-known among these is the Irish potato famine in the beginning of the 20th century, which was due to the expansion of the fungus *Phytophtora infestans* in potato monocultures.

Nevertheless, about 70 percent of the world's food crops are grown in monocultures. The world's agricultural landscapes are planted mostly with some 12 species of grain crops—especially wheat and corn—23 vegetable crop species, and about 35 fruit and nut crop species; that is, no more than 70 plant species cover approximately 1,440 million hectares of presently cultivated land in the world. Reliance on such a small number of crops has reduced the global genetic diversity to an extent that there are fewer and fewer varieties to draw upon for adaptive genes. For instance, in the United States, 60–70 percent of the total bean area is planted with two to three bean varieties, 72 percent of the potato area with four varieties, and 53 percent of the cotton area with three varieties.

Despite the vulnerabilities of monocultures, continuous productivity increases have been achieved through the introduction of improved varieties, mainly promoted by the Green Revolution, accompanied by measures needed to compensate the weaknesses of the system and sustain it, like chemical fertilizer and pesticide inputs, irrigation where farmers have access to supplemental water, hygienic techniques like soil fumigation, and even genetic modifications of organisms.

A well-known argument in relation to biodiversity loss and other negative ecological impacts of monoculture is the land-sparing impact of modern farming practices, which refers to the trade-off of the amount of land that needs to go into production according to different levels of productivity. For example, if yields of the six major crop groups that are cultivated on 80 percent of the total cultivated land area had remained at yield levels farmers achieved in 1961, it would require an additional 1.4 billion hectares of land to meet global food demand in 2004. The key ecological question is therefore whether environmental services other than food production at regional and global scales would be enhanced by focusing food production on less land under intensive management with high yields, versus expanding cultivated area in lower-yielding systems that use farming practices that seek to preserve environmental services at the field and local levels. Although there are many case studies that challenge the productivity argument of the Green Revolution and provide case studies for the high productivity of small-scale farms, mixed cropping, and mixed farming systems, this argument needs further research, since these systems have mainly been neglected by previous research priorities.

Other critical arguments can be summarized as critiques of the mindset behind monoculture and its rationale, which is related to concepts of elimination of diversity not only in regard to nature, but overall. This approach would replace principles of diversity with principles of intolerance and exclusion by prioritizing commercial interests over ecological integration, by ignoring the relation between ecological diversity and the diversity of livelihoods, cultures, and belief systems. This is supported by the fact that the establishment of large-scale monocultures like cotton plantations in the United States, Africa, and India were only possible on the basis of slavery and colonialism, perpetuated by international corporations until today. These corporations externalize harmful side-effects like contamination by chemicals and soil erosions to adjacent areas that are considered peripheries, or to future generations, leaving the farmer without any freedom of choice. For this reason, national action plans of many countries aim at the reduction of monocultures, since there is doubt that sustainable monocultures will ever exist.

SEE ALSO: Agriculture; Genetically Modified Organisms (GMOs); Green Revolution; Livelihood; Potatoes.

BIBLIOGRAPHY. Miguel Altieri, "The Ecological Role of Biodiversity in Agroecosystems," *Agriculture, Ecosystems and Environment* (v.74, 1999); G.R. Conway and J.N. Pretty, *Unwelcome Harvest: Agriculture and Pollution* (Earthscan Publications, 1991); A.K. Duraiappah and Shahid Naeem, *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being: Biodiversity Synthesis* (World Resources Institute, 2005); V.H. Heywood and R.T. Watson, *Global Biodiversity Assessment* (Cambridge University Press, 1995); Andrew Kimbrell, ed., *Fatal Harvest: The Tragedy of Industrial Agriculture* (Foundation for Deep Ecology, 2002); Vandana Shiva, *Monocultures of the Mind: Perspectives on Biodiversity and Biotechnology* (Palgrave MacMillan, 1983).

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Monsanto

THE MONSANTO CORPORATION, based in Missouri, is one of the world's leading suppliers of agricultural inputs created with advanced biotechnology. Monsanto transformed from a predominately chemical company to a seed company focused on a few staple crops and royalties from patents. Using this strategy, Monsanto experienced rapid growth from 2003 to 2005, after roller-coaster gains since 1996 when it began commercial production of genetically modified (GM) seeds. Monsanto's recent gains have not been homogenous around the globe—the company has reported economic losses in the United Kingdom. Monsanto's greatest sales are in North America, followed by Latin America. The main crops, based on acreage, are soybeans, corn, cotton, and canola.

GMOs

Monsanto is a frontrunner in controversial genetic engineering. Transgenetic seeds are spliced with extra-genetic (foreign) information to create desired characteristics, such as drought resistance or pesticide tolerance. Monsanto officials suggest that they prepare genetically modified organisms (GMOs) to end world hunger. Critics charge that after a decade of GM crops, companies are still not able to demonstrate results to help the poor or reduce malnutrition. They argue that Roundup® Ready technology and similar chemical packages represent short-term problem solving.

Although use of this type of agricultural technology may reduce the necessity to till, and therefore reduce soil erosion, it also increases herbicide and pesticide use. The toxic chemicals in pesticides move up the food chain and their increased use creates a public health concern. Excessive use of herbicides could lead to resistant weeds. The impacts of

GM crops on biodiversity are currently unknown, but they could spur significant loss of native species when genes drift to wild areas.

A segment of the public is concerned that transgenetic seed will become the sole agricultural option. To reduce this possibility, or at least stall the process, activists have repeatedly destroyed experimental GM plots, often by uprooting crops. GM critics also charge that it currently profits a small number of transnational corporations and increases their control over the food production chain. Large conglomerates often control seed supply as well as the purchase of agricultural harvests. Firms can now even stop a farmer from collecting seed from his or her own field.

Monsanto lawyers maintain a constant stream of litigation in global courts. The company has sued dozens of farmers for patent violations and won hundreds of thousands of dollars in compensation. After years of court battles, there were mixed results in one of the most infamous cases that pitted Monsanto against an individual Canadian farmer named Percy Schmeiser. Monsanto Canada sued Schmeiser for patent infringement and eventually won the case, but he was not held responsible for reparations.

The elderly farmer grows canola on a large farm in the province of Saskatchewan. He did not sign a Grower's Agreement or Technology Use Agreement with Monsanto for the use of Roundup® Ready canola found on his land. Schmeiser claims he acquired the genetically modified canola through a process of wind drift or cross-pollination. He saved his seeds, as he had done customarily, and planted a new generation. Patent law states that the offspring are the product of Monsanto. Thus, standing patent law does not sufficiently protect non-GMO farmers as they are restricted from planting any seed that becomes contaminated with bioengineered traits.

CONTROL OF SEED PATENTS

Monsanto is involved in extensive litigation over issues of intellectual property rights. In several countries, such as Brazil and Argentina, there have been growing incidences of seed smuggling. Although Monsanto requires the use of contracts that prohibit the sale of future seeds derived from seeds originally purchased from them, seed smuggling is widespread. Companies developing GMOs have the technology to create a type of terminator gene so that reproduction in subsequent generations is impossible; however, there is concern that such a trait could escape into the wild. Drift of modified traits also has the potential to contaminate surrounding conventional and organic agriculture. Recent studies suggest that genetic drift may occur at longer distances than previously thought. Further investigation is necessary.

Monsanto is one of the most visible seed biotech companies, but it is only one of many. Corporate rivals include Syngenta, Dupont, and Dow Chemical. Monsanto had an early advantage over others because it developed methods to "stack" seeds with more than one genetic trait. The company was able to patent traits to sell to other agribusinesses. Because other companies are currently developing competitive patents, Monsanto has recruited aggressively to gain the early advantage around the globe.

Monsanto's rapid global expansion of seed sales has been tied to the strategy of creating economic dependence in new markets. The company introduces its technology at lower prices. Once producers have transitioned to Monsanto products as a cost-saving device, Monsanto raises its price, especially in countries without major competitors for similar products.

However, in locations where Monsanto is fighting for market share with other biotech companies, the firm is more willing to keep prices low. Corporate policies lead to questions of international justice because farmers in some developing countries pay more for seed traits than their counterparts in the United States. Large corporations with the ability to pay Monsanto's prices may receive short-term advantages from their ability to lower productions costs. The greatest savings often comes from labor costs, but greater mechanization in production also leads to a reduction in most agricultural employment.

Monsanto is one of the largest corporate lobbyists in the United States. A policy that the company very actively opposes is required product labeling with GMO use. Monsanto is a significant contributor to research and development in private companies and academic institutions. Long-standing support from some members of academia lends legitimacy to Monsanto's GM seeds and chemical packages.

Monsanto's herbicide called Roundup® was the world's highest selling until the patent approval expired on the original generation. Subsequent generations of Roundup® Ready crops continue to be developed. Other well-known Monsanto products include recombinant bovine growth hormone (rBST) and the artificial sweetener Nutrasweet. Monsanto was also previously one of the producers of the defoliant Agent Orange and paid medical compensation to thousands of victims in South Korea. The company also paid to clean up dioxin and PCBs surrounding U.S. factories that produced the defoliant.

SEE ALSO: Agent Orange; Biodiversity; Biopiracy; Bovine Growth Hormone; Dioxins; Farming Systems; Genetic Patents and Seeds; Genetically Modified Organisms; Genetics and Genetic Engineering; Herbicides; Litigation, Environmental; Lobbyists; Pesticides; Polychlorinated Biphenyls; Undeveloped ("Third") World.

BIBLIOGRAPHY. Sue Branford, "When Even Monsanto Has Doubts," *New Statesman* (March 2004); Monsanto Corporation, www.monsantoag.com (cited July 2006); Maurizio G. Paoletti, *Impact of Genetically Modified Organisms* (Encyclopedia of Life Sciences, 2001); Peter Pringle, *Food, Inc.: Mendel to Monsanto—The Promises and Perils of the Biotech Harvest* (Simon and Schuster, 2005); Robert Schubert, "Farming's New Feudalism," *World Watch* (v.18/3, 2005); Tatiana Serafin, "A Tough Row," *Forbes* (v.176/10, 2005); Pamela Sherrid, "Altered Waves of Grain," *U.S. News & World Report* (v.134/9, 2003).

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Monsoon

THE WORD MONSOON originates in the Arabic term *mausem,* which means season. Monsoon is generally used to refer to the seasonal change in wind patterns between land and ocean, usually associated with well-defined periods of heavy rainfall. While monsoons can occur in North America and Asia, the dramatic weather pattern in the Indian subcontinent (South Asia) is the more well-known monsoon; it largely affects India, Bangladesh, Pakistan, and Sri Lanka. These seasonal changes in wind and rain patterns are very distinct and the South Asian monsoon is generally associated with heavy rainfall in the summer (often accompanied by floods) and dry spells in the winter months. The spatial coverage and intensity of the South Asian monsoon is not seen in the other monsoons. Rainfall of up to 10,000 millimeters can be experienced in parts of India, and most of the annual rainfall occurs during the summer monsoon season.

Monsoons occur due to the difference in specific heat of landmasses compared to oceans. In the summer, as land heats up faster than ocean water, the heat causes air to rise above landmasses, producing a system of low pressure. Air from the ocean moves in, and brings with it high moisture content. The difference in temperature between land and sea can be up to 20 degrees C. In the winter, as oceans retain more warmth and land cools down faster, the reverse occurs and wind blows from land to sea. In the South Asian monsoon, the summer monsoon (June–September) involves winds blowing landward from the southwest (Arabian Sea, Indian Ocean, Bay of Bengal) bringing considerable cloud cover and rainfall; while the winter monsoon (December–March) is a dry period with winds blowing in the opposite direction from the northeast toward the ocean. Monsoons can thus be thought of as very large, constant, and powerful sea breezes, involving large landmasses and oceans, forming one of the more enduring weather patterns seen.

Forecasting the arrival and retreat of monsoon fronts is important for societies in monsoon-dependent areas. It is important to understand regional differences and specificities in order to analyze, model, and forecast local weather patterns and implications of climate shifts. Monsoons can vary by time of onset and withdrawal, frequencies and intensities of storms, spatio-temporal variability of rainfall, duration and timing of monsoon "breaks" (i.e., days without rain), and tele-connection to larger systems of the El Nino Southern Oscillation (ENSO). Monsoons are thus linked to broader patterns such as the ENSO, but also to more local patterns such as the formation of tropical cyclones (typhoons or hurricanes), which are most common in the pre- and post-monsoon times (i.e., just before the monsoon front moves in and after it retreats, in the months of April–May and October–November, respectively). Tropical cyclones form over oceans and move landward, often bringing with them heavy rainfall, gusts, and storm surges.

The advent of monsoons in South Asia is generally associated with much-needed rain as a welcome relief from the dry heat, as well as for agricultural production that depends on the rains. Monsoons have inspired poetry and literature, and the seasons are an integral part of life and culture. As clouds roll in, rain is often welcomed with ceremonies.

Drought can seriously affect agricultural production, which is the mainstay of livelihoods of much of the South Asian population. The prolonged and heavy rainfall, however, can also lead to floods and ensuing damage and destruction. Rainfall and swollen rivers (from both rainfall and increased summer melting of Himalayan glaciers that feed the rivers) can result in devastating floods that cause damage to lives and property and displace millions of people. For instance, the devastating floods in Bangladesh in 1987 and 1988 resulted in most of the country being submerged under water for months, causing considerable suffering and loss to agriculture, industry, and homes, as well as to the economy. Heavy rainfall in general can also make life and business come to a standstill for days in most parts of South Asia. Monsoonal climates generally result in some levels of adaptation, but the inherent variability of the system means that it is difficult to predict when rain will occur or when floods may ensue and with what intensity. As such, South Asian societies are heavily dependent on and influenced by the monsoonal climatic system.

In the United States, the monsoon season affects the southwest between June and September.

In the United States, the monsoon season is generally between June–September, and affects the southwestern part of the country. It is generally known as the North American monsoon, but is often also called the southwest monsoon. The moist air coming up from the Gulf of Mexico brings with it rainfall, and there are associated thunderstorms in the southwestern deserts as well as the areas around the Rocky Mountains. While this monsoonal system is less pronounced and intense than the South Asian monsoon, it is still a distinct seasonal climatic system.

According to scientists, climate change is likely to affect monsoon systems. Climate simulation models predict that climate change from global warming will lead to increased rainfall; heavier storms; floods from rain and melting snowcaps/glaciers; increasing intensity of tropical cyclones; and changes in the monsoon-ENSO connection. Such changes are likely to affect localized weather patterns considerably in monsoonal zones. The increased sea surface temperature, as well as mean air temperature, will likely lead to greater events of extreme tropical cyclones (and associated storm surges) as well as flooding in the Indian subcontinent. This is assumed to be a result of greater temperatures leading to greater moisture, which will lead to a more intense hydrological cycle, and thus greater monsoons. Climate variability is thus likely to result in greater floods and droughts that may make short-term forecasts difficult and adaptation harder. Climate forecast models can predict certain trends but both short- and medium-term changes can be unpredictable.

With large populations in the tropical and temperate monsoon areas directly dependent on land and water resources for lives and livelihoods, changes in monsoonal patterns thus pose a greater concern to these societies. A dramatic change in monsoon cycles, or advent of monsoon rains themselves, can result in failures of the agricultural production cycle dependent on the monsoons. Increasing floods and tropical cyclones also pose threats to people living in coastal areas and floodplains along the hundreds of rivers that exist in South Asia; and high levels of poverty and lack of access to forecast information further compound the ways by which monsoonal unpredictability can affect lives and livelihoods.

SEE ALSO: Bangladesh; Climate, Humid Subtropical; Climate, Tropical; El Niño—Southern Oscillation (ENSO); Floods and Flood Control; Global Warming; India; Pakistan.

BIBLIOGRAPHY. C.P. Chang, B. Wang, and N.C. Lau, eds., *The Global Monsoon System: Research and Forecast* (WMO/TD, 2005); J.S. Fein and P.L. Stephens, eds., *Monsoons* (John Wiley & Sons, 1987); Alexander Frater, *Chasing the Monsoon* (Picador Press, 2005); Intergovernmental Panel on Climate Change, "IPCC Special Report on The Regional Impacts of Climate Change: An Assessment of Vulnerability," www.grida.no (cited April 2006); P.J. Webster, "Monsoons: Processes, Predictability, and the Prospects for Prediction," *Journal of Geophysical Research* (v.103, 1998); World Meteorological Organization, "No. 1266," www.wmo.int (cited April 2006).

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Montreal Protocol

THE MONTREAL Protocol on Substances that Deplete the Ozone Layer is the international environmental agreement designed to protect the stratospheric ozone layer, which shields the earth's surface from radiation in the ultraviolet spectrum. An increase in the intensity of UV-B rays reaching the surface may augment skin cancer rates in humans, decrease plankton production in the oceans, and negatively affect agricultural production throughout the world.

The Montreal Protocol, as it is often referred to in short, provided the framework for phasing out the production of the main ozone depleting chemicals (chlorofluorocarbons [CFCs], halons, carbon tetrachloride, methyl chloroform, hydrofluorocarbons, and methyl bromide). These chemicals were widely used as refrigerants, coolants, aerosol propellants, and industrial solvents.

CFCs were invented in 1928 by Thomas Midgley, Jr. (who also invented the lead additive to gasoline) and were applied widely due to their low costs of production and desirable chemical properties. Global annual reported production of CFCs rose from 544 tons in 1934 to 812,522 metric tons at the height of their use. In 1974, Mario J. Molina and F. Sherwood Rowland published a research paper highlighting the threat of CFCs to the ozone layer in the stratosphere. Their testimony before the U.S. House of Representatives in December 1974 led to a review by the National Academy of Sciences that confirmed the scientific validity of their CFC hypothesis.

In March 1978 the United States, followed by Canada, Norway, and Sweden, banned the use of nonessential aerosols. A number of international scientific conferences were held to study the consequences of ozone depletion. Under the leadership of the United Nations Environmental Programme (UNEP), an ad hoc working group began to negotiate a convention on research, monitoring, and data exchange in 1982.

In March 1985, 43 nations convened in Vienna to complete work on the first international ozone convention, which was later titled the "Vienna Convention." This nonbinding convention requested participating nations to "take appropriate measures" to protect the ozone layer, but more importantly called for renegotiations for a binding agreement.

Two months later, British scientists published data that showed a seasonal "hole" in the ozone layer over Antarctica. The first round of negotiations for a binding protocol were held in Geneva in December 1986, and after two more rounds of negotiations in Vienna and Geneva, the final version of the protocol was opened for signature in Montreal on September 16, 1987. The document is widely recognized as setting a precedent for preventive instead of corrective environmental action on a global scale.

The Montreal Protocol is considered by many as "perhaps the single most successful international agreement to date" (Kofi Annan, Secretary General of the United Nations). What ultimately led to the tremendous success of the negotiations for the final agreement is debatable. The negotiations were expertly directed and greatly influenced by the executive director of UNEP, Dr. Mostafa Tolba.

As Richard Benedick, the chief negotiator for the United States, argues in his seminal account of the negotiations, there were seven components that made a consensus possible. First, the powerful scientific discovery of the underlying chemical process was supplemented by successful collaboration between scientists and policy makers. Second, powerful education campaigns informed public opinion and governments, which resulted in changing negotiation positions for several countries. Third, the role of a multilateral institution (UNEP) in shaping consensus reflected a great degree of sensitivity to individual parties' interests. Fourth, the progressive policies by the major producer of ozone depleting substances, the United States, combined with its central role in international research and leading the way by adopting voluntary controls, provided a strong push toward international consensus. Germany was essential in solidifying the European Union's support of the agreement. Fifth, the involvement of industry and environmental groups played a major role in informing the public and negotiators about the costs and benefits from reduction in CFC production. Sixth, the process leading up to the final negotiations broke the larger issue into manageable pieces (e.g., scientific versus economic issues), which proved to be crucial in obtaining consensus. Finally, the Montreal Protocol has flexible components that allow its adaptation to new scientific and economics findings.

At least 11 countries, making up at least two-thirds of global consumption of the controlled substances, had to ratify the treaty for it to go into effect. This relatively low requirement was met at the earliest allowable date, January 1, 1989, with 30 parties responsible for 89 percent of global consumption having ratified the treaty. It has been amended five times since 1987 (London, 1990; Copenhagen, 1992; Vienna, 1995; Montreal, 1997; Beijing, 1999). By 2006, there were 189 parties to the Montreal Protocol.

The original text specified cutbacks be made relative to 1986 levels. A baseline year in the past was chosen to minimize the possibility of strategic production behavior. The original schedule required developing countries to maintain emissions at 1986 levels until 1992, followed by a 20 percent reduction from 1993 to 1998 and 50 percent reductions by 2000. The 1990 amendments moved the 50 percent reductions up to 1996, followed by a complete phase-out by the year 2000. The 1992 Copenhagen amendments specified a complete phase-out by 1996, which was the schedule the United States had adopted in the 1990 Clean Air Act amendments. The speeding up of the phase-out process was partially motivated by new evidence of the impacts of the regulated substances, but also by the availability of good cheap substitutes. It is generally thought that United States producers were a step ahead of their European counterparts in developing substitutes, which were revealed at a trade fair in 1988. DuPont announced a phase-out of CFC production six months after the signing of the protocol, in March 1988.

Developing countries involved in the negotiations were concerned about regulating products whose benefits embodied the lifestyle their growing populations aspired to obtain. In order to encourage developing countries to sign and ratify the agreement, concessions were made. In the 1987 document, Article 5 specified that any developing country with per capita consumption below 300 grams on the date or within 10 years of entry into force may delay the encoded reductions by 10 years, provided it doesn't exceed the 300 grams per capita threshold.

While the original document included language encouraging direct transfer of technology and aid from developed to developing countries, only the 1990 London amendments established an actual funding mechanism. The Multilateral Fund for the Implementation of the Montreal Protocol was designed to assist Article 5 countries in meeting the reductions. As of April 2006, over U.S. $2 billion in contributions to the fund have been made.

To prevent the leakage of production to non-participating nations, the protocol banned trade in substances covered under the agreement with non-parties. Finally, the parties identified some essential uses for the regulated substances, considered necessary for "the health and safety of society" and for which there were no feasible alternatives. These substances were exempt from the treaty, but the provision is subject to annual review.

Overall, global production of CFC-11 and CFC-12 has gone from 748,511 metric tons in the baseline year 1986 to 15,681 tons in 2003, which is a 98 percent reduction in annual production.

SEE ALSO: Chlorofluorocarbons (CFCs); Global Warming; Ozone and Ozone Depletion; United Nations; United Nations Environment Programme.

BIBLIOGRAPHY. Scott Barrett, *Global Environmental Diplomacy* (Oxford University Press, 2003); Richard Benedick, *Ozone Diplomacy* (Harvard University Press, 1998); Mostafa K. Tolba, *Global Environmental Diplomacy* (MIT Press, 1998); United Nations Environment Programme, "The Montreal Protocol on Substances that Deplete the Ozone Layer," www.unep.org (cited April 2006).

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Moral Economy

THE MORAL ECONOMY is an extremely powerful and influential concept that has far-reaching analytical, but also normative, implications. The term is difficult to define precisely, and continues to be used in a wide variety of contexts across multiple disciplines, including anthropology, sociology, geography, history, development studies, and political ecology. The gist of the moral economy is to point to the myriad ways in which economic behavior and institutions are constituted by and embedded within cultural and political norms, often with a high degree of historical and geographical specificity. This can be a primarily theoretical conceptualization drawing attention to the ways in which particular norms, values, traditions, and social relations constrain (and motivate) economic activities (broadly defined). But it can also be used in a more normative manner, advocating for particular regulations and constraints based on overt or implicit moral principles. In both its analytical and more overtly normative connotations, the concept has wide purchase in scholarship and policy discussions concerning the politics of environmental change, not least in terms of how political and cultural sensibilities about environmental transformations and their implications inform the social regulation of economic activities.

Many locate the idea of the moral economy in Aristotle's distinction between production for use and production for exchange. Aristotle was quite critical of the latter, arguing that economic production purely for gain was immoral. This anticipates Karl Marx's more formal distinctions between use value and exchange value under capitalism, and his excoriation of capitalism as a political economy founded on greed and accumulation for accumulation's sake. However, Aristotle also anticipates and is invoked explicitly by Karl Polanyi who similarly criticized what he called market society, i.e., one in which the market is the main institution governing allocation and social distribution. Polanyi argues in *The Great Transformation* and elsewhere that only in a market society do we find the pretense of exchange unmediated by social and cultural constraints. Other (in Polanyi's view prior) societies were characterized by economies *embedded* within and conditioned by social norms and mores—hence the moral economy.

There is some inconsistency in Polanyi with regard to whether or not he actually thought market society itself, even in the minds of its liberal advocates, was truly disembedded, or whether free market orthodoxy itself necessarily turns on moral arguments, e.g., that the pursuit of self-interest unmediated by state interference is an inherent good. What is clear is that Polanyi felt that the "economy" should be conditioned by social and cultural norms other than greed, since a truly market-centered society featuring unchecked production for exchange would tear itself apart by destroying the social and environmental conditions of its own reproduction.

The moral economy idea was developed and deployed by James Scott in his study of the politics of resistance to colonialism in Southeast Asia. Why, Scott asks, did peasants not rise up more often against their colonial oppressors, given evident political and economic exploitation? His answer, in part, relies on the notion that justice is historical and relational, not objective and absolute, particularly vis-à-vis access rights to natural resources and land. He argues that many peasant communities were motivated by the right to subsistence and by attempts to minimize the risk of starvation, rather than to accumulate surplus. According to Scott, only close attention to the particular, localized material conditions and cultural meanings of food production could reveal this ethic and its influence on political action.

Similar notions of a prevailing moral economy order that shapes historically and geographically specific politics and social movements animate E.P Thompson's work, including his widely influential study of Britain's Black Act. Thompson examines the ways in which complex, specific, and overlapping rights of forest access distributed across complex social strata came under threat by changing political and economic conditions in England after the Hanoverian ascension. He argues that only by looking at the world through the eyes of those involved (to the extent this is possible), particularly those who resisted what they perceived as forest enclosures, could the sometimes violent resistance of the "Blacks" (as they were known) be understood. Among the implications, Thompson shows powerfully that various property rights to forests were not only material economic assets, but also powerful rights in a moral and symbolic sense of the term, the maintenance of which underpinned notions of justice, identity, and a morally acceptable economic order.

These ideas continue to have wide influence in political ecology, and at the intersection of development and environment. This is because the concept points to the need for understanding locally specific social relations, institutions, and cultural constructs prevailing over resource access and resource use. For instance, the idea of moral economy has been a powerful influence on attempts to understand and critique so-called coercive conservation, wherein traditional rights of access considered integral to subsistence among local peoples have been violated by attempts to institutionalize parks and protected areas. Considerable NGO and scholarly effort is also being invested in the positive formulation of moral codes and standards by which to govern the global economy, hopefully to steer it toward more socially and environmentally sustainable outcomes based on notions of fairness, equity, and ecological viability. This requires overt discussion of what principles of economic and environmental justice can be institutionalized at international scales of interaction in pursuit of a moral economy in a positive sense of the term. This is no mean feat, and begs a question that goes all the way back to Aristotle: if greed is not acceptable as the moral foundation of economic relations and institutions, what is?

SEE ALSO: Conservation; Livelihood; Political Ecology; Trade, Fair; Tragedy of the Commons.

BIBLIOGRAPHY. F. Block, "Karl Polanyi and the Writing of the Great Transformation," *Theory and Society* (v.32, 2003); W.J. Booth, "On the Idea of the Moral Economy," *The American Political Science Review* (v.88/3, 1994); D. Goodman, "Reading Fair Trade: Political Ecological Imaginary and the Moral Economy of Fair Trade Foods," *Political Geography* (v.23, 2004); T. Mutersbaugh, "Fighting Standards with Standards: Harmonization, Rents, and Social Accountability in Certified Agro-Food Networks," *Environment and Planning A* (v.37, 2005); R.P. Neumann, *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa* (University of California Press, 1998); K. Polanyi, *The Great Transformation: The Political and Economic Origins of Our Time* (Beacon Press, 1944); A. Sayer, "(De)Commodification, Consumer Culture, and Moral Economy," *Environment and Planning D: Society and Space* (v.21, 2003); J.C. Scott, *The Moral Economy of the Peasant: Subsistence and Rebellion in Southeast Asia*, (Yale University Press, 1976); E.P. Thompson, *Whigs and Hunters: The Origin of the Black Act* (Pantheon, 1975); M.D. Turner, "Political Ecology and the Moral Dimensions of 'Resource Conflicts': The Case of Farmer-Herder Conflicts in the Sahel," *Political Geography* (v.23, 2004).

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Morocco

MOROCCO IS A country on the western edge of North Africa (or as some would claim, it is the westernmost country of the Middle East). It has an area of 172,413 square miles and a population of

Land Tenure in Morocco

Up until the 1880 Treaty of Madrid, all land in Morocco was owned by the sultan. This meant that sale of any land to a European had to be approved by the sultan himself. There was no landed aristocracy, and Arab nobility was based on blood rather than on possession of estates.

The French took over a large portion of Morocco, which they held until independence in 1956. During that period, they divided land into five categories. Much of the land was *makhzen* land, which meant that it was owned by the sultan personally, and also in his capacity as head of state. There was often no discrimination between the two, and the sultan quite often sold land belonging to him in his capacity as head of state. The next category was *habous* property, which was land left to religious or charitable institutions and administered by *nadir*s appointed by the sultans. Some of it had been held for many centuries as *habous* property, and by 1912 vast amounts of land throughout the country was in this category. Much of it was farmland, but it also included much urban property. A law was introduced in 1913 that allowed French settlers to rent it for up to ten years.

Guich land, was the land that was held by the sultan and handed over to various tribes for them to administer as they sought fit. A 1914 law declared this land inalienable, even though much of it was wanted. Indeed, some of it was taken for distribution and sale to French settlers. Collective lands were lands held by tribes, largely by right of force, and were not recognized by either Andulasian or Moroccan laws. Occasionally these holdings were recognized by the sultan. The last category was *melk* lands, which were privately-held properties that accounted for much of the land holdings in the cities.

30.7 million (2005 estimate). Currently, the capital of the country is Rabat, although there are three other "imperial" cities—Marrakech, Fes, and Meknès—that have also served as capitals. Morocco is bordered by Algeria, the Mediterranean Sea, and the Atlantic Ocean. To the south is the disputed territory of Western Sahara. Although claimed by Morocco, the international community does not recognize Western Sahara as part of Morocco.

Three mountain ranges dominate Morocco: the Atlas, the Anti-Atlas, and the Rif. These mountains collectively influence weather patterns coming off the Atlantic Ocean and channel surface rainwater back into Morocco. On the eastern side of the Atlas Mountains, the desert environment of the Sahara predominates. This phenomenon has frequently given rise to a comparison of Morocco with California; Morocco has many, though not all, of the agricultural possibilities of that state.

The population is frequently classified as Arab/Berber although the two groups are not as intermixed as that label might appear. The official language of Morocco is Arabic, but there are also many Berber dialects spoken in the mountains and the south especially. French is also a widely used second language. Religiously, the overwhelming majority of the population is Sunni Muslim. The once large Jewish minority has mostly left for Israel and other destinations.

Historically, the earliest inhabitants were Berbers, but Morocco also had a strong Roman presence. The Arabs conquered the area in the late 17th century. After Moroccan independence in 788, a succession of dynasties ruled Morocco, including the Almoravids and Almohads who ruled both Spain and Morocco. King Mohammed VI is the latest monarch of the Alouite Dynasty, which has ruled Morocco since the mid-17th century. Morocco was also a French protectorate in the early 20th century, which heavily impacted development and gave Morocco its unique urban flavor of old *medinas* set next to French-inspired *villes nouvelles*.

Morocco's economy is heavily dependent on agricultural production, especially for the lucrative European market. Many areas grow high value, water intensive crops like tomatoes, melons, and cut flowers for export. Over the past three decades, the Moroccan government has spent a substantial amount of their capital expanding agriculture both in places that have historically concentrated on agriculture, such as Marrakech, and in new areas, such as around the southern city of Agadir, where aquifers have been accessed. Environmental problems have resulted as saltwater intrusion has increased and the government has been forced to spend more money on protecting, and where possible, augmenting flow back into aquifers.

Service industry jobs employ roughly the same amount of the population as agriculture with industry employing only about a quarter of the amount of people as either of those two sectors. Unemployment remains high and has fueled migration of Moroccans to Europe, particularly to France and Belgium. Unemployment has also created dissatisfaction with the government and a minority Islamist presence has emerged in recent years.

SEE ALSO: Mediterranean Sea; Migration; Sahara Desert; Salinization.

BIBLIOGRAPHY. Kevin Dwyer, *Moroccan Dialogues* (Waveland Press, 1982); Fatima Mernissi, *Dreams of Trespass: Tales of a Harem Girlhood* (Addison-Wesley, 1994); James A. Miller, *Imlil: A Moroccan Mountain Community in Change* (Westview Press, 1984); C.R. Pennell, *Morocco Since 1820: A History* (New York University Press, 2001); Paul Rabinow, *Reflections on Fieldwork in Morocco* (University of California Press, 1977).

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Mosquitoes

TWO THOUSAND FIVE hundred species and 1,000 subspecies of mosquitoes thrive across diverse ecological niches from the arid desert to the subarctic tundra. The life cycle, habitat preference, and temporal behavior of mosquitoes is therefore highly variable and species dependent. Over its life cycle, a mosquito hatches from an egg, develops through aquatic larval stages into a pupae and finally an airborne adult. Larval mosquitoes inhabit almost all temporary natural, human altered or anthropogenic water holding bodies on land. Extraordinary larval habitats include salty water, hot springs, tree holes, inside of plants (e.g., pitcherplants, bromeliads) and even water in between plant cellular tissue. Mosquitoes that transfer diseases to humans preferentially breed in disturbed environments (e.g., burrow pits, hoof prints) or containers (e.g., potable water jars, tires) close to or inside human dwellings.

Only a small fraction of eggs survive environmental hazards, resource scarcity, predation, disease, and competition to develop into adults. Reproductive strategies vary from laying individual eggs or egg clusters across multiple locations to depositing all the eggs in one location as a mosquito raft. Depending on the species, eggs are either deposited into a water body and rapidly develop or are deposited on a surface previously submerged in water. Subsequently re-submerging the eggs combined with other environmental cues initiates hatching of the mosquito into a suitable habitat. The cold-blooded mosquito's rate of development is strongly influenced by the temperature and moisture characteristics of the ambient environment. In general, warm conditions expedite mosquito development while hot or cold conditions stymie mosquito maturation.

Nonpredatory larvae extract and/or browse for food and nutrients from the aqueous environment and store the food for future development. Larvae mature, grow, and shed their exoskeletons three times before metamorphosis accelerates in the pupae stage. Pupae larval muscles and the midgut are completely reconstructed into adult body parts. Pupae are morphologically distinct from larvae, cannot consume food, float at the water's surface, and can survive outside of water. Adult mosquitoes consume nectar, fruit, and honeydew for sustenance and can be important pollinators of plants. Mature males swarm together and attract viable females to copulate and complete the mosquito life cycle. Inseminated females store the sperm and only fertilize their eggs prior to deposition. Of the mosquito species that extract blood, only the females actively seek out blood meals to provide protein for the development of the eggs. Each species has a preferred time of the day to vigorously seek blood and this circadian rhythm informs strategies to minimize mosquito and human contact. Favorable host seeking times of the day are either the nighttime, daytime, or during the twilight dusk and dawn hours. The degree to which a mosquito hunts for human (anthropophilic) or other vertebrate blood (zoophilic) sources is largely species dependent; however, significant intraspecies variation exists.

Female mosquitoes employ a diverse array of tools to identify appropriate sources of blood and extract plasma without alerting the unwitting victim. She is attracted to the heat our bodies continually emit, carbon dioxide and water vapor we exhale, lactic acid excreted in our sweat, and our body movements. Mosquito repellant masks the body's excretions and makes us less appealing blood sources. Upon landing, the mosquito finds the optimal extraction site by touching and chemically "smelling" the skin with her antennae and mouthparts. She proceeds to find blood, insert her mouthparts, and inject chemical filled saliva similar to a drug cocktail administered to a patient before an operation. Saliva chemicals stop blood clot formation, keep the blood vessels enlarged, and thwart any host inflammatory immune response.

Infectious viruses, protozoa, or worms (nematodes) in the biting mosquito may be transferred with the saliva to another host to complete or start a new reproductive cycle.

Agents responsible for a large proportion of the global disease burden such as malaria, dengue, Rift Valley fever, yellow fever, elephantitis, and encephalitides are transmitted during this exchange. The female mosquito ingests two to three times her weight in blood and finds a safe habitat to process the blood.

EXTERMINATION OR CONTROL

Mosquito management historically combines source reduction, surveillance, targeted biological and chemical control, public education, and legislative action at the region, village, household, and individual levels of organization. Multiple remediation activities target the life cycle specific ecological associations of medically important and nuisance mosquitoes. Insecticide application—Dichlorodiphenyltrichloroethane (DDT)—became the dominant method of mosquito control from World War II until it was banned in Western nations in the 1970s.

Mosquito-borne diseases include malaria, dengue, Rift Valley fever, yellow fever, and encephalitides.

Top down military eradication efforts of the mid-20th century are in the process of transitioning into more participatory, community supported, and holistic management activities. Technical "magic bullets" singularly focused on a component of disease transmission have proven costly, inflexible, and detrimental to other management strategies. Divergent conceptions of society's relationship to the mosquito underpin historical shifts from mosquito and disease extermination back toward mosquito mitigation, management, and control. Integrated mosquito management currently attempts to reduce the level of disease transmission by decreasing mosquito abundance.

Source reduction eliminates standing water required for larval development by draining wetlands and marshes or emptying water in man-made containers. Effective source reduction also includes the active management, engineering, and alteration of mosquito habitats.

Channeling, stabilizing, and diverting waterways, controlling the height and motion of standing water, removing invasive or marginal groundcover, and planting trees along waterways historically controlled malaria vectors.

Biological mosquito control intentionally introduces a mosquito predator, parasite, or organic toxin to reduce larval populations in aquatic environments. Predatory mosquito fish (e.g., *Gambusia*, *Tilapia*) consume larval mosquitoes as well as change the habitat vegetation structure to be inhospitable to certain mosquito species. Microcrustacean predatory copepods, carnivorous *Toxorhynchites* mosquitoes, parasitic nematodes, and pathogenic protista are other biological control methods of varying effectiveness.

The mosquito's rapid reproductive cycle and large number of offspring naturally promote genetic resistance against insecticides. Mosquitoes are adapted to the current generation of pesticides such as organophosphates, carbamates, and pyrethroids and all medically important species are resistant to at least one pesticide. Entirely novel pesticides have not been developed in 15 years and significant financial and safety barriers to chemical generation and introduction exist. Indoor residual spraying is a neighborhood level intervention that applies pesticides inside households on surfaces where medically important mosquitoes rest. This strategy targets the infectious females who may transmit a disease to other household members.

Successful household and individual level interventions focus on mosquito-proofing households, personal protection, and behavioral changes. Households that actively replace standing water, have indoor plumbing, door and window screens, and access to running water decrease their interaction with mosquitoes. To avoid mosquitoes that blood-feed nocturnally or during the twilight hours, individuals can shift their outdoor activities to the daytime hours. Changes in activity patterns may be mandated by state policies like the historic nighttime curfew imposed during malaria transmission season in Israel. Distributing insecticide-coated bed nets similarly capitalizes on the nocturnal feeding preference of *Anopheles gambiae* (malaria vector) to provide personal protection. For mosquitoborne diseases (yellow fever, Japanese encephalitis) with effective vaccines, disease management focuses on vaccine manufacturing and distribution, and building and maintaining public health infrastructure instead of mosquito control. Transmission of diseases with vaccines persists in environmentally disturbed and politically and economically disenfranchised or disadvantaged regions.

SEE ALSO: DDT; Disease; Insects; Malaria; Yellow Fever.

BIBLIOGRAPHY. J.D. Gillet, *Mosquitos* (Weidenfeld and Nicolson, 1971); Uriel Kitron and Andrew Spielman, "Suppression of Transmission of Malaria through Source Reduction; Antianopheline Measures Applied in Israel, the United States and Italy," *Reviews of Infectious Diseases* (v.11); William Marquardt, ed., *Biology of Disease Vectors* (Academic Press, 2004); Timothy Mitchell, *Rule of Experts: Egypt, Techno-politics, Modernity* (University of California Press, 2002); Jerry Spiegel et al., "Barriers and Bridges to Prevention and Control of Dengue: The Need for a Social-Ecological Approach," *EcoHealth* (v.4); Andrew Spielman and Michael D'Antonio, *Mosquito: A Natural History of Our Most Persistent and Deadly Foe* (Hyperion, 2001).

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Mountains

MOUNTAINS ARE LANDFORMS that are characterized by their elevation and slope. A broad description is any landscape feature that is over 600 meters in elevation change with steep slopes. The United Nations International Year of the Mountain (2002) separated mountains into two major categories—mountains extending above 2,500 meters and between 2,500 and 300 meters. Lands that have topographic relief of more than 5 percent within 7 kilometers are also considered mountains.

Mountains are formed in a process known as orogeny of which there are three major activities: island arcs and trenches—along the subduction zones of two oceanic plates; cordilleran-type mountain ranges—along the subduction zones of an ocean and continental plate; and the collisional mountain belts—the convergence and subduction of an arc or another continental plate in contact with the overlaying plate of the subduction zone. In addition, erosion over time creates topographic relief mountains. The island arcs and trenches are both submerged below ocean floors and rise above the ocean in island chains throughout the Pacific, Indonesia, and the Caribbean. The long mountain chains along coastal regions demonstrate the cordilleran-type mountains, best illustrated by the Andean Mountains of South America. The Himalayas are being formed by the collisional-mountain process, the contact of one plate with another. The sedimentary forelands formed on the subduction plate can create a different set of mountains resulting from the folding and faulting of the sedimentary layers. Examples of this type of mountain range are the Front Range of the Rocky Mountains, the Appalachian Mountains, and the Subandean Range in Argentina.

Approximately 24 percent of Earth's surface area is mountainous. South Asia is covered by almost 54 percent mountains, the other continents by less: North America (36 percent), Europe (25 percent), South America (22 percent), Australia (17 percent), and Africa only 3 percent. There are over 130 recognized mountain ranges worldwide, with peaks of varying elevations. Mount Everest is the highest mountain above sea level (8,848m), while Mauna Kea is the actual highest mountain measured from its base on the ocean floor to its crest above sea level.

Mountain elevation change has a dramatic effect on local, regional, and global climate. Air moving along Earth's surface is forced upward with mountain contact. As the air climbs the mountain it decreases in temperature at an average rate of 6.5 degrees C per 1,000 meter, the adiabatic rate. Moisture in the atmosphere condenses as it cools and forms clouds and eventually precipitation, rain, or snow. As the air continues over the mountain it contains less moisture and on the descent down the mountain it warms at approximately the same or higher adiabatic rate forming dry, warm winds. The upslope movement of air is on the windward side of the mountain and the downslope movement is on the leeward side. Thus, the mountain will have cooling, wetter conditions on the windward side and drier, warming conditions on the leeward side. The weather station on the windward side of Mount Waialeale is located at 1,569 meters and receives an average of 1,234 centimeters of precipitation; in contrast, the leeward side receives only 50 centimeters. The mountain side (face) is also influenced by its orientation to the sun and its latitude. Sun-facing slopes will be warmer and usually slightly drier than slopes facing away from the sun. Similarly, east-facing slopes will receive the morning sun and be cooler than the west-facing slope.

Mountains are the water towers for the land surface. Because of their orographic effects, mountains are the headwaters of almost all of the major rivers in the world. The Ganges, Indus, Yangtze, and Huang Ho rivers have their headwaters in the Himalayas. The Amazon is fed from the Andes, the Blue Nile from the Ethiopian Highlands, and the Colorado from the Rocky Mountains. Mountain runoff is a function of snow accumulation and precipitation patterns. Changes in stream and river flow will have an impact on the water received in the valley or the delta area of the river drainage. Mountains are the source of over 50 percent of the fresh water humans consume.

Vegetation and wildlife respond to the differences in temperature and precipitation caused by mountain ranges. A zonal pattern occurs with increase or decrease in elevation, however, the pattern is influenced by the windward/leeward side of the mountain, the mountain face aspect, latitude, and continentality (whether it is a coastal or mainland mountain range). Overall, the vegetation in mountain areas is a vertical pattern of the horizontal vegetation change through the latitudes from the equator to the poles. There are five major categories of vegetation: tropical rain forest, temperate deciduous forest, coniferous forest, tundra, and ice and snow.

Correspondingly, there are animal, avian, and insect habitats that associate with each of the different vegetation categories and the multitude of species can be combined to create a species richness index. Research has found that the species richness index decreases with an increase in elevation, similar to the changes identified with an increase in latitude. However, the changes in species richness are amplified in the mountain environment because of the compressed distance to transition from one vegetation zone to another. The Andes are an example of this species richness, with over 45,000 plant species in an area that is only 20 percent of the size of a similar richness in the Amazon forest.

Although 24 percent of the world land base is in mountainous terrain, more than 500 million people (12 percent) live in this region. Though more than 80 percent live below 2,500 meters, human activities extend to the highest reaches of mountains. Major activities on mountains are agriculture, logging, and livestock production. These activities can be found at most elevations; however, agriculture will be limited by growing season length and crop type. Logging will be determined not only by forest type, but also by access to transportation. The timber industry is directly related to a transportation system that can deliver the logs to the mill and to the market.

Two other activities that are also dependent on transportation access are mining and tourism. Because of the orogenic activities that created mountains, they have the potential for a variety of marketable mineral deposits and rock structures, from precious metals to construction materials such as marble, granite, and copper.

Tourism has created a new type of activity that brings over 50 million people to the mountains for passive and activity recreation. Overall, 15–20 percent of the global tourism industry is associated with mountain recreation—hiking, skiing, climbing, and observation. Finally, another form of mountain activity is the spiritual pilgrimage, a combination of religion, spirituality, and tourism. Specific sites have significance to particular religious or cultural groups, for instance Amdo to Tibetans, Kii Mountain to the Japanese, and mountainous Blue Lake in the southern Rocky Mountains for the Taos Pueblo.

The mountain region is a fragile environment and change can have immediate impacts. There are two scales of change that are the most evident—global and local. Global climate change is having an immediate effect on snow accumulation, glacial retreat, solar radiation, and runoff. In Glacier National Park, of the 150 glaciers recorded in 1850 there are now only 27 glaciers remaining. Over this time period around the world the temperature has increased .45 degrees C (±.15 degrees C).

In addition, nitrogen in the atmosphere has increased and this has led to a shift in mountain vegetation patterns. At the local scale, devegetation of the hillsides leads to rapid erosion of the slopes. More than 40 percent of the slopes in Nepal have been abandoned by farmers because of the loss of fertility. In Ethiopia, mountain forests covered 75 percent of the land, but deforestation decreased that number to only 4 percent.

In other situations, it is not just deforestation that is destroying the landscape, but rapid development. The desire to visit, the need for comfortable accommodations, and the disposable mentality are taking their toll on the mountains. In South Korea, although the mountains account for only 4 percent of the area, over 30 million visitors come to the mountains for recreation. In the high elevations of the Himalayas the more than 225 lodges need to keep their guests comfortable and over 1,000 tons of firewood are burned daily to keep them warm. New tourism in the Himalayas is also leaving its mark on the landscape in the form of rubbish. It is estimated that over 17 tons of materials are left behind per one kilometer of trails into the mountains.

The increase in the intensity of local mountain activities and the impacts of global climatic change are changing this fragile environment. Through United Nations initiatives, national government policies, and successful local strategies the mountains may be saved for future generations of humankind to experience.

SEE ALSO: Andes Mountains; Appalachian Mountains; Climate; Deforestation; Ecosystem; Global Warming; Livestock; Nitrogen Cycle; Rocky Mountains; Ural Mountains.

BIBLIOGRAPHY. N.J.R. Allan, G.W. Knapp, and C. Stadel, *Human Impact on Mountains* (Rowman and Littlefield Publishers, 1988); A.L. Bloom, *Geomorphology: A Systematic Analysis of Late Cenozoic Landforms* (Waveland Press, 1998); K.N. Brooks et al., *Hydrology and the Management of Watersheds* (Iowa State University Press, 1997); W.R. Christopherson, *Geosystems: An Introduction to Physical Geography* (Prentice-Hall, 2000); M.H.P. Hall and D.B. Farge, "Modeled Climate-induced Glacier Change in Glacier National Park, 1850–2100," *BioScience* (v. 53/2, 2003); C. Korner and E.M. Spehn, eds., *Mountain Biodiversity: A Global Assessment* (Parthenon Publishing, 2002); P.B. Stone, ed., *The State of the World's Mountains: A Global Report* (Zed Books, 1992);

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Movements, Environmental

TO IDENTIFY A movement, or movements, as environmentally oriented is to cast the politics of environmentalism in terms of social movement theory. Other notable social movements include the labor, women's, civil rights, peace/antiwar, student, animal rights, and antiglobalization movements, all of which have at times been linked to environmental movements. Classically, social movements are considered to have a type of life cycle. They germinate in order to challenge some form of oppression within society, they build and mobilize affinity groups around issues of solidarity common to an oppressive cause, culminating in success or failure. If social movements fail, theorists have charted how other movements may attempt to revisit the failed issue or reorganize collective actors previously associated with the failed movement as part of a resurgent political strategy. If social movements are victorious, social movement theory has tended to represent them as inevitably ossifying and fragmenting, with leading movement intellectuals and organizations often cementing the movement's overall bureaucratization and rigid institutionalization through their demands for its rigid formalization.

Environmental movements do not appear to accurately reflect this model. Instead, such movements have remained vital and capable of adjusting to meet the dynamic needs of differing social, cultural, political, and historical conditions. They have celebrated many great and small victories without having become either de-radicalized or sclerotic. Likewise, environmental movements have been dealt innumerable setbacks and have arguably been defeated in the large, if one is to judge them by the ongoing exponential growth of global human population, the continued development of unsustainable economic systems, and the ever-burgeoning planetary ecological crises of the last 30 years. Still, this has not led to the marginalization or evaporation of environmental movements. Rather, environmental movements are flourishing as they never have before and remain poised as central agents of sociopolitical change during the 21st century.

Environmental movements involve collective activist networks of individuals, groups, formal and nonformal organizations, and institutional bodies that struggle for social transformation around environmentally-related causes such as global climate change, antitoxics, the conservation of natural resources, population growth problems, the end to nuclear arms and other weapons of mass destruction, the protection of pristine wild places and biological species, corporate accountability, and the promotion of environmental justice principles. Environmental movements work at local, regional, national, transnational, and global levels, and can be structured as loose affiliations of a transient nature, or as longer-term alliances that consist of well-established corporate and noncorporate organizations, including political parties such as the international confederation of Green parties. While environmental movements have played crucial roles in lobbying politicians, as well as in getting governments to produce and enforce sound environmental legislation; having a professional environmental policy approach is only one function of environmental movements. Environmental movements work in legal and illegal ways to transform mainstream values, educate the public about social problems of an environmental nature, create sustainable cultural alternatives, and block environmental harms through myriad forms of protest and direct action.

Sometimes it is implied that the wide variety of global environmental movements are facets of a larger, all-inclusive ecology or Green Movement that has the gestation of a planetary consciousness, the mass proliferation of appropriate technologies, and the broad democratization of science as its goals. Others fold even this larger environmental movement into the emergent movement for global justice, which is often called the movement of movements because of its ability to signal the need for radical change on many fronts. Yet, at least in an Anglo-American context, the terminology of *environmental movement* is most often used to denote the rise of modern environmentalism in advanced industrialized nations since the 1960s; though scholars also frequently extend this time frame to include previous American movements such as the conservation, preservation, and transcendental movements of the 19th and early 20th centuries as important foundations of contemporary environmental activism. A singular environmental movement exists, but the manner in which this movement is made manifest and experienced throughout the world differs significantly, with singular movements sometimes working in contradiction to each other's immediate aims. The environmental movement can refer to anything from a history of localized green activism, to a theorized worldwide revolution predicated on ideas of ecological well-being.

The American environmental movement is often hailed as the birthplace of environmentalism. While nothing resembling an environmental movement existed until the mid-19th century when both the conservation and transcendental movements took root amongst sectors of society concerned with the consequences of the Industrial Revolution, a legacy of ecological harms can be traced all the way back to the initial colonization of North America by European merchant ships, which brought with them a variety of highly invasive species and plagues through the Columbian Exchange.

NATIVE AMERICANS

Native Americans, Mesoamerican tribes, and many Canadian First Peoples who had been living in relative ecological harmony with the land for millennia continue to bear the oral traditions of this history, the living testimony of the perilous environmental and social legacy of colonization. Native voices play an increasingly prominent role in the environmental movement, where they offer articulations of and legitimation for alternative cosmological visions and sustainable living practices. Notably, Winona LaDuke, a leading spokesperson of the indigenous peoples' movement, ran for vice president of the United States as the U.S. Green Party nominee in 1996 and 2000.

If American indigenous societies have tended to produce place-based ecological knowledge and promote a general conservation ethic in their cultural practices, it is only recently that they have more widely practiced public forms of environmental activism. This is in contradiction to the false images of Native American environmental activists that have been fostered by white environmentalists since the 1970s in order to better ground the movement in cultures that appear to represent land-based alternatives to modernity. The most infamous example of this practice was when an 1854 speech by Suquamish leader Chief Seattle was entirely rewritten by screenwriter Ted Perry to support the message of the 1972 environmentalist film *Home*. The so-called Perry version of Chief Seattle's speech has since been quoted by political leaders at Earth Day celebrations, by environmental ideologues such as Joseph Campbell and Bill Moyers, and has served as the basis for a best-selling environmentally-themed children's book, *Brother Eagle, Sister Sky: A Message from Chief Seattle*.

19TH CENTURY AMERICAN MOVEMENTS

The first nonindigenous movement for American environmental conservation began in earnest during the mid-19th century. Thomas Jefferson is sometimes considered the father of the American conservation movement because of his founding work as a naturalist and his call in the book *Notes on the State of Virginia* for the country to be inhabited as a series of small-scale, subsistence-styled farms, a vision more recently defended by important environmentalists such as Wendell Berry. However, Jefferson's late 18th century book was known to only a few people and did not exert much popular influence.

On the contrary, Ralph Waldo Emerson's *Nature*, published in 1836, was widely read and established the transcendental movement that demonstrated the manner in which the American environment should be extolled and utilized as a rich spiritual and aesthetic resource for deepening the American experience of the world. This idea represented a dramatic shift from the long-standing tradition in which the American wilderness was perceived as base, threatening, and requiring the improvements offered by civilization.

Over the next two decades, transcendentalists such as Emerson, Henry David Thoreau, Margaret Fuller, and Bronson Alcott published their work in the *Dial* journal, which became a key movement mouthpiece. Under the transcendentalists' influence, various forms of nature writing became commercially successful genres, and romantic painterly depictions of the American West, such as those produced by the Hudson River school artists, generated enthusiasm about the country's natural wonders. Further, the transcendental movement linked its environmental outlook to a larger social consciousness that radically critiqued political issues of the day, such as the federal government's treatment of Native American populations, the horror of slavery practices, the national passage of the Fugitive Slave Act, the war between the United States and Mexico, women's civil rights, animal welfare, and the social effects of industrialism. The transcendental movement also experimented with utopian forms of community such as Brook Farm, Fruitlands, and Walden.

THE CONSERVATION MOVEMENT

By the mid-19th century, those living on America's eastern seaboard were beginning to see the effects of deforestation, depopulation of species, soil erosion, water issues, and urban pollution in the large cities. Science and technology were also beginning to make revolutionary breakthroughs, including in previously uninvestigated domains such as the science of conservation ecology as represented by the work of George Marsh. A conservation movement arose that sought to combine the culturalism of transcendentalism with science and technology's ability to measure and limit human impacts on the environment as part of a progressive social vision for rationally managing natural resources for human betterment. This movement has an enduring legacy and notched many accomplishments including the creation of the world's first national park system, beginning in 1872 with the formation of Yellowstone National Park, along with the adoption of conservation policies instituting state and national wildlife refuges, forests, and protected species.

The presidency of Theodore Roosevelt is often hailed as a central moment of the conservation movement and is notable for the historic clash between Gifford Pinchot, considered the father of American conservation forestry, and John Muir, the founder of the Sierra Club. A debate erupted over whether to place a dam, a common conservation project undertaken during the early 20th century, in Yosemite Park's Hetch Hetchy Valley in order to create a reservoir to support the city of San Francisco. Muir called for the valley's preservation at all costs and defended nature in transcendental terms as equally important, if not more so, than civilization. Pinchot spoke of the utility of the project and counseled for its approval as long as the park (as with other natural resources) was conserved and managed scientifically for the public's good. Roosevelt ultimately approved the project, despite great controversy and debates about whether to preserve natural places or to manage them for human use.

THE 1960s AND 1970s

Muir's new preservation movement fought against the further desecration of national lands and was successful in preventing further encroachments on the national parks. Especially notable in this respect is the Wilderness Society, created in 1935, which has since protected over 100 million acres of land from development through the passage of the Wilderness Act of 1964. This legislation designated specific areas as "wilderness," or as areas "where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

As a result of legislation such as the Wilderness Act, the National Environmental Policy Act, the Endangered Species Act, and the Clean Air Act, the 1960s are often seen as the era that birthed the contemporary environmental movement. In 1962, Rachel Carson's *Silent Spring* shocked the country by exposing the environmental dangers of ubiquitous pesticides such as DDT. In 1969, a massive oil spill off the Santa Barbara coast became the first extensively televised environmental disaster, generating public outrage, anti-oil activism, and demands for marine protection culminating in the Marine Mammal Protection Act. Finally, in 1970, the first Earth Day was conducted in San Francisco, and the American environmental movement began to have global effects.

After the 1970s, the environmental movement's mainstream organizations grew increasingly powerful and global, often partnering with corporations and governments to promote policy change toward sustainable development, implementing industrial reforms, marketing green consumption strategies, and purchasing large land grants as part of private and private/public conservation initiatives. A prominent organization of this type is Friends of the Earth International, founded in 1969 by the former Sierra Club Director, David Brower, which now links organizations from 70 countries.

RADICAL MOVEMENTS

By contrast, a plethora of radical environmental movements have mushroomed around philosophies such as social and deep ecology, ecofeminisim, and ecosocialism. Inspired by these philosophies, and especially the writings of Edward Abbey, the radical group Earth First! was founded in 1980 to critique the mainstream movement's reformist tactics. Instead, Earth First! promoted direct action to protect the earth and celebrated the guerilla eco-saboteur art of monkey wrenching environmentally harmful technologies.

This militant wing of the movement further developed with the rise of the Earth Liberation Front (ELF) as an offshoot of Earth First!. The ELF celebrates anarcho-primitivist philosophies, and has been known to firebomb sport utility vehicle dealerships and commit arson to destroy large developments in areas they believe should remain wild. They believe in harming no living being, but exist to inflict maximum economic damage against environmentally destructive corporations and personages. Their mission is also educational and they routinely release anonymous communiqués explaining their actions after the fact. Earth First! and the ELF have demonstrated solidarity with a range of other social movements. In response, the United States and British governments have engaged in repression and targeting of these groups, labeling them and their supporters ecoterrorists.

ENVIRONMENTAL JUSTICE

A final radical development of the American environmental movement is the recent struggle for environmental justice, which fights against the unequal distribution of environmental harms and hazards across society, and often links environmentalism with urban and civil rights issues. The movement arguably began in 1978 during the Love Canal crisis, when Lois Gibbs successfully organized a campaign that exposed how citizens were becoming mysteriously ill due to the city of Love Canal having been knowingly developed on top of a corporate waste landfill composed of toxic chemicals. As a result of Gibbs's community activism, the federal government created the Superfund Act, which fines polluting companies and provides emergency funds for environmental cleanup. Since Love Canal, the environmental justice movement has grown worldwide, empowering poor and minority communities in a myriad of local struggles, and now represents a significant challenge to the idea that environmentalism is primarily about wilderness protection, resource conservation, lifestyle changes, or population reduction. The environmental justice movement has mounted a critique of mainstream environmentalism as a predominantly white and middle-class movement based on affluent social concerns about how to improve quality of life.

The environmental justice movement's focus on race, class, and gender issues as opposed to the non-anthropocentric environmental concerns developed within the American environmental movement also typifies many of the environmental movements of less affluent countries, where grassroots environmentalism is often concerned with peasant survival issues that arise because communities' access to resources becomes imperiled or displaced by industrial and commercial enterprise. These movements affirm traditional rights and uses of land in opposition to privatization schemes that involve environmentally harmful processes of road construction, clear-cut logging, invasive mining, and industrialized agriculture techniques. Traditional uses, it is maintained, are ecologically sustainable and tend toward the maintenance of the commons. Many of these movements are decidedly radical in their ideology and militant in their resistance, though their protest runs the gamut from forms of Gandhi-inspired, nonviolent *Satyagraha* to armed struggle.

Some environmental movements of the Global South have become internationally renowned, including India's Chipko movement, Kenya's Green Belt movement, Nigeria's Ogoni movement, Brazil's Rubber Tappers movement, and Mexico's Zapatista movement. Chipko literally means "to hug," and the 1970s movement for which it is named featured peasants, especially women villagers, of the Himalayan foothills who hugged the trees, practiced ecological restoration, and undertook national and international lobbying efforts in order to block timber cutting of the local forests. The lasting success of Chipko is debatable, but it has been an inspirational movement that has seeded other movements such as the antigenetic modification of food movement theorized by former Chipko activist Vandana Shiva. The Green Belt movement, founded in 1977 by 2004 Nobel Peace Prize winner Wangari Maathai, focused on mobilizing and empowering women to drive environmental and social change. Through the movement's work, over 30 million trees have been planted, women have been trained to utilize natural resources sustainably and earn a living wage, and ecotourism has been promoted.

Meanwhile, movements such as Chico Mendes's Rubber Tappers movement and the Movement for the Survival of the Ogoni People have achieved measures of success at the cost of their leaders' lives. Mendes, who was influential in organizing union workers and gaining international assistance toward ending illegal destruction of the rain forest, was murdered for his activity. Likewise, the poet Ken Saro-Wiwa was officially executed by the Nigerian state for his role in promoting Ogoni self-determination and protesting against international oil companies such as Royal Dutch Shell that drilled and destroyed Ogoni land without making reparations to the people. The Zapatistas have also been heavily persecuted in their struggle for indigenous rights, which began as a response to their displacement by a proposed bio-reserve. The Zapatista movement enlisted the use of the internet to generate international awareness of their plight and to strategize virtually with a range of organizations and individuals.

SEE ALSO: Carson, Rachel; Earth First!; Environmentalism; Green Movement; Love Canal; Maathai, Wangari; Mass Media; Mendes, Chico; Muir, John; Native Americans; Roosevelt, Theodore Administration; Sierra Club; Thoreau, Henry David; Wilderness Act; Yellowstone National Park.

BIBLIOGRAPHY. Steven Best and A.J. Nocella, eds., *Igniting a Revolution: Voices in Defense of the Earth* (AK Press, 2006); Timothy Doyle, *Environmental Movements in Majority and Minority Worlds: A Global Perspective* (Rutgers University Press, 2004); Ranjit Dwivedi, "Environmental Movements in the Global South: Issues of Livelihood and Beyond," *International Sociology* (v.16/1, 2001); Robert Gottlieb, *Forcing the Spring: The Transformation of the American Environmental Movement* (Island Press, 2005); Wangari Maathai, *The Green Belt Movement: Sharing the Approach and the Experience* (Lantern Books, 2003); D.N. Pellow and R.J. Brulle, eds., *Power, Justice, and the Environment: A Critical Appraisal of the Environmental Justice Movement* (MIT Press, 2005); Christopher Rootes, ed., *Environmental Movements: Local, National and Global* (Frank Cass Publishers, 1999); Bron Taylor, ed., *Ecological Resistance Movements: The Global Emergence of Radical and Popular Environmentalism* (State University of New York Press, 1995).

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Mozambique

IN 1975 THE Republic of Mozambique won its independence after nearly 500 years as a Portuguese colony. The following decades were filled with civil war (1977–92), massive emigration by the white population, economic dependence on South Africa, and severe drought. After Marxism was discarded and a new constitution adopted in the late 1980s, Mozambique began to move toward democracy and the development of a market economy. The United Nations brokered a peace settlement in 1992.

Although Mozambique is still a poor country and remains heavily dependent on foreign aid, the economy has grown dramatically since peace was declared. The size of the foreign debt has been reduced through participation in the International Monetary Fund's Heavily Indebted Poor Countries (HIPC) and Enhanced HIPC initiatives. The Mozambican government has not yet been able to adequately exploit natural resources that include coal, titanium, natural gas, hydropower, tantalum, and graphite.

Just over five percent of the land area is arable, with the most fertile area being located around the Zambezi River in central Mozambique. More than 80 percent of the population is engaged in subsistence agriculture. With a per capita income of $1,300, Mozambique is ranked 200 of 232 counties on world income. Some 70 percent of the population live in poverty, and 47 percent are seriously undernourished. Over a fifth of the labor force is unemployed. The wealthiest 10 percent of Mozambicans share almost a third of the country's wealth, while the poorest 10 percent hold less than three percent of resources. The United Nations Development Programme's Human Development Reports rank Mozambique 179th in the world in overall quality of life issues.

Bordering on the Mozambique Channel in the Indian Ocean, the southeast African nation has a coastline of 2,470 kilometers and 17,500 square kilometers of inland water resources. Mozambique shares land borders with Malawi, South Africa, Swaziland, Tanzania, Zambia, and Zimbabwe. The land area of Mozambique is diverse, with costal lowlands rising to uplands in the central section, high plateaus in the northwest, and mountains in the west. Elevations range from sea level to 2,436 meters at Monte Binga. The climate ranges from tropical to subtropical. Mozambique is subject to severe droughts, and the central and southern areas experience devastating cyclones and floods.

Environmental health is a major issue for the population of 19,686,505. With an HIV/AIDS adult prevalence rate of 12.2 percent, 1.3 million Mozambicans live with this disease, which had killed 110,000 people by 2003. Only 42 percent of the population have sustained access to safe drinking water, and only 27 percent have access to improved sanitation. Mozambicans have a very high risk of contracting food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, and typhoid fever and the water contact disease schistosomiasis. In some areas, the population also faces high risk of contracting malaria and plague.

This susceptibility to disease produces a lower than normal life expectancy (39.82 years) and growth rate (1.38 percent), and higher than normal infant mortality (129.24 deaths per 1,000 live births) and death rates (21.35 deaths per 1,000/population). Women give birth to an average of 5.5 children each. Dissemination of disease prevention information is difficult because less than one-third of adult females and less than two-thirds of adult males are literate.

During the long years of civil war and prolonged drought, many Mozambicans deserted the remote areas of the country for the cities and coastal areas, overburdening the environment. The result has been increased levels of desertification and major pollution of both surface and coastal waters from agricultural runoff and by the release of waste products from the petroleum and refining industries, and the textile, paper, and cement industries. The impact of the mining industry has been massive, producing air, soil, and water pollution that include emissions of toxic gas and destruction of forests and habitats. Soil erosion has been a by-product of coastal erosion and the flooding of mountain and coastal areas. Poachers threaten the elephant population in their pursuit of ivory. It is believed that several hundred thousand landmines may have been hidden in Mozambique, creating major threats to humans and the environment, and the process of removing them is ongoing.

In 2006, scientists at Yale University ranked Mozambique 121 of 132 countries on environmental performance, considerably below the comparable income and geographic groups. The lowest scores were assigned in the categories of environmental health and biodiversity and habitat. Around 39 percent of land area is forested, but deforestation is occurring at a rate of 0.2 percent. Although the government has protected 8.4 percent of land, the rich biodiversity was seriously threatened by the prolonged civil war. Of 179 identified mammal species, 14 are endangered, as are 16 of 144 bird species.

The Ministry of Environmental Affairs and Tourism has the responsibility for implementing and monitoring environmental laws and regulations in Mozambique in conjunction with related agencies such as the Ministry of Health. The framework for these laws was provided by the National Environment Management Program of 2002 that focused on managing the various aspects of the environment to maximize sustainable development and the eradication of poverty. Specific programs targeted air, water, and soil pollution; waste management, hygiene, sanitation, and overall environmental heath. Other government efforts focused on the protection of biodiversity. In 2002, for example, Mozambique partnered with South Africa and Zimbabwe to establish the Greater Limpopo Transfrontier Park that encompasses 35,000,000 hectares spanning Mozambique's Limpopo National Park, South

Africa's Kruger National Park, and Zimbabwe's Gonarezhou National Park. It is one of the largest multinational conservation areas in the world. Mozambique participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Desertification; Endangered Species; Mining; Poaching; Portugal; South Africa; Zimbabwe.

BIBLIOGRAPHY. Central Intelligence Agency, "Mozambique," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Mozambique," hdr.undp.org (cited April 2006); World Bank, "Mozambique," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Muir, John (1838–1914)

WHEN JOHN MUIR was a young man, few would have predicted that he would become a celebrated preservationist, founder of the Sierra Club, and advocate for national parks. Born in Dunbar, Scotland, Muir showed an early proclivity for mechanical work. His family immigrated to rural Wisconsin, near the town of Portage, in 1849. His father was a strict Calvinist and instructed Muir, the eldest male child, in Biblical teachings, but did not allow any of his eight children to attend school. Muir obtained books from friends and soon developed an interest in science. His mechanical abilities won him recognition at the Wisconsin State Fair where he displayed some of his ingenious devices, one of which was an intricately carved alarm clock attached to a bed that tilted at a predetermined time, heaving the sleeper to a standing position.

Muir studied briefly at the University of Wisconsin. An accident in a carriage parts factory, however, changed his life. Nearly blinded, Muir regained his sight a month later and vowed to train his eyes on the beauty of the natural world. He traveled extensively, walking from Indianapolis to the Gulf of Mexico. Muir intended to visit South America, but a bout of malaria encouraged him to travel to California instead. Arriving in San Francisco, Muir quickly looked for the road out of town. His journey took him to the most picturesque, awe-inspiring place he had yet seen: Yosemite. Muir was astonished by the Sierra Nevada Mountains, spending weeks at a time exploring their plants, geology, watersheds, massive forests, and hidden valleys. Muir argued

John Muir, inspired by Yosemite's wild landscapes, became instrumental in its designation as a national park.

that Yosemite Valley was formed by glacial activity, a position contrary to that held by leading professional geologists. Muir spent years researching in the mountains, discovering active glaciers there.

These wild landscapes, however, were much more than a laboratory to Muir. Influenced by the writings of transcendentalists—particularly Henry David Thoreau—Muir saw a deep connection between nature and spirituality. Natural splendor was part of God's creation, and Muir approached it worshipfully and preached its glories with fervor.

With fellow nature-loving friends, Muir founded the Sierra Club in 1892. Muir was elected president of the group, a position he held until his death. The Sierra Club's goals at its founding were to explore and render accessible the mountain regions of the Pacific Coast, to publicize them, and to work for preservation of the forests and natural areas.

Muir worked tirelessly, using all of his connections to protect wild landscapes in the west and was instrumental in the designation of Yosemite as a national park. President Theodore Roosevelt camped with Muir in the Yosemite region, and Muir impressed upon him the importance of using federal authority to protect such natural temples from the avarice of men.

Muir, though a charismatic and a persuasive naturalist, did not win all of his battles for preservation. After the San Francisco earthquake of 1906, the thirsty city turned its eyes to the mountains. City leaders wanted to create a reservoir at Hetch Hetchy, one of the valleys in Yosemite National Park. John Muir and many of his colleagues from the Sierra Club mounted a campaign to raise public awareness of the threat to the beautiful valley. Gifford Pinchot, a former friend of Muir, was a conservationist and the chief forester. Pinchot was not a preservationist, however, and he believed that the highest use of the valley was to provide water to San Franciscans. Eventually, the dam was built and the valley transformed. A broken-hearted Muir dubbed Pinchot and those who favored his position "temple destroyers."

Few have done as much as John Muir to publicize the grandeur and splendor of the mountain regions of the west and few have done as much to protect them. Earning a place on California's state quarter, John Muir's enthusiasm for nature—from the smallest flower to the grandest vista—has made him an icon of the environmental movement.

SEE ALSO: Movements, Environmental; Nature Conservancy; Pinchot, Gifford; Preservation; Sierra Club; Yosemite National Park.

BIBLIOGRAPHY: Michael Cohen, *The History of the Sierra Club, 1892–1970* (Random House, 1988); John Muir and William Cronon, ed., *John Muir: Nature Writings* (Library of America, 1997); Roderick Nash, *Wilderness and the American Mind* (Yale University Press, 2001); Linnie Marsh Wolfe, *Son of the Wilderness: The Life of John Muir* (Knopf, 1946).

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Mulholland, William (1855–1935)

WILLIAM MULHOLLAND (1855–1935) is remembered as a central figure in the struggle to make sufficient water resources available to the then nascent cities of California that were to grow into the metropolitan superpowers of Los Angeles and San Francisco. Most notably, he had a pivotal role in changing the course of the Owens River to water Los Angeles, much against the wishes of those people then living on its banks and deriving their living from it. Lives were lost in the subsequent struggle and Mulholland has frequently been held up subsequently as something of a scapegoat, although the extent of culpability remains contested.

The development of the western United States was hampered by insufficient convenient water resources. In order for great cities to be born out of the desert and other unfriendly areas, it was necessary to rearrange the deployment of water resources. This was hampered by technical factors—e.g., the need to build extensive aqueducts to change the course of rivers—as well as human factors, such as the presence of people in the way of development plans. Indigenous peoples were mostly driven away from their traditional homes in a series of military campaigns (one of which Mulholland participated in personally), while so-called "Americans" were dealt with in a variety of different ways. At the beginning of the 20th century, Mulholland shared the vision for Los Angeles, then a humble town, to become a great city. He had arrived in America from his native Ireland having supported himself by a series of low-wage jobs, which may have helped to forge him into the tough and hard-minded individual that some believed him to be. To realize the vision for Los Angeles, it was necessary to divert the course of the Owens River, which flowed more than 200 miles away. Accomplishing this against the wishes of the settlers of the Owens River Valley required extensive and complex negotiations and transactions, including land deals and political wrangling, which were apparently partly facilitated by Mulholland's various connections, although such a substantial undertaking could never be the work of one person alone.

The initial aqueduct was completed by 1913 and Los Angeles began its ascent. However, the water resources provided exceeded what was required by the young city and Mulholland was obliged to enter into a second round of private sector irrigation and dam project dismantling in order to redistribute the water to the extent that it would make the scheme sufficiently profitable. Armed resistance broke out among the settlers in the region who were forced by this drive to move, and a series of environmental problems were unleashed. This led in due course to the disaster of the St. Francis Dam, which collapsed in 1928, allowing a massive flood of water to flow down toward the sea, sweeping away all in its path. Unknown numbers of people were killed, made homeless, or dispossessed by this disaster, for which Mulholland was eventually found responsible; he was obliged to live out his days in disgrace.

Transforming the environment to this extent, Mulholland managed to create both winners and losers, though it was not always immediately obvious who had won and who had lost. Those who proved to be winners by benefiting from the newly organized irrigation systems tend to have louder and more persistent voices than those who lost out in the past.

SEE ALSO: Locks and Dams; Los Angeles River; Rivers; United States, California; Watershed Management.

BIBLIOGRAPHY. Abraham Hoffman, *Vision or Villainy: Origins of the Owens Valley–Los Angeles Water Controversy* (Texas A&M University Press, 1992); Catherine Mulholland, *William Mulholland and the Rise of Los Angeles* (University of California Press, 2002).

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Multiple-Use and Sustained-Yield Act (MUSY)

THE FOREST MANAGEMENT Act of 1897 limited the purposes of federal forests to "securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States." The Multiple-Use Sustained-Yield Act (MUSY) of 1960 defined the purposes of the national forest to include "outdoor recreation, range, timber, watershed, and wildlife and fish purposes" (16 USC 528). The passage of MUSY marked the culmination of years of efforts by recreational, grazing, and wilderness advocates to secure statutory authority for additional activities in federal forests. The act gives the U.S. Forest Service wide latitude in determining the appropriate uses and yields of any given activity on any given area of the federal forest system.

The decade prior to the passage of the act was marked by increased pressure on the federal forest system by competing user groups. In the 1950s, recreation visits to national forests increased by over 300 percent. During the same period, timber production more than doubled, from 3.5 billion board feet to 8.3 billion board feet. Likewise, throughout the decade, ranching interests repeatedly sought to codify a right to grazing access of national forest ranges. In response to the efforts to increase non-timber uses on forest lands, the timber lobby began to actively campaign beginning in the late 1950s to clarify and confirm the importance of timber in Forest Service management. At the same time, the Forest Service actively positioned itself as the mediators of multiple user demands. As Paul Hirt has argued, in theory and practice, however, Forest Service decision makers worked in tandem with timber interests to protect the preferential position of timber production on forest service land while also insuring that sustained yield remained solely an economic term.

Despite the general support offered to the bill during debate by various interest groups, the resulting act has done little to redefine sustained yield and multiple use or prescribe new procedures for balancing the multiple uses stipulated in the act. Prior to MUSY, timber industry and Forest Service definitions of multiple use were nearly identical. Multiple use was understood to be hierarchical, with timber being the critical and priority use of forest resources. All other uses were subordinate to continued timber harvesting. Although the act required equal consideration be given to each of five resources on the federal system, the act was "supplemental to, but not in derogation of, the purposes for which the National Forests were established as set forth in the Act of June 4, 1897." The Forest Management Act of 1897 was the very same act that privileged timber in the establishment of the forest system

Likewise, prior to MUSY sustained yield was understood to mean the maximum feasible production of timber in any given area. In the act, however, this definition was not redefined. Rather, sustained yield was described as a process of planning for yields of forest resources at such a level as to be sustained in perpetuity without impairment of the productivity of the land. The act defined sustained yield as "the achievement and maintenance in perpetuity of a high-level annual or regular periodic output of the various renewable resources of the National Forests without impairment of the productivity of the land." The bill received support from timber, grazing, and wildlife advocates among groups as disparate as the American Pulpwood Association and the National Wildlife Federation. In practice, the act codified the set of practices and policies already in use on the national forests. Though the Forest Service claimed the authority previously to manage the national forests for multiple uses, the act provided the statutory authority necessary for the Forest Service to defend policies that limited, privileged, or restricted certain activities on federal lands.

Following the passage of the act, the Forest Service engaged in multiple-use planning on federal forests throughout the system. Forest and district-level multiple-use plans were prepared. Despite language in the act that required equal consideration be given to all five uses of the national forest lands, Forest Service budgets remained tied to timber production targets and thus received the largest portion of funds. Though the act codified the rights for non-timber uses of Forest Service lands, the decade following the passage of MUSY saw increased timber harvesting and clearcutting controversies in the national forest system. The budget environment and timber revenue generation guaranteed the continued dominance of timber production in the national forests following the act.

SEE ALSO: Clear-Cutting; Forest Management; Forest Service (U.S.); Maximum Sustainable Yield; National Forest Management Act; National Parks Service (U.S.); Nontimber Forest Products (NTFPs); Recreation and Recreationists; Timber Industry.

BIBLIOGRAPHY. Paul W. Hirt, *A Conspiracy of Optimism: Management of the National Forests since World War Two* (University of Nebraska Press, 1994); D. Le Master, *Decade of Change: The Remaking of Forest Service Statutory Authority during the 1970s* (Greenwood, 1984); W. Rowley, *U.S. Forest Service Grazing and Rangelands* (Texas A&M University, 1985); C. Wilkinson and M. Anderson, *Land and Resource Planning in the National Forests* (Island Press, 1987).

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Mumford, Lewis (1895–1990)

LEWIS MUMFORD WAS a humanistic intellectual, social and urban historian, urban planner, and journalist. Born on October 19, 1895, in Flushing, New York, he went on to take undergraduate courses in various subjects that interested him but never actually completed a university degree, being forced to abandon formal education after a diagnosis of tuberculosis. By the time of his death in Amenia, New York, on January 26, 1990, he had established himself and his school of thought, which examined urban morphology and city culture and experience in systematic terms—the city as a human environment and a living thing in its own right.

He began writing commentaries for numerous publications, among them *The Dial*. In 1919 he became an associate editor of that magazine, and the next year Mumford moved to London to work as acting editor of *The Sociological Review*, organ of the Sociological Society. While in England, he became acquainted with the ideas of Ebenezer Howard, including the garden city, and met the protagonists of the town planning movement. From 1931 to 1963, he became a critic on architecture for *The New Yorker*, writing the column "The Sky Line," which was a platform to disseminate his views of urban and social processes.

He was very influenced by the work of Patrick Geddes, a biologist who produced innovative ideas in urban planning and the shaping of modern city that considered the social implications and the ecological integration of the city in the environment. Mumford corresponded extensively with Geddes and adopted the regional survey as a method to explore the city and understand its processes.

Mumford reflected on the shaping of the urban civilization and the role of technological change—technics, in his words—in social processes. He adopted a historical perspective, with natural resources and kinds of energy key factors. From an early optimistic vision, which considered the favorable contribution of technology to improving environmental, social, and economic conditions, he evolved to a rather distrustful perspective on uncontrolled technology and some contemporary urban plans.

In *Technics and Civilization* (1934) Mumford divides the history of technology into three phases: *eotechnics*, *paleotechnics,* and *neotechnics*, each with different resources and energy and identifiable transformations in nature and cities. Technology is not always the same; when armonic and in balance with human nature it is polytechnic, and when disharmonic it is monotechnic. He also introduced the concept of *megamachine*, designating the large hierarchical political organizations that handle humans as simple components. His more pessimistic view of technology was reflected in the double volume *The Myth of the Machine I: Technics and Human Development* (1967) and *The Myth of the Machine II: The Pentagon of Power* (1970).

Mumford called for mobilization against the totalitarian threat in Europe and supported the intervention of the United States; however, after the death of his son Geddes in the conflict he became less optimistic. He wrote and spoke out against atomic weapons and fought United States participation in Vietnam.

In *The Culture of Cities* (1938) Mumford examines the character of a city and writes a history of urbanism. He contributed to the revival of the concept of regionalism with his ecological perspective, recognizing the region as a space integrated with the city. He critically observed the process of suburbanization, proposing recentralization—understood as decentralized planning of small, dispersed, well connected centers, with a low housing and population density, and interspersed green areas—following the principle of bringing the city into the country and the parks into the city. He was awarded the National Book Award in 1962 for *The City in History* (1961), essentially an updating of *The Culture of Cities*.

In 1939, the American Institute of Planners produced the film *The City*, commissioning Lewis Mumford to write the commentary and Aaron Copland to create the musical score. The film is a synthesis of Mumford's vision, displaying the contrast between the effects of urban congestion and life in new planned garden cities such as Redburn, New Jersey, or Greenbelt, Maryland, and portraying the challenges of the modern city.

SEE ALSO: Garden Cities; Megalopolis; Technology; Urban Planning.

BIBLIOGRAPHY. Thomas P. Hughes and Agatha C. Hughes, eds., *Lewis Mumford: Public Intellectual* (Oxford University Press, 1990); Donald L. Miller, ed., *The Lewis Mumford Reader* (Pantheon Books, 1986); Donald L. Miller, *Lewis Mumford: A Life* (Weidenfeld and Nicolson, 1989); Frank G. Novak, ed., *Lewis Mumford and Patrick Geddes: The Correspondence* (Routledge, 1995); Rosalind H. Williams, "Lewis Mumford's Technics and Civilization," *Technology and Culture* (v.43, 2002).

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Mutation

A MUTATION IS a permanent change in the genetic material of a cell, as represented by the genes that compose the deoxyribonucleic acid (DNA) molecules that determine the nature and structure of organic material. The cause of the mutation may be internal and result from a malfunction in the process of transmission from one cell to its successors, or it might be stimulated by an external source such as the proximity of chemicals or radiation.

In accordance with the principles of evolution, it is possible that a mutation may represent a better ability to interact with the environment and more chance of long-term survival with the opportunity to pass the genetic change to subsequent generations. However, it is much more likely that a mutation will be detrimental to the organism's long-term survival chances, since organisms have generally passed through large numbers of previous generations, each of which has offered the small opportunity to adapt better to the environment.

HUMAN MUTATION

Consequently, mutation within humans is most commonly seen in the malformations or deformities caused by the spraying of Agent Orange in the Vietnam War, or the release of nuclear radiation at the Chernobyl power plant. Conditions such as sickle cell anemia are examples of mutations within blood cells.

The process of mutation occurs when codons, which are the genetic codes that specify the number, type, and location of amino acids within the DNA molecule, are altered. Since the molecules are so complex and some amino acids are replicas of each other, a mutation may be unnoticeable or at least trivial in nature. It is also possible that the effect of a mutation may be recessive, in other words, overpowered by the dominant gene that is provided by one of the two parents. While some mutations simply substitute one amino acid for another, others insert a new element repeatedly and these can be very destructive of the cells formed with such DNA. Others produce a localized effect within part of an organism, while different types of mutations affect sex cells that may then be transmitted to new generations. Mutation can be deliberately used in the attempt to create more successful organisms, such as in the case of genetically modified organisms (GMOs), which offer a better yield for farmers. This process has been used as crossbreeding for many centuries and has resulted in the wide variety of dogs and cats, as well as many different strains of rice.

Viruses in particular are liable to mutate themselves through response to environmental conditions that are not predictable or controllable. For example, there is a significant risk of the H5N1 virus known as avian influenza (more commonly "bird flu") mutating from its current form into one that can be transmitted between humans, at which point it would have the capability to cause a pandemic disease.

More positively, genetic modifications may be able to help reduce or eliminate the threat of congenital diseases and conditions and to augment human beings (and other creatures) both physically and mentally through mutation. These issues are controversial.

People who believe that the structure of human life is divinely ordained or that genetic mutation will be used in an inappropriately eugenic way, or who fear the unintended consequences of such changes, oppose genetic modification. Opposition to GMOs is very strong in many countries, especially in Europe, because of a range of ethical, commercial, and health issues.

SEE ALSO: Agent Orange; Genetically Modified Organisms (GMOs); Genetic Diversity; Genetic Patents; Genetics and Genetic Engineering.

BIBLIOGRAPHY. F. Armstrong and J.C. Mathers, "Kill and Cure: Dietary Augmentation of Immune Defences against Colon Cancer," *Proceedings of the Nutrition Society* (v.59/2, 2000); Errol C. Friedberg, Graham C. Walker, and Wolfram Siede, *DNA Repair and Mutagenesis* (American Society of Microbiology, 1995); Graham R. Taylor and Ian N. Day, eds., *Guide to Mutation Detection* (John Wiley & Sons, 2005); H.C. Wilson, "Are We Prepared?" *Disaster Prevention and Management* (v.15/2, 2006).

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Mutual Aid

MUTUAL AID IS a term used in a number of areas of life including biology, social relations, economics, and politics. It refers to help that is given by one party to another. The party may be nonhuman or it may be human. In the case of humans, it is usually aid given according to prior agreements. In biology, mutual aid is termed mutualism. It describes the mutual benefit and the interactions that take place between two or more species. The mutualism between two species can be lifelong contact that is physical or chemical. If the mutualism between them is lifelong, it is referred to as symbiosis. Clown fish live in symbiotic relationship with sea anemones. On the other hand, pollinators such as bees that interact with flowering plants have a nonsymbiotic relationship.

The mutual relationship may be obligate (necessary for both to live). Legumes such as alfalfa, clover, peas, beans, lupins, and peanuts are nitrogen-fixing plants that produce nodules rich in nitrogen with the mutual aid of rhizobia bacteria. The relationship is also of mutual aid to gardeners and farmers whose land is enriched with nitrogen in a second mutual benefit. Facultative (either partner can live alone) relationships are nonobligate. The relationship between people and pets is nonobligatory. However, in the case of a seeing eye dog that aids a blind person, the relationship is obligatory. The development of mutual aid relationships between species has been a subject of concern to biologists who specialize in evolutionary developments. One set of relationships that is not mutual aid is parasitism, because the benefit for one is at the expense of the other.

In politics mutual defense pacts are a form of mutual aid. The Constitution of the United States is a mutual defense pact between the states where an attack upon one is an attack upon them all. Historically, all of the American states have had militias that could be called upon to repel an invasion. The principle of mutual aid has guided their organization. Mutual defense can also mean responding to disasters or emergencies. Fire departments in rural areas often have mutual response agreements.

Numerous mutual aid societies have been formed over the years that are aimed at helping people who belong to the group. Insurance is a form of mutual aid. Participants are aiding those who need help while guarding themselves from the risk against which they are insured. Mutual aid groups are often sponsored by social workers to help people who are oppressed, vulnerable, or in need of help to overcome social, economic, or ecological ills. For example, when the Japanese town of Minamata suffered from Minamata disease, many residents and other sympathizers formed a mutual aid society to comfort, aid, and advocate for the redress of grievances of the victims.

Politically, mutual aid has been a principle idea of anarchism and libertarian socialism. Pierre-Joseph Proudhon was a French anarchist and an advocate of mutualism. Russian Prince Peter Kropotkin advocated the development of mutual aid societies. He believed that government was the cause of all social ills. The solution was the abolition of all government. In his anarchistic "state of nature" people would voluntarily join together for mutual benefits and then would trade their products for those of other people in other groups. Kropotkin's vision of a system of voluntary associations that would create an economy where mutual exchanges took place was described in his book *The Conquest of Bread*. He was influenced in his thinking by Darwin's theory of evolution and by the development of mutualism in biology.

SEE ALSO: Bookchin, Murray; Darwin, Charles; Evolution; Kropotkin, Peter; Parasites; Social Ecology; Symbiosis.

BIBLIOGRAPHY. David T. Beito, *From Mutual Aid to the Welfare State: Fraternal Societies and Social Sciences* (The University of North Carolina Press, 2000); Douglas H. Boucher, ed., *Biology of Mutualism: Ecology and Evolution* (Oxford University Press, 1988); Alex Gitterman and Lawrence Shulman, eds., *Mutual Aid Groups* (Columbia University Press, 2005); Peter Kropotkin, *Mutual Aid: A Factor in Evolution* (Porter Sargent Publishers, 1888); Dominique Moyse Steinberg, *The Mutual-Aid Approach to Working with Groups: Helping People Help Each Other* (The Haworth Press, 2004).

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Myanmar

A MILITARY JUNTA has ruled Myanmar, commonly known as Burma or the Union of Burma, ever since General Ne Win gained power in 1962. His successors have ruled the country with an iron fist ever since. A tropical country in the path of seasonal monsoons, Burma is about the size of the state of Texas. Its population of 50 million people lives under one of the most oppressive governments in the world.

Although Myanmar's official environmental policy is good (it signed the Kyoto protocol and various other international agreements), high levels of corruption and mismanagement have exposed large swaths of Myanmar's jungles to rampant deforestation. The highly secretive and controlling nature of the Myanmar government makes it difficult to find reliable environmental statistics.

The French oil company Total has developed oil fields in the country and allegedly provides hundreds of millions of dollars in funds to the military government. Oil money has been linked to Myanmar's purchases of arms from China and Russia, though Total denies these allegations and claims that the money is used for economic development.

Although Total and other international companies working in Myanmar would have their own internal environmental regulations, the military junta would have little reason to enforce strict environmental controls. Nobel Prize winner and leader of the democratic opposition Aung San Suu Kyi is being held under house arrest and has been kept incommunicado. With a military government that stifles all dissent it seems unlikely that basic human rights concerns—let alone the social and environmental concerns of the population—will be addressed under the current status quo.

SEE ALSO: China; Deforestation; Drugs; Fossil Fuels; India; Mekong River; Opium (and Heroin); Thailand.

Official corruption and mismanagement have exposed Myanmar's jungles to rampant deforestation

BIBLIOGRAPHY. British Broadcasting Corporation News Country Profile, "Burma," news.bbc.co.uk (cited April 2006); Central Intelligence Agency, *World Fact Book*, "Myanmar," www.cia.gov (cited April 2006); Yale Center for Environmental Law and Policy, *2005 Environmental Sustainability Index* (Yale University, 2005).

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N

Nader, Ralph (1934–)

RALPH NADER IS a renowned and effective crusader for consumer rights, advocate of general public rights, and environmentalist. His opposition to big insurance companies, "corporate welfare," and the "dangerous convergence of corporate and government power," constantly brings him into conflict with business and government. He was born to Nathra and Rose Nader (both of Lebanese origin), on February 27, 1934, in Winsted, Connecticut. It was probably Nathra Nader's love of politics that inspired Ralph to become a lawyer and a political scientist. Ralph graduated magna cum laude from the Woodrow Wilson School of International Affairs of Princeton University in 1955 with a major in government and economics. He continued at Harvard Law School and graduated in 1958 with honors. As a student at Harvard, Nader became interested in the automobile industry and researched the design of automobiles. In his article "The Safe Car You Can't Buy," published in *The Nation* in 1959, he concluded, "It is clear Detroit today is designing automobiles for style, cost, performance, and calculated obsolescence, but not… -for safety."

After finishing his studies, he served in the United States Army for six months in 1959 before working as a lawyer in Hartford and teaching at the University of Hartford. In 1964 he began work in the office of then Assistant Secretary of Labor Daniel Patrick Moynihan.

Nader continued his earlier research on the automobile industry and in 1965 published *Unsafe at Any Speed*, a study that illustrated the unsafe designs of many American automobiles, especially those of General Motors. General Motors retaliated in part by surveilling Nader. Nader filed suit and, in a case decided by the New York Court of Appeals in 1970, he received a public apology and net settlement of $284,000. He also became an advisor to a Senate subcommittee on automobile safety.

Nader was successful in getting Congress to pass the National Traffic and Motor Vehicle Safety Act in 1966, the Wholesome Meat Act in 1967, and the Clean Air Act and Freedom of Information Act in the 1970s. He also played a key role in the creation of the Environmental Protection Agency, the Occupational Safety and Health Administration, and the Consumer Product Safety Commission. In the early 1980s Nader spearheaded a powerful lobby against Federal Drug Agency approval for mass-scale experimentation with artificial lens implants. He went on to create an organization of energetic young lawyers and researchers known as "Nader's

Raiders." They produced systematic exposés of industrial hazards, pollution, unsafe products, and governmental neglect of consumer safety laws. He has also continued to work for consumer safety and for the reform of the political system through his group Public Citizen.

Nader launched a third party in 1990 focused on the issues of citizen empowerment and consumer rights and to address campaign finance reform, worker and whistle-blower rights, and class-action lawsuit reforms. Nader ran for president as an independent candidate in 1992. In 1996 and 2000, he ran as a nominee of the Green Party with Winona LaDuke as his vice-presidential running mate. In 2004 he ran as an independent with Green Party activist Peter Miguel Camejo as his vice-presidential nominee.

SEE ALSO: Consumers, Ecological; Consumers, Economic; Democracy.

BIBLIOGRAPHY. Patricia Cronin Marcello, *Ralph Nader: A Biography* (Greenwood Press, 2004); Ralph Nader, *Unsafe at Any Speed* (Knightsbridge Publishing Co., 1991); Ralph Nader, *The Ralph Nader Reader* (Seven Stories Press, 2000).

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Naess, Arne (1912–)

ARNE NAESS, KNOWN as the father of deep ecology, is a Norwegian ecophilosopher, naturalist, environmental activist, and professor emeritus of philosophy at the University of Oslo. He is the founder of *Inquiry: An Interdisciplinary Journal of Philosophy and the Social Sciences* and the author of more than 30 books. Deep ecology, the movement Naess is credited with founding, critiques mainstream environmentalism and proposes a set of new metaphysical, ecological, spiritual, and sociopolitical alternatives.

Naess's conference paper "The Shallow and the Deep, Long-Range Ecology Movement," given in Bucharest in 1972, was the first recognized formulation of the principles of deep ecology. This paper rejected the idea of the separation of humans and nature in favor of a "relational, total field" image of nature based on "biospherical egalitarianism" in which all ecological beings have an equal right to exist. Naess's work also contrasted his vision of deep ecology with the contemporary or "shallow" environmental movements of the 1970s and 1980s, which he accused of being concerned only with superficial institutional fixes for pollution and resource depletion for the benefit of affluent sectors of society in developed countries, and of thus being anthropocentric.

Other elements of Naess's deep ecology include the principles of diversity and symbiosis, an anti-class posture, the fight against pollution and resource depletion, complexity in place of complication, and local autonomy and decentralization. Sources and spiritual inspiration for deep ecology philosophy are found in Eastern spiritual traditions, Native American traditional religions, Ghandian nonviolence, and selected thinkers from Western religion, philosophy, and art. Deep ecology is a normative value system based on personal change and the transformation of values and understanding toward an alternative way of thinking about the relationships between individuals, society, and nature.

Naess's 1989 theory, Ecosophy-T, his own personal application of the principles of deep ecology and ecological wisdom, involves the achievement of ecological harmony or equilibrium through a fundamental principle of self-realization, or the placement of self as part of nature through the eradication of boundaries between human and ecosystem activities. Naess developed a four-level system to represent his deep ecology framework that is depicted in what he calls the *apron diagram*. Level one encompasses a broad set of philosophical and religious principles such as Buddhism, Christianity, or other sets of norms that influence action and that inform the eight-point Deep Ecology Platform outlined in level two of the apron. These principles, or discussion points, were developed in collaboration with George Sessions, another key deep ecology thinker, and are broadly seen as the unifying features of the deep ecology movement. Combining philosophical ideas with action, the platform's third level expresses the general consequences of the principles in society. Level four expresses the concrete decisions made by individuals in particular situations.

While Naess and extensions of deep ecology philosophy have been criticized as being biocentric and even misanthropic, the anticlass and self-questioning posture within deep ecology seeks to transform human-to-human relationships as well as those between humans and nature. Along the same vein, the stance against pollution and resource depletion is a normative stance based on the idea that all beings—humans included—must be able to satisfy vital needs through the preservation of the diversity of all life forms.

SEE ALSO: Deep Ecology; Environmentalism; Human Ecology; Social Ecology.

BIBLIOGRAPHY. Bill Devall and George Sessions, *Deep Ecology: Living as if Nature Mattered* (Peregrine Smith, 1985); Alan Drengson and Yuichi Inoue, eds., *The Deep Ecology Movement: An Introductory Anthology* (North Atlantic Publishers, 1995); Eric Katz, Andrew Light, and David Rothenberg, eds., *Beneath the Surface: Critical Essays in the Philosophy of Deep Ecology* (MIT Press, 2000); Arne Naess, "The Shallow and the Deep, Long-Range Ecology Movement. A Summary," *Inquiry* (v.16, 1973); Arne Naess, *Ecology, Community and Lifestyle: Outline of an Ecosophy* (Cambridge University Press, 1989); *The Selected Works of Arne Naess,* Volumes 1–10 (Springer, 2005).

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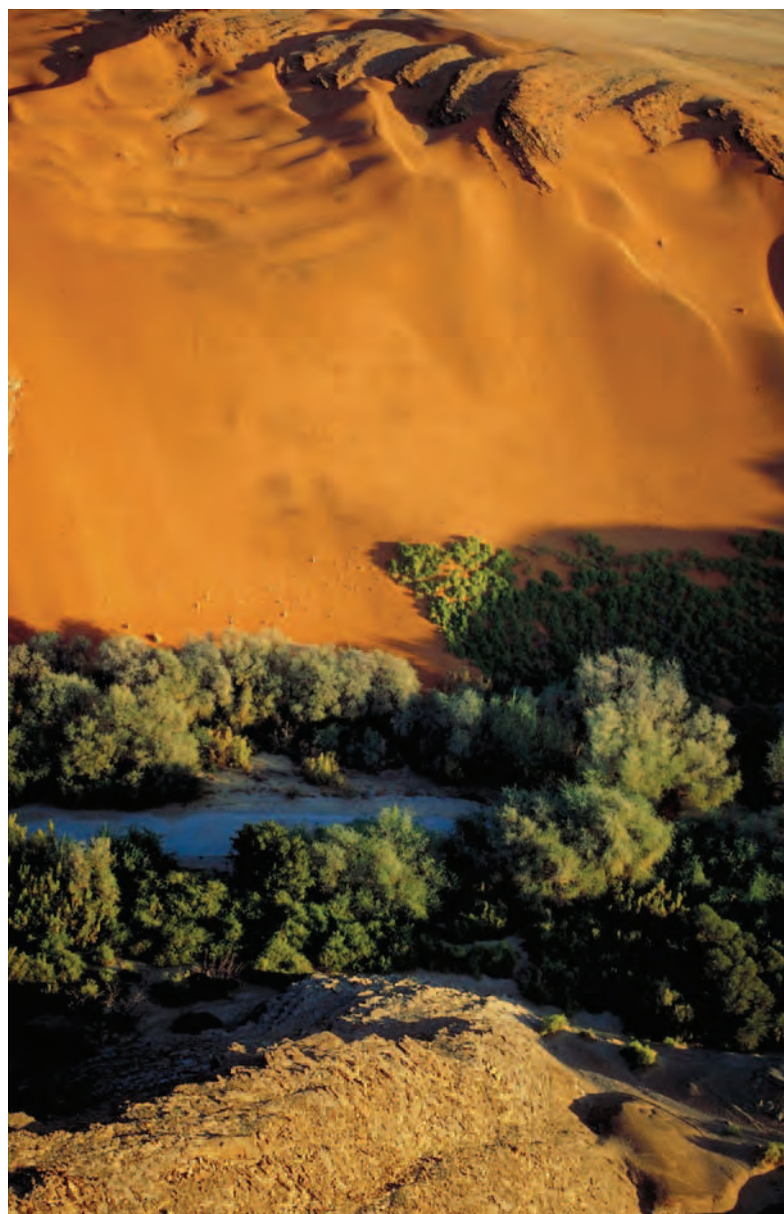
Namibia

NAMIBIA IS A relatively small southern African country of two million inhabitants, but has a rich and diverse cultural and environmental landscape. Formerly known as South West Africa, present day Namibia has four major population groups: the Khoisan (including Bushmen), who are the original inhabitants of southern Africa; the Ovambo, Bantu-speakers largely concentrated in the northern part; the white settlers, mostly of Dutch and German origins; and the Coloreds or Basters, the people of mixed race. These diverse groups were brought together under a single nation state by the colonial boundary-drawing exercise known as the "scramble for Africa" and South West Africa came under German control.

After the end of World War I, the defeated Germans had to cede their colonies to the League of Nations, which passed on the responsibility for administration of South West Africa as a mandate to South Africa. The white minority-ruled state in South Africa decided to rule it as part of its own territory, even after the United Nations rejected South Africa's plea to formally annex South West Africa. Due to years of internal resistance led by the

With 14 percent of its land protected, Namibia is the first country to include environmental protection in its constitution.



South West Africa People's Organization (SWAPO) and external pressure, South Africa finally ended its occupation in 1990 and the independent nation of Namibia came into being.

Namibia is unevenly endowed with natural resources. A large part of the country is desert, and only about one percent of the land is arable. However, the country has huge reserves of nonfuel minerals like diamonds, uranium, lead, zinc, and tin. Mining is a large part of the economy, accounting for more than 20 percent of the country's Gross Domestic Product (GDP). Though its per capita GDP makes it a medium income country, income distribution is highly unequal. From its Gini coefficient, Namibia has the most unequal distribution of wealth in the world—the richest 10 percent of the country's population account for 65 percent of its wealth.

During colonial times, and especially during apartheid, which was extended to Namibia by South Africa, the local population's access to land was extremely limited. Arable land is already scarce and largely restricted to northern Namibia, where the dense Ovambo population is dependent on agriculture. These factors have led to extreme pressure on land in the north, which has made land degradation a serious issue.

The Namibian state has taken environmental issues seriously and in 1992 developed a Green Plan to tackle these problems. The plan seeks to ameliorate problems such as desertification, land degradation, pollution, and biodiversity loss. One of the major programs has been the National Program to Combat Desertification (NAPCOD), which has been operational since 1997 in the entire north-central region of Namibia.

Namibia is the world's first country to include the protection of the environment in its constitution, and more than 14 percent of the country's land is protected. However, not everyone is happy with the current state of affairs. Conflicts have emerged between the state and communities such as the seminomadic Himba, who have been displaced as a result of a large hydroelectric project on the river Cecene.

SEE ALSO: Colonialism; Desertification; Land Degradation; South Africa.

BIBLIOGRAPHY. L.R. Cliffe et al., *Food Security & Environmental Effects of War and Drought in The Horn and Southern Africa: A Comparative Study of Ethiopia, Eritrea, Mozambique and Namibia* (Routledge, 1998); *Human Development Report* (UNDP, 2005); J. Saul and C. Leys, *Namibia's Liberation Struggle: The Two-Edged Sword* (Ohio University Press, 1995).

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Narmada Dam

FOR DEVELOPING COUNTRIES, big infrastructure such as buildings, industries, and dams are synonymous to development—the bigger the infrastructure, the more developed a country looks. In the same vein, the first prime minister after independence in India, Shri Jawahar Lal Nehru, had a dream of building dams across large rivers in India. He believed that dams were the temples of modern India and would bring prosperity to rural India through the Green Revolution. The prosperity Nehru envisioned did come to some parts of India.

The Narmada River flows through central India for 1,290 kilometers and divides north and south India. The Narmada Dam Project, another of Nehru's visions, involves construction of a series of dams on the Narmada to support increasing demand for water for irrigation (especially in drought-prone areas of India) and to produce hydroelectricity. Although the idea was first conceived in the 1940s, the project did not begin until 1979.

The government plans to build 30 large, 135 medium, and 3,000 small dams to harness the waters of the Narmada and its tributaries. The height of the largest dam, named the Sardar Sarovar Dam after the first home minister, Sardar Vallabh Bhai Patel, has led to a controversy. With a height of 163 meters it will be the third highest dam in India. The dam is also located in an area with high seismic activity. Social issues, such as relocation of people and allocation of land, add to the concerns about this dam.

Groups that support the building of the dam maintain that the plan would provide large amounts of water and electricity, which are desperately needed for development in the region. Some of the benefits expected from the implementation of the Sardar Sarovar Project are: irrigation, increased drinking water supply, power generation, and some employment. After submerging some agricultural land, it is estimated that building of this dam will allow irrigation of about 1,792,000 square kilometers of land. The water will be spread to about 3,393 villages in Gujarat (75 percent of this area falls in drought-prone areas) and to about 730 square kilometers in the arid areas of another state, Rajasthan (mainly a desert area, but agriculture has flourished where water has been brought in). The dam will also produce electricity and provide drinking water facilities to about 8,215 villages and 135 urban centers in Gujarat.

Although there are benefits to this dam, there is still resistance to its development. The Narmada Bachao Andolan, or Save Narmada Movement, questions the basic assumptions of the Narmada Valley Development Plan and believes that the cost-benefit analysis is greatly inflated in favor of building the dam (and development) and that the plans are based on untrue and unfounded assumptions about the hydrology and seismology of the area. The opposing group believes that the planning of the project does not take all the environmental factors into consideration. They also feel that the construction is leading to large-scale abuse of human rights and the displacement of many poor and underprivileged people who will lose both their land and their livelihoods.

The Sardar Sarovar Project controversy ended up in the Supreme Court of India in the form of a lawsuit decided on October 18, 2000. In a two-to-one majority judgment, the Supreme Court allowed immediate construction of the dam up to a height of 90 meters. It further authorized construction of up to 138 meters in increments of five meters, subject to approval by the Relief and Rehabilitation Subgroups of the Narmada Control Authority. This unfettered clearance from the Supreme Court, despite major unresolved issues on resettlement, the environment, and the project's costs and benefits, was seen as disturbing, especially considering the fact that the World Bank has withdrawn some project funding based on new facts.

A memorandum to the executive of the Operations Evaluation Department (OED) of the World Bank, leaked in 1995, admits serious shortcomings in the environment, resettlement, and rehabilitation components, the project's appraisal, and supervision performance. The evaluation supports most of the conclusions of the Morse Commission on environmental issues and resettlement of people, and rates the World Bank appraisal and supervision as unsatisfactory. Citing problems with the resettlement process, the OED states, "substantial obstacles still remain."

The World Bank had imposed basic conditions such as identifying the number of people to be displaced and completion of resettlement plans, which were supposed to be fulfilled as far back as 1985. On the issue of resettlement, the evaluation reveals that World Bank conditions, which the government of India failed to meet in March 1993, have still not been met. This will cause further delays in dam construction.

In spite of the court ruling allowing construction to proceed on the dam, the struggle continues. Leaders of Narmada Bachao Andolan, most prominently Medha Patkar, insist on their principles of justice, human rights, democracy, and equitable and sustainable development. In 2006 Patkar and others went on a massive hunger strike. The court and government proceeded with the project nevertheless.

The survival of a project of this sort, with its lack of international support and great local controversy, demonstrates the political and ideological momentum of dam building itself and the complex relationships between mastery of rivers, nationalist ideology, and resource politics.

SEE ALSO: Dams; India; Patkar, Medha; Water Law; Watershed Management.

BIBLIOGRAPHY. Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (Zed Books, 1996); Sanjay Sangvai, *The River and Life: The Story of the Narmada Bachao Andolan* (Earthcare Books, 2002); D.D. Souza, *The Narmada Dammed: An Inquiry into the Politics of Development* (Penguin Books India, 2002).

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Nash Equilibrium

THE NASH EQUILIBRIUM is the central equilibrium theory in noncooperative game theory. A Nash equilibrium is an outcome where no individual would be better served by changing his or her strategy, considering the strategy choices of all other players thinking the same way. It is the outcome of all individuals in a scenario, their decisions interact and they all seek to maximize their own welfare or utility knowing that others do so as well. John Nash, a mathematician, defined and proved this result in his 1950 dissertation. The Nash equilibrium concept is typically applied to situations in which two or more individuals are making decisions, one or more of their outcomes are influenced by the decisions of others, and they incorporate the decision making of others into their calculations when making their own decisions. Some assumptions underlie the Nash equilibrium, including rationality and, usually, a degree of knowledge regarding other players' wants and beliefs.

The Nash equilibrium has been applied to a variety of situations including imperfect competition in markets, social interaction, animal behavior, and international policy. Nash equilibria are not always socially desirable. Often, on topics of environmental concern, the Nash equilibrium is a typical or likely outcome, but not optimal. For cases of public goods and common property resources dominated by individual decisions rather than government oversight, the socially desirable or socially efficient outcome is not achieved because individuals mostly pursue their own welfare. Individual utility maximization can lead to Nash equilibrium outcomes in which everyone is worse off than if they had cooperated. These outcomes often arise when costs from behaviors are borne by society or a larger group, while the benefits of those behaviors accrue to individuals.

Such is the case for environmental scenarios as varied as maintaining a community garden or the Atlantic cod fishery. In such cases it is typically in an individual's best interest that all other players make choices contributing to the socially optimal outcome, while they themselves make a choice that benefits the individual, a behavior known as "free-riding." In the case of fishing, for example, an individual fisherman may ignore legal or conventional fishing limits, knowing (or hoping) that other fishers will not, thereby maximizing his fishing take at the expense of others. Since all fishers act with the same knowledge and motivation, in theory the result is one in which all fishers behave in this way—reaching a Nash equilibrium that is undesirable, since it leads to overfishing and depletion of the resource for all involved. This is the theorized reason that unregulated fishing, hunting, logging, or other resource extraction can lead to rapid depletion. Government intervention can often improve these situations by limiting individual options.

Efforts to control climate change are an example of individual behavior leading to a socially undesirable outcome. Carbon dioxide emissions on their own do not have negative local impacts. When there are positive costs to limiting carbon dioxide emissions, the costs must be borne by individuals or individual nations, but the benefits of carbon dioxide suppression are spread across the entire planet. Without a powerful authority capable of enforcing a socially optimal agreement among nations, this reduction is unlikely to occur when free-riding options exist or individual priorities differ.

Much research has been done regarding means of achieving a social optimal that differs from a Nash equilibrium. Researchers in cooperative game theory posit that binding contracts, possibly involving side payments, might help, and theoretical and behavioral social research suggests that punishment for cheating or free-riding can be useful when games are repeated.

SEE ALSO: Externalities; Game Theory; Prisoner's Dilemma.

BIBLIOGRAPHY. Colin Camerer, *Behavioral Game Theory* (Princeton University Press, 2003); Herbert Gintis, *Game Theory Evolving* (Princeton University Press, 2000); Nick Hanley and Henk Folmer, eds., *Game Theory and the Environment* (Edward Elgar, 1999); Shaun Hargreaves Heap and Yanis Varoufakis, *Game Theory: A Critical Introduction* (Routledge, 1995); John Nash, *Equilibrium Points in N-Person Games* (Proceedings of the National Academy of Sciences, 1950).

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National Environmental Policy Act (NEPA)

THE NATIONAL ENVIRONMENTAL Policy Act (NEPA) of 1969 is an important procedural land use planning statute followed by all federal agencies as well as local (state, county, city, or industrial) projects that require a federal permit or receive funding from federal agencies. Often referred to as the "Magna Carta" of U.S. environmental policy, the statute also empowers any member of the public to take part in many decisions that affect federal public lands through information gathering, commenting, and even agency appeals. When President Richard Nixon signed NEPA into law on New Year's Day, 1970, he hailed the Act as providing the "direction" for the country to "regain a productive harmony between man and nature."

In December 2005 the House Resources Committee's NEPA Task Force proposed weakening NEPA.

PURPOSE AND PROVISIONS

Agencies such as the Bureau of Land Management, U.S. Forest Service, and U.S. Fish and Wildlife Service must comply with the various levels of the NEPA planning process before federal actions are undertaken. A multitude of actions on federal public lands such as timber sales, mining permits, grazing permits, road building, land sales, wildlife management, ski area development, water developments, and even agency-wide planning that guides entire geographical regions are subjected to the NEPA planning process.

Under NEPA, federal agencies are required to analyze and disclose environmental consequences of proposed actions on federal public lands. For instance, in Section 102 of the law, agencies are required to reveal: (1) the environmental impact of the proposed action, (2) any adverse environmental effects that cannot be avoided should the proposal be implemented, (3) alternatives to the proposed action, (4) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and (5) any irreversible commitments of resources that would be involved should the action be implemented.

The NEPA process thus requires the federal agency proposing an action or project to produce an environmental assessment (EA). If the proposed action is found to be of a less significant nature, agencies will issue a "finding of no significant impact" (FONSI) and a decision notice (DN).

Citizens and the public (towns, nongovernmental organizations [NGOs], chambers of commerce, tribes, businesses, and so on) can supply comments in the scoping and draft phases of these projects. For instance, the public can identify important resource concerns they may have, identify alternatives to projects (as well as oppose agency plans outright), and appeal and refute the FONSI and DN by concisely and thoroughly stating how they feel the federal action will, for instance, violate a Land and Resource Management Plan (in the case of the U.S. Forest Service) or harm endangered species of plants, insects, or animals. There is no geographical restriction placed on public comments; residents of a state can comment on federal actions in any other state or U.S. territory.

If the federal action is found to be of major consequence, one that broadly and significantly affects the quality of the human environment, the agency must undertake an extensive environmental impact statement (EIS). According to Robert Dreher:

> Analysis of alternatives is the "heart" of an EIS. Comparing the environmental impacts of an agency plan with the impacts of alternative

courses of action defines the relevant issues and provides a clear basis for choosing among options. By considering and, where appropriate, adopting reasonable alternatives that meet agency objectives with less environmental impact, federal agencies can achieve NEPA's environmental protection goals while implementing their primary missions.

After completing an EIS, it is also possible that an agency will abandon all or part of its proposal.

Although NEPA is an impetus for an agency to carefully examine the consequences of its decision for other resources and values, NEPA does not *require* that an agency change its decision to take action even if its final choice is in fact detrimental to the environment. Many federal agencies have eventually made environmentally disastrous decisions even after their completion of the NEPA process showed that they may potentially be breaking other environmental laws, such as the Endangered Species Act. Federal agencies have wound up fighting thousands of lawsuits brought by public interest environmental organizations that wish to overturn harmful agency decisions.

NEPA also created the President's Council on Environmental Quality (CEQ), which is responsible for advising the president and vice president on national and international environmental policy matters. The council also ensures that federal agencies adhere to NEPA guidelines.

ACCOMPLISHMENTS

Some of the more important aspects of NEPA are that its requirements have added greater public accountability for federal agencies, as well as increased the visibility of, and accessibility to, federal agency decision making. It is "action forcing," requiring agencies to study the potential impacts of their actions before environmental damage can occur, rather than allowing nuisance laws to resolve the problems after the damage is done. It calls on federal agencies to use the science of ecology and look more holistically at cumulative impacts of proposed actions.

Before the implementation of NEPA, federal agencies (with little or no advance notice or public debate) were able to embark upon massive timber cutting programs that destroyed entire ecosystems, and even dam valleys to the detriment of homes, businesses, farms, and habitat. With NEPA, the public has a useful tool for staying informed and influencing potentially harmful decisions that affect themselves and the environment.

NEPA has resulted in prominent success stories. In 1971 environmentalists stopped the Army Corps of Engineers from dredging the Cache River in Arkansas, where the recent sighting of the ivory-billed woodpecker, once thought extinct, later occurred. In the mid-1980s, the Pacific Northwest experienced a severe gypsy moth invasion. The U.S. Department of Agriculture (USDA) proposed to spray the town of Salem, Oregon, with the toxic pesticide carbaryl. Concerned citizens suggested the alternative biological insecticide B.t. (*Bacillus thuringiensis*). When the USDA refused to consider this alternative in its EIS, the citizen group sued the USDA in court and won. The agency later reported that B.t. use led to one of the most successful moth eradication programs in the history of the agency.

At the time of this writing, NEPA is under attack. In December 2005 the Republican staff of the House Resources Committee's NEPA Task Force released 13 draft proposals to amend and rewrite important definitions within NEPA. These reforms were supported by agency officials who feel that their decision-making autonomy is restrained by NEPA provisions, resource extraction and user industries (resorts, motorized recreation, and so on), and their political allies who would like expedited decisions and easier access to resources.

Some of the proposals to reform NEPA include: (1) exempting large categories of government activity from the NEPA environmental review process; (2) restricting the substance of environmental analysis under NEPA, in particular by allowing federal agencies to ignore environmentally superior alternatives to a proposed action; and (3) limiting opportunities for the public to comment on and challenge agency decisions.

SEE ALSO: Bureau of Land Management; Ecology; Environmental Impact Statements (EIS); Fish and Wildlife Service; Forest Service; Nixon Administration, Richard; Public Land Management.

BIBLIOGRAPHY. George Coggins, Charles Wilkinson, and John Leshy, *Federal Public Land and Resources Law* (Foundation Press, 1993); Council on Environmental Quality, www.whitehouse.gov/ceq (cited April 2006); Robert Dreher, *NEPA under Siege: The Political Assault on the National Environmental Policy Act* (Georgetown University, 2005); Robert Fischman, Maxine Lipeles, and Mark Squillace, *An Environmental Law Anthology* (Anderson Publishing, 1996); National Environmental Policy Act, 42 U.S.C. Sections 4321–4345, www.eh.doe.gov/nepa (cited April 2006); Sierra Club, "NEPA Legal Process Encourages Creative Problem Solving, Public Participation and Decision Making Based on Sound Data: 8 NEPA Success Stories," www.sierraclub.org (cited April 2006); Surfrider Foundation, "Guide to NEPA and EISs," www.surfrider.org (April 2006); Wilderness Society, "National Environmental Policy Act: Bedrock Legislation of Environmental Protection Faces Threats from Congress and Bush Administration," www.wilderness.org (cited April 2006).

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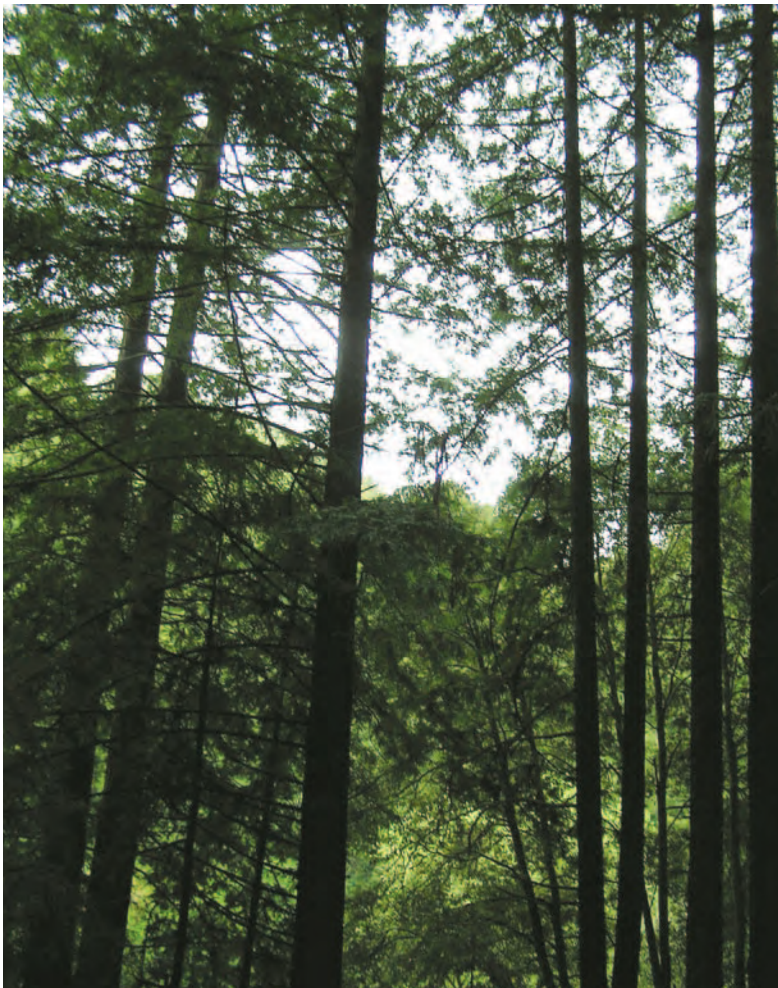
National Forest Management Act (NFMA)

THE NATIONAL FOREST Management Act (NFMA) of 1976 (NFMA) is the principal statute governing the administration of the national forests. The act is an amendment to the Forest and Rangeland Renewable Resources Planning Act of 1974, which called for the management of renewable resources on national forest lands. The 1976 legislation reorganized and expanded the 1974 act, requiring the Secretary of Agriculture to assess forest lands and develop and implement a resource management plan, regularly revised, for each forest unit. NFMA also set standards and procedures for timber harvesting.

The amended act emerged out of controversy over clear-cutting practices in the Monongahela National Forest in West Virginia and the Bitterroot National Forest in Montana. Throughout the late 1960s, efforts by West Virginia legislators and conservation organizations culminated in a successful legal battle to stop clear-cutting practices in the Monongahela. During the same period, a University of Montana study led by Arnold Bolle concluded that management of the Bitterroot National Forest was focused almost solely on maximum timber yields, leading to serious ecological problems. In the years after these debates, courts throughout the United States applied the Monongohela decision to shut down timber sales elsewhere in the national forest system. Facing a serious challenge to its ability to govern national forests, and an equally serious challenge to the viability of commercial timber production on federal lands, the U.S. Forest Service (USFS) pursued a comprehensive legislative remedy to the problem of timber harvesting practices on federal land.

Two competing legislative solutions sought to resolve the problem of timber production in the national forests. One, sponsored by West Virginia Senator Jennings Randolph and written with the help of Arnold Bolle and others, enjoyed the broad support of conservation organizations such as the

In 2005 the USFS created a broad categorical exclusion from its Environmental Impact Statement obligations.



Sierra Club, which saw in the act a means to increase public participation in forest planning, increase transparency in USFS decision making, and reduce the power of the timber lobby in setting forest planning agenda. However, the bill that ultimately became NFMA was one sponsored by Senator Hubert Humphrey and strongly supported by the timber industry.

NFMA added prescriptive requirements related to the identification of various uses and provided specific limits to timber harvests of the national forests. In January 2005 the USFS issued a new forest planning rule creating a sweeping categorical exclusion from its previous obligation to conduct an Environmental Impact Statement (EIS) during forest planning. These new standards release the USFS from meeting specific environmental outcomes in operation, and instead dictate process standards. In regard to public lands management, the changes have been presented as an attempt to streamline forest planning and direct resources away from lengthy planning processes prescribed by NFMA.

SEE ALSO: Clear-Cutting; Forest Service (U.S.); Forests; Public Land Management; Timber and Timber Industry.

BIBLIOGRAPHY. D. Le Master, *Decade of Change: The Remaking of Forest Service Statutory Authority during the 1970s* (Greenwood Press, 1984); C. Wilkinson and M. Anderson, *Land and Resource Planning in the National Forests* (Island Press, 1987).

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National Geographic Society (NGS)

THE NATIONAL GEOGRAPHIC Society (NGS) is the world's largest nonprofit scientific and education institution. Established in 1888 under its first president, Gardiner Greene Hubbard, the NGS aims to increase and disseminate geographical knowledge of the natural and social world. Headquartered in Washington, D.C., the Society is involved in a wide range of activities. Principal among these has been the production of the *National Geographic Magazine,* which for over a century has brought information on the environment, nature, society, and culture to millions of people in an accessible form. Now published and distributed in 30 languages, it has a worldwide circulation of nine million copies, of which 2.1 million copies are published in local languages other than English. As its average reader in the United States is aging—the majority are over 50 years of age—or moving to the internet, the NGS has evolved into new media and new markets. In association with the broadcasters NBC, FOX, and BSkyB, the National Geographic Channel is broadcast in 25 languages and claims to reach more than 200 million households in 146 countries. Its Web site claims an average 55 million page views a month. Earnings from these activities have provided grants for scientific and interdisciplinary field research, conservation and education projects, and expeditions. As a consequence, the NGS can be regarded as a powerful media organization that must balance the commercial realities of publishing and television with its educational and scientific mission and the demands of environmental politics.

Historically, the *National Geographic Magazine* embodied society's interest in advancing and disseminating knowledge as part of its contribution to public education and civic improvement. But the Society originally cultivated an outlook that reflected Western supremacy over the rest of the world. Scholars have suggested that the Society exercised a kind of conservative humanism that celebrated diversity and promoted universal values while permitting it readers to consign non-Western peoples to an earlier stage of progress. This comfortable armchair geography, shaped in the neo-imperialist contexts of the 20th century, typically obscured Western relationships with the Global South. Other critics have suggested that today the Society presents uncritical reflections on the consequences of globalization and tends to commodify nature for human spectacle.

Despite these criticisms, however, the NGS is an unrivalled advocate for the natural world, maintains a firm commitment to conservation and preservation, and continues to ensure geographical issues remain a focus of public debate. It has not taken a conservative approach to debating climate change, for example, nor has it balked from underlining the relationships between consumption and resource and environmental exploitation around issues such as diamond production. Somewhat paradoxically, despite the NGS's awesome media presence, Americans' knowledge of basic world geography is among the poorest in the Western world according to the National Geographic–Roper Survey of Geographic Literacy. In response, the NGS has developed programs to address "geographical illiteracy" in American schools and introduced a range of other publications including *National Geographic Explorer Classroom Magazine* and *National Geographic Kids Magazine*. This ongoing interest in education reveals its commitment to progressive change and demonstrates its continuing faith in geography as a path to both self-knowledge and responsible use of the planet's natural and cultural resources.

SEE ALSO: Education; Geography; Mass Media.

BIBLIOGRAPHY. A. Bonnett, "Geography as the World Discipline: Connecting Popular and Academic Geographical Imaginations," *Area* (v.32, 2003); A. Catherine Lutz and Jane L. Collins, *Reading National Geographic* (The University of Chicago Press, 1993).

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National Marine Fisheries Service (U.S.)

ESTABLISHED IN 1871, the National Marine Fisheries Service (NMFS) is the oldest conservation agency in the United States. Originally called the Commission of Fish and Fisheries, this federal agency was later renamed the NMFS and reorganized as part of the newly-established National Oceanic and Atmospheric Administration (NOAA) in 1970.

The commission initiated the nation's first scientific studies of fish species and biology in Woods Hole, Massachusetts, and was devoted to the protection, study, management, and restoration of fisheries. Although fisheries research began in Woods Hole as early as 1871, a permanent station did not exist there until 1885. A center of marine science, Woods Hole was conceived and implemented largely by one man, Spencer Fullerton Baird, who was the first U.S. Commissioner of Fisheries.

Also known as NOAA Fisheries, the NMFS is housed within the Department of Commerce and tasked with the mission of "stewardship of living marine resources and their habitat through science-based conservation and management and the promotion of healthy ecosystems." As such, NOAA Fisheries has an obligation to conserve, protect, and manage living marine resources in a way that ensures their continuation as functioning components of marine ecosystems. Its mission also includes providing economic opportunities and enhancing quality of life for the public so that "the American people may enjoy the riches and benefits of healthy and diverse marine ecosystems." This requires managing valued marine resources in such a way as to protect the health and biodiversity of important aquatic ecosystems while also maintaining and enhancing current and future opportunities for their sustainable use.

Many factors, both natural and man-made, affect the status of fish stocks, protected species, and ecosystems. Although these factors cannot all be controlled, the agency strongly influences many of them through the use of best available scientific and management practices. Maintaining and improving the health of marine systems is a difficult task that involves balancing a diverse array of public needs and interests without compromising the long-term biological integrity of coastal and marine ecosystems.

NOAA Fisheries is responsible for the management, conservation, and protection of living marine resources within the United States's Exclusive Economic Zone (from state waters to 200 nautical miles offshore). NOAA Fisheries also plays a supportive and advisory role in the management of living marine resources in coastal areas under state jurisdiction, as well as providing scientific and policy leadership in the international arena and implementing international conservation and management measures as deemed appropriate.

NOAA Fisheries derives its mandates and authorities from numerous statutes, most importantly the Magnuson-Stevens Fishery Conservation and Management Act (MSA), the Endangered Species

Act (ESA), and the Marine Mammal Protection Act (MMPA). Under these acts, NOAA Fisheries assesses and predicts the status of fish stocks, ensures compliance with fisheries regulations, and works to recover protected marine species (i.e., salmon, whales, and turtles) without unnecessarily impeding economic and recreational opportunities.

With the help of six regional offices and eight councils, NOAA Fisheries works with local communities and proximate land management agencies on a diverse array of fishery management issues. Through such means as collaborating with commercial and recreational fishermen for the collection of biological data and coordinating science and management strategies with regional and state interests, NOAA Fisheries continually strives to balance competing public needs and interests in the use and enjoyment of the nation's ocean resources.

SEE ALSO: Ecosystem; Endangered Species Act (1973); Fish and Wildlife Service (U.S.); Fisheries; National Oceanic and Atmospheric Administration (NOAA); Save the Whales Campaign.

BIBLIOGRAPHY. National Oceanic and Atmospheric Administration, "NOAA Fisheries Service," www.nmfs.noaa.gov (cited October 2006); National Oceanic and Atmospheric Administration, "Woods Hole: The Early Years," www.nefsc.noaa.gov/history (cited October 2006); National Research Council, *Science and the Endangered Species Act* (National Academy Press, 1995); National Research Council, *Science and Its Role in the National Marine Fisheries Service* (National Academy Press, 2002); National Research Council, *Cooperative Research in the National Marine Fisheries Service* (National Academy Press, 2003).

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National Monuments

A NATIONAL MONUMENT is a historic or natural landmark, a historic or prehistoric structure, or other object of historic or scientific interest set aside by a national government for public enjoyment or edification. Ireland, Scotland, Singapore, and Wales have national monuments or systems of national monuments. The most extensive system is that of the United States.

In the United States, there are nearly 100 national monuments covering more than 70 million acres and ranging in size from less than 1 acre to 11 million acres. National monuments are different from national parks in that national monuments are usually smaller areas established to protect specific features of historic or scientific interest rather than spectacular natural areas with a wide variety of features (although the 11-million-acre Wrangell–St. Elias National Monument proclaimed in 1978 was larger than any national park). Hunting, mining, and other consumptive uses such as grazing are permitted in national monuments, but are generally prohibited in national parks.

While only Congress can legislate national parks, a process that may take many years, the president can proclaim national monuments, a process that takes only the stroke of a pen. Since 1906 presidents have proclaimed more than 100 national monuments, many of which Congress has subsequently converted to national parks. Grand Canyon, Grand Teton, Zion, Bryce Canyon, Capitol Reef, and Olympic National Parks all originated as national monuments. Congress has also created 38 national monuments. The National Park Service has responsibility for administering most of the national monuments. The U.S. Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service, and the U.S. Forest Service are the primary agencies that administer the rest.

The president derives the authority to create national monuments from the 1906 Antiquities Act, which authorizes the president to proclaim national monuments on federal lands that contain "historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest." The president is instructed to reserve "the smallest area compatible with the proper care and management of the objects to be protected." The original purpose of the act was to protect objects of antiquity, such as cliff dwellings, pueblos, and other archeological ruins in the southwest. Its sponsors assumed that national monuments would be small in area and confined to the southwest. The act proved to be loosely written, however, and enterprising presidents have been able to apply it to a wide range of sites. Although its use has been challenged in court, it has become a powerful executive tool for shaping sometimes controversial conservation policies in the United States.

That the Antiquities Act would not be used in the limited way its sponsors had intended became immediately evident when President Theodore Roosevelt used the reference to "objects of…scientific interest" to proclaim a natural geological feature, Devils Tower in Wyoming, as the first national monument in 1906. President Roosevelt continued to interpret the act broadly and in 1908 used it to proclaim an even larger "object of scientific interest": the 800,000 acre Grand Canyon National Monument.

This expansive use of the Antiquities Act encountered no significant congressional opposition until 1943, when President Franklin D. Roosevelt created Jackson Hole National Monument in Wyoming. The president saw this as a way to accept a donation of lands acquired by John D. Rockefeller, Jr., for addition to Grand Teton National Park after Congress had declined to authorize the park expansion.

Critics protested that the president was using the Antiquities Act to circumvent Congress. Congress passed a bill to abolish the monument, but the president vetoed it. The state of Wyoming also challenged the proclamation in court. When the monument was finally incorporated into Grand Teton National Park, as a concession to opponents, the legislation prohibited further use of the Antiquities Act in Wyoming without the approval of Congress.

For decades afterward presidents used their authority to create national monuments sparingly and usually with advance congressional consultation and support. The next substantial use of the proclamation authority came in 1978, when President Jimmy Carter proclaimed fifteen new national monuments in Alaska after Congress had adjourned without passing a major Alaska lands bill strongly opposed in that state.

The presidential proclamation authority was not used again until 1996, when President Bill Clinton proclaimed the 1.7 million acre Grand Staircase–Escalante National Monument on public land managed by the BLM in Utah. This action was controversial in Utah and several cases were filed challenging the designation of the monument on a number of grounds. The president directed that the monument should continue to be managed by the BLM, making it the first national monument that the BLM would manage. President Clinton subsequently used the presidential proclamation authority to establish 14 more new national monuments and significantly expand others. In 2001 the BLM created a National Landscape Conservation System to administer these new national monuments and other areas already under its jurisdiction.

SEE ALSO: Antiquities Act; Bureau of Land Management (BLM); National Parks; National Park Service (U.S.); Roosevelt (Theodore) Administration.

BIBLIOGRAPHY. Bureau of Land Management, National Monuments Managed by the Bureau of Land Management, www.blm.gov (cited October 2006); National Park Service, "Antiquities Act of 1906," www.cr.nps.gov/history (cited May 2006); National Park Service, National Monuments Managed by the National Park Service, www.nps.gov (cited October 2006); Robert W. Righter, "National Monuments to National Parks: The Use of the Antiquities Act of 1906," *Journal of the Southwest* (v.20, 1989); Hal Rothman, *America's National Monuments: The Politics of Preservation* (University of Kansas Press, 1994); Raymond Harris Thompson, "Part One: The Antiquities Act of 1906," *Journal of the Southwest* (v.42, 2000); Carol Hardy Vincent and Pamela Baldwin, *National Monuments and the Antiquities Act* (Congressional Research Service, 2000).

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National Oceanic and Atmospheric Administration (NOAA)

AS A SERVICE to all American citizens, the National Oceanic and Atmospheric Administration (NOAA) plays an important role in daily life. The stated mission of NOAA reads: "to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our nation's economic, social, and environmental needs."

In the early 19th century Thomas Jefferson set up the first science-based agency in the United States, called the Survey of the Coast. It was formed primarily to make sure that coastal areas were protected during times of hostility and war. The Survey of the Coast, the Weather Bureau, and the Bureau of Commercial Fisheries, along with other agencies, merged and evolved into NOAA over the course of almost two centuries. On October 3rd, 1970, then President Richard Nixon established NOAA under the Department of Commerce to help serve a national need for resource protection and weather knowledge for "better protection of life and property from natural hazards" and "for a better understanding of the total environment…[and] for exploration and development leading to the intelligent use of our marine resources." In order to accomplish its main goals, NOAA operates through six major organizations: the National Weather Service; the National Ocean Service; the National Marine Fisheries Service; the National Environmental Satellite, Data and Information Service; NOAA Research; and Program Planning and Integration.

Some of the agency's major functions are regulating the use of natural resources of marine and coastal ecosystems; understanding and interpreting weather and changes in climate so that other agencies can relay information and citizens can respond properly; providing the data necessary for weather forecasts and water cycle events like floods, storms, or droughts; and providing information about the weather to commercial and individual transportation agencies in order to keep transport systems running effectively. Through the National Weather Service, NOAA also acts as an impartial supplier of environmental information about the weather and the oceans.

NOAA information and recorded data is a valuable national resource. National Weather Service and NOAA environmental and weather satellites gather vital information beyond current temperatures and weather. Data is collected from many different domains, such as oceans, coastal areas, agricultural regions, and forest fire zones, which often leads to early, sometimes life-saving detection of forest fires and new volcanic ash. Also, NOAA serves as a provider of environmental stewardship services in the course of managing the environments of coastal and marine areas by regulating land use, supervising fisheries and marine facilities, and protecting endangered species.

Besides physically monitoring resources in coastal and marine areas, NOAA researches ecosystems, climates, weather types and systems, water and the water cycle, and transportation and commerce. Data collected by NOAA is used to study important phenomena such as hurricanes, solar flares on the sun, tornadoes, ocean tides and currents, and holes in the ozone layer. Through the recognition of the close link between the world's oceans and its delicate atmosphere, NOAA has harbored the same philosophy of protection and conservation of natural resources since its creation in the early 1970s.

SEE ALSO: Climatology; Coastal Zone; Hazards; Hurricanes; Oceans; Ozone and Ozone Depletion; Transportation; Water; Weather;

BIBLIOGRAPHY. National Oceanic and Atmospheric Administration, "NOAA History," www.history.noaa.gov (cited July 2006); Eileen L. Shea and U.S. Department of Commerce, "A History of NOAA," www.lib.noaa.gov (cited July 2006).

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National Parks

NATIONAL PARKS ARE widely recognized as an American invention and export, created in the 19th century western United States and eventually adopted in nearly every country in the world. Wallace Stegner once remarked that national parks were the best idea America ever had. Perhaps, but by the end of the 20th century, scholars had begun to critically reassess the idea of national parks as an unmitigated good, contributing new insights to our understanding of nature-society relations.

THE YELLOWSTONE MODEL

The world's first national park was created in the western United States, though it is debatable whether it was Yosemite or Yellowstone. Yosemite was actually the first federally designated protected area, created by a Congressional act signed by President Abraham Lincoln in 1864. However, it remained under the jurisdiction of the state of California and did not become part of the federal national park system until 1890. Yellowstone, which the U.S. Congress established in 1872 as a federally controlled park, is thus generally acknowledged as the world's first.

Since Yellowstone became the prototype on which parks in other countries would be modeled, its enabling legislation is significant. Congress declared the territory in present day Wyoming and Montana to be:

> hereby reserved and withdrawn from settlement, occupancy, or sale under the laws of the United States, and dedicated and set apart as a public park or pleasuring ground for the benefit and enjoyment of the people; and all persons who shall locate, or settle upon, or occupy the same or any part thereof, except as hereinafter provided, shall be considered trespassers and removed therefrom.

The legislation further called on the executive branch of the federal government to establish regulations that "provide for the preservation, from injury or spoliation, of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition." Key elements of the legislation, which have subsequently come to define national parks worldwide, are the placement of ownership and administration with the central government, prohibitions on settlement and occupancy, emphasis on public recreation, mandate to preserve natural conditions, and state's right of eviction. These provisions, which have proven over time to be frequently contradictory and controversial, collectively provide the legal definition of a national park.

The national park idea was quickly adopted in other European settler colonies, particularly in the British Dominion territories. Between 1879 and 1890, Australia, New Zealand, and Canada all created their first national parks. Countries in other regions were slower to embrace the national park idea. Sweden established Europe's first in 1910, Belgium's King Albert, following a visit to Yellowstone, created Africa's first in 1925 in the Belgian Congo, and in South America, Argentina led the way, designating the first park in 1934.

COLONIALISM

The forces behind the historical development of a global national parks movement were complex, but have much to do with the rise and fall of European colonial empires. As European empire reached its height at the turn of the 20th century, hunters, scientists, and philanthropists in Europe created a variety of international organizations concerned with nature protection in the colonies. One of the more prominent was the London-based Society for the Preservation of the Fauna of the Empire (SPFE), which designed and promoted international agreements among European colonial powers. By the 1930s it had pushed through an international convention for African colonies that emphasized national parks, explicitly modeled after Yellowstone, as the primary instruments of conservation. The onset of World War II, however, delayed any serious progress in the creation of national parks in the colonial world.

THE GLOBAL MOVEMENT

Postwar international politics and the rise of institutions of global governance transformed the global national parks movement. Beginning with the founding of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1947, there was a proliferation of organizations with direct interest in national parks. Chief among these is the International Union for the Conservation of Nature and Natural Resources (IUCN, later renamed the World Conservation Union). Established in 1948 under UNESCO auspices, the IUCN was delegated, among other duties, the task of coordinating and monitoring a global network of protected areas. It established the United Nations List of National Parks and Equivalent Reserves, adopted a global biogeographic classification system that is used to assess, map, and plan protected area coverage worldwide, organized a series of decadal world congresses on national parks, and created a global protected area classification system. Under the IUCN's classification system, a national park is defined as a "natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems…(b) exclude exploitation or occupation…and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities…" Administration and control is ideally placed in the hands of each country's central political authority.

The IUCN's definition substantially reflects the legislation that established Yellowstone National Park. But not all of the world's national parks conform to this model. One of the reasons that the IUCN sought to standardize the definitions of protected areas is because the meaning of the term *national park* varied geographically. In some European countries, for example, national park laws allow occupation and exploitation and as a result parks may include towns, villages, agricultural fields, mines, and logging operations. Such international variations in national parks hint at the importance of the specific political, cultural, and historical context in shaping their meaning and purpose.

NATIONAL IDENTITY

A wide range of cultural and political impulses led to the emparkment of Yosemite and Yellowstone. Most important was a prevailing interest among the American political and cultural elite in constructing a coherent national identity, rooted in the landscapes of nature and distinct from settlers' origins in Europe. For writers such as Ralph Waldo Emerson and landscape painters such as Thomas Moran, the source of American's unique national identity could be found in what were perceived to be North America's abundant and monumental natural landscapes. The idea that these landscapes could be preserved in national parks as expressions of American national identity has two components. First, that these monumental landscapes are uniquely North American and that settlers' encounters with them have forged a distinct national identity. Second, that by preserving them, Americans can renew their common sense of national self through periodic visitation. In the 1860s, with the federal government seeking to reunify the United States and forge a common national identity following the Civil War, the national park idea's time had come. Their landscapes soon "became symbols of American national identity."

National parks were also important to the formation of national identity grounded in nature and natural landscapes in the European settler colonies of Africa. Kruger, established in 1926 as the continent's second national park, played an important role in the formation of a collective national identity among white settlers in the early years of the South African Republic. In Southern Rhodesia (now Zimbabwe), the location of Cecil Rhodes' grave in Matopos National Park helped mark the rugged landscape as a symbol of (white) nationhood and "the ceremonial heart of the Rhodesian nation."

TOURISM

The early national parks movement also found support among business interests, particularly in the railroad and banking industries. Business interests hoped to profit from increased railroad passenger traffic and helped lobby for national park establishment. Tourist traffic increased quickly in Yosemite Valley in the years immediately following its designation as a park, and grew exponentially after the completion of the transcontinental railroad in 1869. Critics soon began complaining about crowds and the damage they caused to the park's environment. Thus one of the central contradictions in the national park idea was evident from the beginning. Which is, the more parks are treated as a "pleasuring ground" or managed for "recreational and visitor opportunities," the more likely that pursuit of tourism profits will conflict with the goals of nature preservation.

Outside North America and the British Dominion territories, the movement to create national parks came later and under very different circumstances. During the height of European colonialism, efforts to create national parks began to develop after 1930, mostly promoted by such groups as the SPFE and their equivalents in other European metropoles. Questions of nationalism and national identity played less of a role in park creation in those colonized territories without significant settler populations. Following World War II, the number of national parks created in the colonial territories of Africa and Asia increased, though slowly. Wildlife conservation was an important motivation, but new political and economic interests were emerging.

As the colonial world headed toward political independence from Europe in the 1950s and 1960s, international conservationists grew uneasy, wondering if the new governments would be sympathetic to the national parks idea. International conservationists sought to convince the emerging independent governments that establishing national parks would be a sign of their political maturity, marking their entry into the global community of "civilized" countries. Perhaps a more convincing argument to cash-strapped Third World leaders was that a lucrative international tourism industry could be built on a foundation of national parks. To rally political support among their national citizenries—which, by and large, were from rural, agrarian backgrounds and held interests often at odds with the national park model—the newly independent governments used advertising and school curricula to convince the masses that their parks and wildlife should be a source of national pride.

RECENT CRITIQUES

In the years following decolonization a veritable global conservation boom occurred, marked by an enormous increase in the number of national parks in the world. More than half of the world's national parks, which numbered 3,881 by 2003, have been created since the 1970s and most of these were established in tropical Third World countries emerging from colonial rule. While the number and areal coverage of national parks have expanded and their ecological importance grown, scholars from a variety of disciplinary perspectives have begun to critically examine the history, cultural transferability, social distribution of costs and benefits, and ecological efficacy of the Yellowstone model.

Influenced by a broad range of theoretical positions, including postcolonialism, post-structuralism, and nonequilibrium ecology, scholars have begun to challenge the moral certitude of mainstream histories of the national park movement. Earlier "definitive" histories treated the preservation of national parks as a story of moral and political triumph. While supporting the goal of environmental conservation and biodiversity protection, recent studies have taken a more critical approach, suggesting that the Yellowstone model for national parks raises serious questions of social justice and ecological efficacy.

FORTRESS CONSERVATION

One of the principal themes in recent critiques is that many, if not most, national parks have been created through a process of displacement of local populations, the enclosure of local commons by the state, and the dispossession of the territorial claims of sovereign nations. Scholars refer to the Yellowstone model as "fortress conservation," whereby nature is locked away inside the boundaries of the national park and society is locked out. The implementation of this approach in most cases required the curtailment of local resource use and access and in many cases the eviction of entire communities, thus constituting a form of enclosure.

Historically conservation enclosures have been conducted with minimum involvement of resident populations and the state has often resorted to force in enforcing evictions and curtailing access. In east Africa, for example, pastoralists have lost over 20,000 square kilometers of grazing commons to national parks and game reserves in Kenya and 3,234 square kilometers in Tanzania's Mkomazi Game Reserve alone. Historians recently have linked the establishment of U.S. national parks to the concept of "manifest destiny" and the dispossession and removal of Native American peoples to a system of reservations.

EFFECTS OF POPULATION DISPLACEMENT

The issue of displacement suggests a second theme in recent critiques, which is that advocates of fortress style parks have tended to disregard historic human occupation and its effects on the ecology and landscape of territories targeted for preservation. In contrast, critical studies of U.S. parks detail how various Native American tribes had occupied, used, and significantly shaped the ecology of such iconic parks as Yosemite, Yellowstone, and Glacier. In south Asia and sub-Saharan Africa as well, research has identified areas of critical wildlife habitat in national parks that are the product of past occupation and use. Where east African pastoralist land use practices have helped to create favorable wildlife habitat conditions, their exclusion could actually be detrimental to biodiversity. Often park managers must implement practices such as controlled burning, wildlife culling, and brush clearance in an attempt to slow undesirable ecological change, in effect mimicking the influence of evicted populations.

CLASS AND RACE

A third theme in the critical literature concerns the role of national parks as symbolic landscapes in the construction of national identities, which tended to be restricted and exclusionary. Early ideas regarding U.S. national parks appealed to white, bourgeoisie identity, suggesting that only the cultivated classes of certain "races" could fully appreciate the wild grandeur of nature. Native Americans resident in the national park territories were seen at best as too culturally backward and uncultivated and at worst too degenerate and savage to appreciate the natural landscapes. Black Africans did not belong inside colonial-era African national parks, which had little or nothing to do with reaffirming black African identity. During the Apartheid era in South Africa, black residents were legally restricted from entering such powerful symbols of white South African identity as Kruger National Park.

BIODIVERSITY

Finally, critics of the fortress conservation model argue that it is based on the notion of steady state or stable equilibrium ecology that has been challenged by new ideas of nonequilibrium ecology. Attempts to bound and "preserve" nature through management interventions to halt ecological change have been ineffective where "biodiversity depends directly upon natural patterns of disturbance." The fortress model is based on the idea that biodiversity conservation can best be achieved by creating protected areas where ecosystems can be maintained in perpetuity, undisturbed by human activities. However, nonequilibrium ecology suggests that flux, dynamism, and nonlinear and unpredictable change, not some idealized "natural" stasis, are the ecological norm.

In sum, critical assessments of fortress approach to national parks suggest that it is deeply flawed for reasons of ecology, politics, and social justice. In ecological terms, global biodiversity losses have accelerated during the same period in which the number of

More than 125 years after its creation, Yellowstone National Park began working with the Native American tribes to identify, protect, and provide access to sacred and ceremonial sites within the park's boundaries.

parks and equivalent reserves increased exponentially. The emphasis on the Yellowstone model has meant that communities are displaced and local commons enclosed on principle, raising questions of social justice. Efforts to address these problems are evident in some of the current trends in national parks.

CURRENT TRENDS

Three somewhat interrelated current trends in thinking on national parks are worth noting. The first has to do with biodiversity conservation. The 1992 Convention on Biological Diversity now provides the framework and rationale for international efforts to stem biodiversity loss, focusing on *in situ* conservation in national parks and protected areas. So-called biodiversity hotspots—geographic concentrations of high biodiversity—are being mapped worldwide and targeted for national park or similar protected status. Because national parks are viewed as the primary containers of the world's biodiversity, their number and importance will continue to grow.

A second trend involves new initiatives to resolve or mitigate the historic displacements of communities from national parks. For example, more than 125 years after its creation, Yellowstone National Park hired its first staff anthropologist to begin working with the Native American tribes to identify, protect, and provide access to sacred and ceremonial sites within the park's boundaries. In Australia, the government in 1985 officially recognized Aboriginal ownership of four national parks that had been under state ownership and control.

The final trend is the spread of transboundary parks, sometimes called peace parks, now evident in nearly every world region. These parks are formed when two or more neighboring countries agree to jointly manage national parks that are contiguous, but lie on opposite sides of an international border. In some regions they are part of a larger effort of sociopolitical integration and the suppression of national and ethnic conflicts. In effect, transboundary parks reverse the 19th-century emphasis on linking natural landscapes to distinct national identities, stressing instead commonalities and cooperation among peoples. Europe now has the largest number of transboundary parks. Their worldwide numbers doubled in the 1990s and will likely continue to increase significantly.

SEE ALSO: Biodiversity; Colonialism; Fortress Conservation; National Park Service (U.S.); Native Americans; Postcolonialism; Roosevelt (Theodore) Administration; Tourism; World Conservation Union (IUCN); Yellowstone National Park; Yosemite National Park.

BIBLIOGRAPHY. W. Adams, and M. Mulligan, eds., *Decolonizing Nature: Strategies for Conservation in a Post-colonial Era* (Earthscan, 2003); D. Brockington, *Fortress Conservation: The Preservation of the Mkomazi Game Reserve Tanzania* (James Currey, 2002); D. Brockington and K. Homewood, "Degradation Debates and Data Deficiencies: The Mkomazi Game Reserve, Tanzania," *Africa* (v.71/3, 2001); K. Brown, "The Political Ecology of Biodiversity, Conservation and Development in Nepal's Terai: Confused Meanings, Means and Ends," *Ecological Economics* (v.24, 1998); P. Burnham, *Indian Country, God's Country: Native Americans and the National Parks* (Island Press, 2000); J. Carruthers, *The Kruger National Park: A Social and Political History* (University of Natal Press, 1995); A. Chase, *Playing God in Yellowstone: The Destruction of America's First Park* (Harcourt, Brace, Jovanovich, 1987); M. Colchester, "Salvaging Nature: Indigenous Peoples, Protected Areas and Biodiversity Conservation," UNRISD Discussion Paper (United Nations Research Institute for Social Development, 1994); S. Germic, *American Green: Class, Crisis, and the Deployment of Nature in Central Park, Yosemite, and Yellowstone* (Lexington Books, 2001); R. Keller and M. Turek, *American Indians and National Parks* (University of Arizona Press, 1997); Kenneth Olwig, *Landscape, Nature and the Body Politic: From Britain's Renaissance to America's New World* (University of Wisconsin Press, 2002); Mark Spence, *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks* (Oxford University Press, 1999); L. Warren, *The Hunter's Game: Poachers and Conservationists in Twentieth-Century America* (Yale University Press, 1997); K. Zimmerer, "The Reworking of Conservation Geographies: Nonequilibrium Landscapes and Nature-society Hybrids," *Annals of the Association of American Geographers* (v.90/2, 2000).

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National Park Service (NPS)

CREATED IN 1916 by an act of Congress, the National Park Service (NPS) is a federal agency within the Department of the Interior that manages all U.S. national parks, many national monuments, and historic and conservation areas of various designations. The NPS employs over 20,000 people and extends over 84.4 million acres of land in 49 States, the District of Columbia, American Samoa, Guam, Puerto Rico, Saipan, and the Virgin Islands.

The stated goal of the NPS is "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." From the outset, the NPS was charged with a true paradox: To find a balance between preservation and public enjoyment.

In 2006 the national park system controlled 390 park units, 58 of which are designated as national parks. The remaining units include national historical parks, monuments, memorials, preserves, historic trails, outdoor recreation areas, wild and scenic rivers, lakeshores, seashores, battlefields, and cemeteries. The national park system is the oldest in the world and is often called "America's best idea." It has served as a model for national park designation and protection worldwide, as the success of the U.S. national park system spurred other countries to follow suit.

It was concern about the impact of development on the native people, wildlife, and wilderness of the American West that prompted the concept of national parks; artist George Catlin is often credited with the idea. Two of the cornerstones of the early park system were those crown jewels of the West, Yosemite and Yellowstone National Parks. Yosemite was first designated a state park in 1864 and made a national park in 1906; Yellowstone became the first national park in 1872.

Many national park and national monument designations soon followed. However, national parks were established before a system to manage them was formed. This caused numerous problems at the outset, as there were no funds to maintain, enforce, and protect the parks from looters, vandals, poachers, and unruly tourists. Some of the first park superintendents worked without pay or used their own funds to finance management of parks. Congress continued to create parks without securing funds to manage or protect them—causing problems for park managers for years.

Without a management system, competing interests caused further debates. Utilitarians, who believed lands should be used for irrigation, urban water supplies, and hydroelectric dams, clashed with preservationists, who wished to protect the aesthetic beauty of these places. Finally, in 1916 President Woodrow Wilson signed legislation creating the NPS, and Stephen Mather was named the first director.

Over the next several decades the NPS continued to expand, acquiring lands primarily in the western United States. Reorganization of the system in the 1930s expanded NPS further, allowing for the service to take over the management of all present and future national monuments and the War Department's historic parks and monuments. The NPS now managed both historic and natural sites across the United States and increased its presence in the east. Franklin D. Roosevelt's New Deal in the 1930s created the Civilian Conservation Corps (CCC). The CCC employed thousands of jobless young men during the Great Depression in conservation, rehabilitation, and construction projects in both national and state parks. Today many of the structures that they built remain among the most impressive in the system.

Park visitation and developmental pressures continued to increase during the 1950s through 1970s. Americans were becoming more attached to their automobiles and wanted to experience the beauty of the parks by car. Rampant road building prompted the passage of the Wilderness Act of 1964. This act created additional protection from roads, vehicles, and other forms of human disturbance on federal lands. From the 1970s through the 1990s the expansion and growth of the NPS outpaced any previous time period. Ninety-seven new parks were created during this period alone. Park visitation also has steadily increased, with 4.6 million visitors in 2004. A steady stream of visitors and encroaching urban areas take their toll on park lands. Since 1980 the service has focused on improving protection of the parks' natural and cultural resources while continuing to accommodate increasing numbers of visitors.

As with any social institution, the NPS's objectives are often dynamic, guided by the values, ideals, and concerns of society. Over the years, the NPS has expanded its role from park enforcement and management to a wider range of goals. A recent mandate involves increasing ethnographic research to document cultural, religious, or subsistence connections of Native Americans and other diverse cultural groups to park land. The NPS is also emphasizing education and interpretation activities, using parks as classrooms to help increase public understanding of the importance of ecosystem health and protection. By educating the public about land stewardship and conservation, the NPS hopes to ensure that the next generation will be able to experience the beauty of this country's public lands.

SEE ALSO: National Parks; Public Land Management; Yellowstone National Park; Yosemite National Park; Wilderness Act.

BIBLIOGRAPHY. Barry Mackintosh, *The First 75 Years: Preserving Our Past for the Future* (Eastern National Park and Monument Association, 1990); Barry Mackintosh, *The National Parks: Shaping the System* (National Park Service, 1991); National Park Service, www.nps.gov (cited April 2006); Hal Rothman, *America's National Monuments: The Politics of Preservation* (University Press of Kansas, 1989); Dyan Zaslowsky and the Wilderness Society, *These American Lands* (Henry Holt, 1986).

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National Wild and Scenic Rivers Act

IN RESPONSE TO the alarming rate of damming, dredging, diking, diverting, and destruction of many rivers and free-flowing water sources in the 1960s, Congress created the National Wild and Scenic Rivers Act (1968). Human destruction and indifference toward the nation's system of rivers in the late 20th century was becoming a crisis and government intervention was deemed necessary to prevent further spoilage of natural river environments. However, the act does not designate rivers as national parks—it merely serves to protect their ecological and aesthetic integrity. The goal behind the national system is not to stop the progress of development of rivers but to defend their character and require that any or all development ensures the security of the free-flowing water.

When the National Wild and Scenic Rivers Act was signed by President Lyndon B. Johnson on October 2, 1968, immediate action was taken to improve the function and the value of many polluted or clogged rivers and other free-flowing bodies. The act defines a river as "a flowing body of water or estuary, or a section, portion, or tributary thereof, including rivers, streams, creeks, runs, kills, rills, and small lakes." "Free-flowing," in turn, is defined as "existing or flowing in natural conditions without impoundment, diversion, straightening, rip-rapping or other modification of the waterway." In addition to government intervention, many volunteers were enlisted near affected areas to restore contaminated rivers and to keep unaffected rivers in a more natural state, which is often described as a "living landscape." The actual policy of the act is to make certain that selected rivers possessing remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values are preserved in free-flowing condition and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations.

The National Wild and Scenic River Act classifies each included river as wild, scenic, or recreational. Wild rivers are those that are generally only accessible by trail and are free of impoundments. In most cases, these rivers are unpolluted and are taken to be a representation of pre-Columbian America. Scenic rivers are similar to wild rivers in that they are free of pollutants and impoundments, but are accessible by both trails and roads. Recreational rivers are denoted by easy accessibility by road, railroad, or both; having or not having had impoundments in the past; and having or not having development along shorelines. The act also indicates specific rivers that are protected and the methods and agendas for adding

After the Wild and Scenic Rivers Act was signed in 1968, immediate action was taken to improve polluted rivers.

additional water bodies to the act. Agencies that manage the rivers covered by the act include some state agencies, the U.S. Bureau of Land Management, National Park Service, U.S. Fish and Wildlife Service, and the U.S. Forest Service, among others.

While a majority of the included rivers are located in the wildernesses of Alaska and the northwest portion of the United States, other rivers covered include the Rio Grande (New Mexico and Texas portions); Michigan's Au Sable, Pere Marquette, Black, Bear Creek, and Manistee; and selected segments of the Delaware.

SEE ALSO: Bureau of Land Management; Fish and Wildlife Service (U.S.); Forest Service (U.S.); National Park Service; Recreation and Recreationists; Rivers.

BIBLIOGRAPHY. Paul Bledsoe, "Babbitt Commemorates 30th Anniversary of Wild and Scenic Rivers Act," www.doi.gov/news/archives (cited June 2006); Federal Wildlife Laws Handbook, "Wild and Scenic Rivers Act," ipl.unm.edu/cwl (cited June 2006); Dotti Lewis, "Wild and Scenic Rivers Act," Marquette County Community Information System, www.mqtinfo.org (cited June 2006); National Wild and Scenic Rivers System, www.rivers.gov (cited January 2007).

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Native Americans

THE NATIVE AMERICANS in the United States are the indigenous people of the continental United States and their descendents, covering a large number of tribes and communities. For simplicity, many scholars divide them into the following main cultural groups: the Native Indians of the eastern Woodlands covering New England and eastern Canada; of the southeast; of the plains covering most of the Midwest; of the plateau west of the Great Plains; of the southwest; and of the predominantly fishing communities in modern-day California. There are still major cultural differences between the tribes within these areas.

It is believed that the origins of the Native Americans go back to about 50,000 years ago when some hunters and their families from Siberia crossed the Bering Straits into what is now Alaska. Gradually they moved south until they populated North and South America.

THE NORTHEAST

The Native Americans who moved to what is now New England and eastern Canada developed into woodland farmers, and the tribes there include the Abenaki, the Susquehannock, the Massachuset, the Narraganset, the Delaware, the Powhatan, the Iroquois, the Huron, the Algonkin, the Ottawa, the Menominee Sauk, the Potawatonmi, the Erie, the Miami, the Illinois and the Shawnee. On the island of Labrador was the Beothuk tribe, which differed slightly in customs from those on the mainland. Archaeological work has found items at settlements dating back to between 200 B.C.E. and 400 C.E. located alongside the rivers of the northeastern and midwestern United States. Known as the Hopewell culture, these were the ancestors of the communities that were the first to come into contact with the Europeans. Many accounts of their lifestyle survive.

The woodland Indians lived in small settlements, and planted crops of corn, beans, and squash. Women tilled the fields while the men hunted deer, rabbits, bear, and other wild animals including the woodland buffalo. The men also collected wild fruits and vegetables, with artichokes, cherries, grapes, onions, persimmons, and potatoes all forming an important part of the diet.

The method of agriculture was what became known as "slash and burn," by which the tribes would clear a part of the forest, slashing bark from the trees, and then burn the undergrowth. This cleared the land for planting crops, but the method rapidly depleted the soil, forcing the people to move to another area about every 15 years when crop production started to decline. They did use some fertilizers, but not enough to allow the soil to recover. Environmentally it has proven not to be a good system, but with a very small population living in the woodlands, it was easily sustainable as the woodlands would regrow gradually, reestablishing themselves.

Leadership of the tribes was entrusted to chieftains, with some of these becoming known as kings in early English accounts. Powhatan was the ruler of a large part of what is now Virginia, and had contact with the Jamestown settlement. He controlled some 200 villages and was able to raise a force of several thousand warriors quickly, using them to attack and subdue other villages. His daughter Pocahontas married the Englishman John Rolfe and accompanied him to London, where she was presented to Queen Elizabeth I.

As a result of the fighting between some tribes, many of the villages were protected by stockade fences, as shown in early paintings by artists such as John White who captured many scenes of the region. The crops planted and harvested by the women—the corn, beans, squash, and tobacco—were located within these enclosures. The women were also involved in making clothing from animal skins, with deerskin cloaks used for warmth in winter. As these tribes were the first to come into close contact with the European settlers, they were also the first to assimilate.

Some, like the Wampanoags in Massachusetts, welcomed the Europeans. However, of the 10,000 who were probably living there when the *Mayflower* arrived in 1620, nine-tenths of the population succumbed to smallpox and other diseases introduced by the settlers. In 1636 a number of English settlers attacked the Pequots, who retaliated, and in the following year the English allied with the nearby Narragansets and killed most of the Pequot nation.

THE SOUTHEAST

Southeastern communities were also farming settlements, and archaeological work at Poverty Point, Hardaway, and Etowah has shown strong variations from the Hopewell culture. These tribes were the Cherokee, the Catawba, the Creek, the Choctaw, the Chickasaw, the Caddo, the Natchez, the Timucua, and the Calusa. As with their near neighbors to the north, they also lived in small communities, practicing slash and burn techniques. The men hunted wild animals, especially deer, and were involved in skirmishes with the Spanish.

THE GREAT PLAINS

The Native Americans of the Great Plains were very different, and although they did farm in river valleys, they also hunted the buffalo and other animals, moving as the herds roamed the Great Plains. These tribes included what became the Sioux Confederation, and also, from the north to the south, the Sarcee, the Blackfoot, the Crow, the Cheyenne, the Pawnee, the Arapaho, the Kiowa, the Osage, the Wichita, and the Comanche. Archaeological work has been done on their early settlements at Huff Village and Simonsen.

The Indians of the Great Plains had connections with nearby tribes, although the differences between the Blackfoot in the north and the Comanche in the south were marked. Many of the communities in this part of North America consisted of 20 to 30 families. They lived in tipis, which could be easily dismantled, and they followed the buffalo herds, which they hunted with great skill.

Most often, a number of hunters would creep up on an individual buffalo and kill it with arrows. All parts of the buffalo were then used, with the meat feeding many families, and the leather being important for clothing and for tipis. Occasionally a large number of Indians from the Great Plains would gather together to plan a *piskin,* or communal drive.

The drive involved the preparation of traps, or the use of natural features, such as a rocky outcrop, and then a large group would make as much noise as possible and force the buffalo to stampede toward the trap or cliff. This often resulted in the deaths of many buffalo, providing enough meat and leather to last a long time. The number of buffalo killed as a percentage of the overall herds was very small and every part of the buffalo was used. Unlike the wanton killing by European Americans in the 19th century, the hunts did not endanger the buffalo population, which flourished alongside the Indians for centuries.

In the societies of the Plains Indians, many women enjoyed a high status, but the work undertaken by men and women was strictly delineated. Men hunted and prepared meat. Women looked after the home, preparing it for transport when needed, and raised the children. Women were also involved in much of the craftwork, such as matting, making and stringing beads, and piecing together clothing.

THE SOUTHWEST

In the southwest, the Pueblo Indians were probably the most settled of the Native American groups, with the most well-known being the Apache. The other tribes were the Pueblo, the Navajo, the Hopi, the Mohave, the Papago, the Pima, and the Coahuiltec. Much evidence about their early life comes from the archaeological work carried out at Mesa Verde, Tyuonyi, and Pueblo Bonito. To the west were tribes of desert gatherers, with archaeologists finding remains of their lifestyle at Hogup Cave and Danger Cave. These were the tribes known as the Ute, the Paiute, and the Shoshone. To the north of them were the Nez Perce and the Shuswap.

These tribes lived in one of the least hospitable parts of what became the United States, and as a result the tribes were smaller and the communities produced some of the most adept hunters, who pursued deer, elk, and mountain sheep. The Nez Perce of this region famously refused to hand over their lands by treaty and managed to evade U.S. forces until cornered at Yellowstone River, Montana.

THE WEST COAST

Along the west coast of North America, the communities predominantly lived off the sea, but also had small agricultural concerns along the coast. The tribes around modern-day Washington State, Oregon, and adjoining parts of Canada are the Kwaktutl, the Nootka, and the Chindok. In California and Baja California (in modern-day Mexico) were the Yurok, the Karok, the Pomo, the Yokuits, the Chumash, and the Cochimi. In some parts, especially along the northwest coast of modern-day British Colombia, there were battles over control of fishing grounds, and many warriors wore armor made from wooden slats and built walls around their encampments.

THE REVOLUTIONARY WAR

In the early years of British settlement in North America, land was taken from or ceded in various treaties by the Native Americans. Some tribes supported the British; others were allied to the French. The particularly brutal manner in which some tribesmen fought was regarded as repugnant by Europeans, who recoiled at the concept of scalping the defeated after a battle. Nevertheless, both sides were anxious to create alliances. During the American Revolutionary War, the British managed to get the support of many Native Americans who had hoped that a British victory might end further colonial expansion westward.

When the British signed the Treaty of Paris in 1783 at the end of the war, they ceded Native American lands to the new United States without informing the inhabitants. The new U.S. government tended to regard the Native Americans as having been conquered, but as they had not actually been defeated in battle, the occupation of their lands was a long process as the Native Americans did not recognize the Treaty of Paris.

THE INDIAN WARS

The Indian Removal Act of 1830 compelled many Native Americans to move westward, and those who refused were taken on forced marches. In one horrendous march, known as the "Trail of Tears," some 4,000 Cherokees died. After the American Civil War, the westward expansion of the United States saw a massive encroachment on Native American lands, ushering in the "Indian Wars." Although the Native Americans had victories, such as the Battle of the Little Bighorn in 1876, they were defeated on most occasions. The treaties they signed were not honored by the U.S. government, which pushed the tribes into reservations where sometimes brutal forced assimilation programs were introduced.

At the same time, the destruction of the buffalo herds ended any hope for Plains Indians to return to their former lifestyle. The U.S. government and state governments encouraged the settlement of Indian lands. The lands taken were opened up for cultivation after World War I, and with so much of it marginal agricultural land, it was not long before the Dust Bowl forced many of the new farmers off their lands.

In recent years Native American lifestyles and cultures have been recorded in detail. There were 2,786,652 Native Americans recorded by the U.S. Census Bureau in 2003, with 413,382 living in California, 294,137 in Arizona and 279,559 in Oklahoma, with the others in the remaining 47 states, the District of Columbia and the territories. The U.S. government currently recognizes 563 tribal governments.

SEE ALSO: Disease; Dust Bowl, U.S.; Hunter-Gatherers; Hunting; National Parks; Smallpox; United States, California; United States, Middle Atlantic; United States, Midwest; United States, Northeast; United States, Pacific Northwest; United States, Southeast; United States, Southwest.

BIBLIOGRAPHY. Angie Debo, *The Rise and Fall of the Choctaw Nation* (University of Oklahoma Press, 1934); Angie Debo, *A History of the Indians of the United States* (Pimlico, 1995); John Ewers, *The Blackfeet: Raiders on the Northwestern Plains* (University of Oklahoma Press, 1958); George Bird Grinnell, *The Cheyenne Indians: Their History & Ways of Life* (Cooper Square, 1923); Arlene Hirschfelder and Martha Kreipe de Montano, *The Native American Almanac: A Portrait of Native America Today* (Macmillan, 1993); Jason Hook, *The American Plains Indians* (Osprey, 1999); James H. Howard, *The Dakota or Sioux Indians: A Study in Human Ecology* (University of South Dakota Press, 1966); Michael Johnson, *The Tribes of the Sioux Nation* (Osprey, 2000).

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Native Species

NATIVE SPECIES ARE the species of plants, animals, and insects that have inhabited a given area or region prior to human disturbance. These original inhabitants are adapted to the specific environmental conditions of their area. They make up the various interdependent parts of the food chain and are an integral part of the regional web of life. Most species have a resident natural predator within the food web that keeps populations of native species in check.

Native species have received a lot of attention in the last decade in two main interest areas: (1) landscaping in an increasingly energy- and water-restricted world; and (2) nonnative invasions. Conventional landscaping traditionally uses exotic plants to enhance an area with colors and shapes from a standard toolkit of vegetative materials. The act of conventional landscaping produces an artificial ecosystem to the extent that earth is often scraped clean and a full array of plant materials is placed to live upon it. Although such plantings are culturally accepted and even expected, they are energy- and water-intensive. As a result, in the last decade there has been more and more interest in native species plantings, since these plants are already adapted to the nutrient and water regimes of the area and therefore require little, if any, added inputs of energy (e.g., petroleum-based fertilizer and insecticides) or water. Additionally, native plantings tend to attract the native fauna and insects, benefitting pollination and the local ecosystem overall.

One area of particular interest within the native landscaping movement is grass-free lawns. Conventional lawns require large amounts of water and fertilizers, insecticides and pesticides to stay green. In many drought-stricken areas of the United States, homeowners are replacing their green lawns with hardy native groundcovers that require no extra irrigation.

Nonnative invasions are another reason why native species have received a lot of recent attention. The introduction of nonnative species is nothing new—ever since humans have colonized new areas, they have consciously or unconsciously brought nonnative species with them. Ecological imbalance occurs when nonnative species take over the niches of native species because of a lack of natural predators in that ecosystem. They simply out-compete native plants and animals for space, food, or water. In some cases, nonnative species make it difficult or impossible for native species to survive by fundamentally altering natural disturbance regimes and other ecological processes.

Nonnative species are introduced via deliberate and nondeliberate acts of human disturbance. Several prominent historical examples of the unintended introduction of nonnative species include the Japanese beetle, Japanese honeysuckle, and rats brought from the Old World to the New World in ships' hulls. Humans have also intentionally introduced invasive species in attempts to deal with ecological issues, but with negative repercussions for the rest of the ecosystem, such as in the introduction of the zebra mussel to the Great Lakes and the cane toad to Australia. Nonnative species continue to spread largely due to lack of public education. Nurseries continue to sell invasive plants as landscape materials and exotic plants and animals remain popular. Nonnative species endanger the earth's already threatened biodiversity. In the process of invasion, nonnatives can push rare species to the edge of extinction.

There are many actions that people can take to help forestall the invasion of nonnatives. First of all, they can become informed about the status of their local native species—the extent to which development and invasive species are threatening or have diminished the native species makeup of their region. Usually there is a local chapter of Audubon or Sierra Club involved in such matters. They can also become versed in the conventional landscape materials that nurseries continue to sell and advocate for the replacement of invasive species with suitable substitutes. Lastly, they can choose to landscape their spaces with native species and to educate the public about the many benefits of native propagation.

SEE ALSO: Biodiversity; Cane Toad; Invasive Species; Lawns; Natural Landscaping; Zebra Mussel.

BIBLIOGRAPHY. A.W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (Cambridge University Press, 1986); C.S. Elton, *The Ecology of Invasions by Animals and Plants* (Methuen, 1958); Paul C. Hellmund and Daniel Smith, *Designing Greenways: Sustainable Landscapes for Nature and People* (Island Press, 2006); D. Pimentel, ed., *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal and Microbe Species* (CRC Press, 2002).

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Natural Capital

NATURAL CAPITAL IS a term that has emerged to describe the relationship between human means of production and the earth's ecosystem. More specifically, numerous academics and scholars have sought to consider environmental and natural resource features within a Marxist theoretical framework. For Marx, capital represented not simply material wealth, but control over the means of production in society. This rather abstract way of thinking came from Marx's own work with dialectical materialism, an analytic approach that involves seeing the world in a constant state of emergence from different antithetical processes. As such, for Marx, capital is not a thing, but rather a process or set of force relations. Reiterated more precisely, capital is not simply a thing that one possesses; it is a process of production and exchange in whichever greater amounts of capital accrue to the capitalist class, for example, the bourgeoisie. Those who control the means of production are thus able to control the capitalist system by continually exploiting the labor power of the proletariat masses.

The more efficiently the owners of the means of production can exploit the labor power of their workers, the more surplus value they derive, and consequently, the more capital they are able to accumulate. In this way, capital is manifested in material wealth as well as in the process that perpetuates it.

In a majority of his work, Marx considered the process of capital from the standpoint of industrial capitalism. For this reason, capital has most often been thought of in terms of material objects, structures, or institutions that have been manufactured by humans such as mechanized equipment, factories, government institutions, and schools. The means of production, however, are not limited to the material or social apparatuses that people construct.

Capital may also be bound in the naturally occurring objects of the environmental landscape. Marx first explored this idea in a section of his book *Das Kapital*. In this section, which focuses primarily on the concept of ground rent, Marx explains the ways in which a capitalist may use the natural landscape to more efficiently exploit the labor of the proletariat class, thus increasing his own capital returns. A river, for example, is often something that exists naturally, yet can be added to the means of production in order to increase productive outputs.

Natural capital, therefore, is a term that considers the earth's natural resources within the context of a capitalist mode of production. It is often used to signify the productive potential of a given ecological resource or environmental feature. Places may be said to "have a lot of natural capital" if they are rich in natural resources that make them productive and economically valuable. For example, a piece of farmland with nutrient-rich topsoil, consistent precipitation, easily harvestable fields, and transport access has more natural capital than one with poor soil, frequent droughts, and unstable or impassable terrain. From this perspective, natural capital is any naturally existing phenomenon that facilitates the expanded circulation and accumulation of capitalist processes.

In the continuously expanding body of literature that has emerged from scholars investigating issues of natural resource management, conservation, economic impacts upon the environment, and political ecology, natural capital has come to be synonymous with natural resources in many ways. By viewing the quantity or quality of resources such as timber, water, or oil within a given area as the natural capital of that space, some researchers have worked to measure natural capital more precisely. This arguably provides a more quantifiable method for comparing the natural capital of one space or object to another.

While this approach has yielded a number of fascinating insights, one must be careful not to conflate the idea of natural capital with a simple natural resource commodity. For example, a forest, mine, or petroleum reserve is a natural resource, not an all-telling measure of natural capital. Natural resources may comprise an important element in the make-up of natural capital, but they are not the sole indicator: natural capital refers more to the relationship between the environment and capitalist accumulation than it does to a specific natural object or element. In this way, it is most accurate to think of natural capital as the way processes of capitalist production affect and are affected by the natural environment.

SEE ALSO: Capitalism; Marx, Karl; Resources.

BIBLIOGRAPHY. David Harvey, *Justice, Nature and the Geography of Difference* (Blackwell Publishing, 1996); Ann Marie Jansson et al., eds., *Investing in Natural Capital: The Ecological Economics Approach to Sustainability* (Island Press, 1994); Karl Marx, *Capital* (v.1, Penguin Books, 1976); Karl Marx, *Capital* (v.3, Penguin Books, 1981).

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Natural Gas

NATURAL GAS, A highly flammable fossil fuel, is an important nonrenewable energy resource. Less polluting than other fossil fuels like coal and oil, natural gas is deemed relatively environmentally-friendly, helping to increase demand for the fuel in recent years. As a hydrocarbon, natural gas is primarily composed of methane, a colorless, odorless, lighter-than-air gas.

Methane is the simplest of all the hydrocarbons in molecular makeup, consisting of one atom of carbon and four atoms of hydrogen. While natural gas is relatively clean-burning, methane itself is a greenhouse gas, more efficient at trapping heat than even carbon dioxide (the major offending gas in the enhanced greenhouse effect). Burning natural gas, as with all hydrocarbons, releases carbon dioxide into the atmosphere. Increased levels of methane and carbon dioxide in the atmosphere are thought to contribute to global warming and such related potential environmental hazards as climate change, polar ice melting, glacial retreat, and the rise in sea levels.

As is the case with other fossil fuels, natural gas is thought to have been formed hundreds of millions of years ago, with dead organic matter sinking to the bottom of ancient seas. Plankton and algae, thought to be the source material for natural gas, sank to the bottom of the seas, and slowly began to be covered in silt and other sedimentary materials. Over many millions of years, the weight of the accumulating sediment, combined with the weight of ocean water, exerted tremendous pressure on the organic material. With the pressure, heat also acted on the organic source materials and over millions of years transformed these materials into hydrocarbons in the form of natural gas. This process is similar to the formation of crude oil, and natural gas and oil are often found at similar locations today. Over time and under extreme pressure, oil and gas were forced into relatively porous sandstone or limestone, referred to as reservoir rock. Subsequent deformation of the earth's crust acted to trap oil and gas into pockets under impermeable cap rock like marble or granite.

The three major geologic forces trapping oil and gas into pockets within the earth's crust are folding, faulting, and pinching out. Folding results from horizontal pressure being exerted on the cap rock, forming a fold (or anticline). Faulting represents a fissure in the cap rock, with a large section of cap rock slipping down, forming a hydrocarbon-trapping cavity. In the pinching out process, impermeable rock is forced upward into the reservoir rock, resulting in pockets trapping oil and gas. In each case, as gas is lighter than oil, natural gas migrates to the top of these deposits. Geologists are able to locate oil and natural gas deposits, often deep within the earth's crust, by looking for evidence of these geologic processes.

HISTORY

While the history of natural gas extends back hundreds of millions of years, its status as a natural resource of practical use by human beings is a relatively recent phenomenon. Gas seeping from the ground would occasionally be ignited by a bolt of lightning, producing a flame that confounded early civilizations. One such inexplicable flame, from around 1000 B.C.E., was found on Mount Parnassus in ancient Greece. Around 500 B.C.E., in what may mark the first human use of natural gas as a fuel, the Chinese harnessed the energy from these flames to boil seawater. The Chinese were also the first to employ a rudimentary system of piping gas by forging together sections of bamboo shoots.

The first well drilled specifically to extract naturally occurring natural gas (as opposed to gas produced from coal) was constructed in 1821 in Fredonia, New York. The well's builder, William Hart, is widely considered the "father of natural gas" in the United States. In 1859, in what is considered the birth of the oil industry in the United States, Colonel Edwin Drake, using a derrick and drill, struck oil and natural gas nearly 70 feet below the earth's surface. A 5.5-mile pipeline was built connecting Drake's well to nearby Titusville, Pennsylvania.

During the 19th century natural gas was used primarily as a source of illumination. As electricity gained prominence in the late 19th century as a source of light, a much-needed market emerged for natural gas. In 1885, Robert Bunsen invented the Bunsen burner, enabling the safe control of a burning flame. Soon a market emerged for natural gas in cooking and heating homes.

After World War II, an extensive pipeline system was built, allowing natural gas to be shipped to individual households in the United States. Today, natural gas accounts for approximately 25 percent of total energy consumed in the United States. Natural gas is used to heat and cool homes, to generate electricity, and to provide fuel for residential cooking stoves. Natural gas is also being developed to power vehicles, offering an environment-friendly alternative to gasoline-burning modes of transportation.

EXTRACTION AND SUPPLY

Moving natural gas from its location in the earth's crust to the end user requires an elaborate process of exploration, extraction (production), processing, shipment, storage, and further transport to local demand points. As the easiest and closest natural gas reserves have been exploited, exploration continues in deeper, more difficult to reach locations. The primary exploration technique involves the use of seismic shock waves, which are sent into the earth's crust, reflect off underground geologic formations, and allow geologists to map the crust's interior. Once produced by dynamite and other explosives, seismic waves are now primarily produced by vibrator trucks that "stomp" the ground.

Recent computer technology has enabled geologists to construct three- and four-dimensional images of the crust's geology. Extraction of natural gas is similar in many ways to the extraction of oil. A drilling rig is constructed, and a hole is drilled in the earth's crust down to the natural gas deposit, allowing the gas to be brought to the surface and collected. Since natural gas from the ground often includes other compounds (gasses, oil, and water), processing removes impurities and other substances, yielding the methane that is piped to markets. Other substances removed during the processing of natural gas include ethane, propane, butane, pentane, and sulfur. Underground gas pipelines transport the processed natural gas to underground storage facilities near markets, and when needed, it is then distributed to homes and businesses.

Natural gas is not a ubiquitous resource. Some countries have a plentiful potential supply while others do not. The largest proved reserves of natural gas in the world are found in Russia (27.2 percent of the world total). The unequal distribution of natural gas in the earth's crust is demonstrated by the fact that over 57 percent of the world's proved reserves are found in three countries (Russia, Iran, and Qatar). Other large, but proportionally smaller reserves, are found (in descending order) in Saudi Arabia, the United Arab Emirates, the United States, Algeria, Nigeria, Venezuela, Iraq, and Kazakhstan. Examining natural gas production (exploitation of reserves) yields a more accurate picture of current supply. The world's largest producers of natural gas are Russia (22 percent of world production) and the United States (20 percent of world production). Other major producers include (in descending order) Canada, the United Kingdom, Indonesia, Algeria, Iran, Norway, the Netherlands, and Saudi Arabia.

SEE ALSO: Alternative Energy; Fossil Fuels; Geology; Methane; Russia (and Soviet Union).

BIBLIOGRAPHY. Michael Economides, "The Coming Natural Gas Cartel," www.foreignpolicy.com (cited March 2006); Mark Finkelstein et al., "Buried Hydrocarbons: A Resource for Biogenic Methane Generation," *World Oil* (v.226, 2005); NaturalGas.org, "From Wellhead to Burner Tip," www.naturalgas.org (cited March 2006); The Natural Gas Supply Association, "The History of Natural Gas," www.ngsa.org (cited April 2006); Natural Gas Vehicle Coalition, "About Natural Gas Vehicles," www.ngvc.org (cited March 2006); Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (Free Press, 1991).

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Natural Landscaping

NATURAL LANDSCAPING IS a minimalist strategy for beatifying the grounds of homes or professional buildings. The basic technique of natural landscaping is not to simply allow a space to return to its natural state, but instead to design a garden, yard, or grounds so that it is in harmony with nature. The design of natural landscapes is one that imitates areas found in nature such as meadows, wildflowers, trees, plants, and native grasses. This design technique creates environments that are easy to maintain and have economic and environmental benefits. Among

Natural landscaping uses native species to create privacy screens and local rocks to beautify islands of trees.

these is a marked reduction in mowing of traditional lawns, water consumption, and fertilizer use and the restoration of habitat.

The use of xeriscaping (landscaping that maximizes water conservation) as a form of natural landscaping can reduce water use by two-thirds. It also means that in times of drought the natural landscape area will be more drought resistant than landscapes that use plants that require much more care and water.

Professional landscapers who seek to achieve a natural look will use native species to hide utility buildings or other work areas. They will also work with holes or other unsightly areas to fashion them into an area that looks like a natural park. If the area to be landscaped is small, then the design will use borders that create a natural feel to the landscape area. In addition using plants native to the area can create privacy screens that give the feeling that the home or residence is sheltered in a remote wooded area when it is actually in a suburban or urban area.

Natural landscaping design techniques create shady, hidden places that add not only interest to small areas but also habitat for birds and other small mammals such as chipmunks and squirrels. With planting of perennial native grasses and flowers, these animals will find abundant feed. Natural rocks from the property or imported from close by can also beautify islands of trees or the borders of plantings.

SEE ALSO: Gardens; Landscape Architecture; Landscape Ecology; Lawns; Native Species; Xeriscape.

BIBLIOGRAPHY. Mark A. Benedict and Edward T. McMahon. *Green Infrastructure: Linking Landscapes and Communities* (Island Press, 2006); Kathleen Norris Brenzel, ed., *Western Landscaping* (Sunset Books, Incorporated, 2006); Paul C. Hellmund and Daniel Smith, *Designing Greenways: Sustainable Landscapes for Nature and People* (Island Press, 2006).

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Natural Regulation

MOST OFTEN USED in environmental and natural resource policy discourse, natural regulation is generally understood to mean environmental conditions not directly altered by humans. Often, the term is used to contrast areas with minimal direct human influence, such as congressionally designated wilderness areas on federal lands in the United States, with directly managed areas such as commercial forest land used to produce timber for lumber and paper.

Within the context of natural resource management, natural regulation is based on the rationale that nature knows best, and will therefore achieve an ideal state if left alone. The concept is fueled by the belief that an ecosystem is in need of repair because man has used it too intensively for self-gain (or sustenance) for reasons such as logging, mining, hunting, and urban development. Other contributing factors are outmoded management policies such as fire suppression, wolf extermination, and elimination of woody debris from streams that have proved to cause more problems than they solved because of man's ignorance of nature's complexities.

The *Merriam-Webster Dictionary* makes *natural regulation* sound like an oxymoron, when "natural is based on an inherent sense of right and wrong, not artificial, and untouched by the influence of civilization and society," while "regulation implies a prescription by authority in order to control an organization or system." Connecting such words reveals a teleological notion that is unscientific according to contemporary ecological science, as it contradicts the current chaos paradigm that has largely overturned the related concept of balance of nature. Depending on the spatial and temporal scales at which nonhuman-controlled environments are studied, nature appears anything but regulated (for example, consider natural disasters such as Hurricane Katrina in 2005, and the series of tsunamis from the 2004 Indian Ocean earthquake). As some scholars of natural resource management policy have suggested, there tends to be a confusion of the term *natural regulation* to describe an empirically verified state of nature, when in fact it delineates a human value preference for what should or should not be done to an environment.

Frederic Wagner of the National Center for Ecological Analysis and Synthesis suggests that "much of the debate on natural regulation fails to distinguish between the [management] policy and [scientific] hypothesis" that make up the term. Part of the problem can be traced to junk science, blamed for simplifying and distorting scientific claims for personal motivations, whether it be as innocuous as a reporter complying with a word count limit for a newspaper article, or as deliberate as a lawyer constructing a case to win a lawsuit.

An applied policy example of natural regulation is in the western United States in Yellowstone National Park (YNP) by the National Park Service (NPS) on the recommendation of a 1963 report by the National Academy of Sciences to return the area to what it was like before Euro-American settlement. A founder in the development of our understanding of ecology, V.C. Wynne-Edwards, brought some of the supporting concepts for natural regulation to the forefront in 1962 with the book *Animal Dispersion in Relation to Social Behavior*, suggesting that certain species thrive by regulating their own populations via group selection to use their resources sustainably. Three and a half decades later, ecologist Mark Boyce supports natural regulation policy based on the belief that humans can learn from environments in which they are not involved, and are likely to mess them up if they become involved.

In 2002, the National Academy of Sciences put out a review of the natural regulation in YNP in recognition of it being one of the most contentious management issues in the park since its inception. Alston Chase's 1985 book *Playing God in Yellowstone* is a commonly cited source of criticism that sparked considerable backlash from the NPS. Other well-known critics are political scientist Charles Kay and Richard Keigley of the U.S. Geological Survey, who both have associated natural regulation more with politics than science. Biogeographer Amy Hessl illustrates the inevitable limitations of applying natural regulation in that political boundaries such as land ownership don't coincide with ecological processes operating at different spatial scales. However, she implicates support for such an evolution in policy at YNP when she calls attention to management actions connected with declines in aspen populations, identified as the most important indicator species of biological diversity there.

Given that ecosystem boundaries don't correspond with legal boundaries, a policy of natural regulation may actually threaten the ecological values inside of a protected area. Although fire suppression is blamed for wiping out aspen cover in some areas, permitting prairie fires and unlimited wild ungulate grazing can also drastically reduce biodiversity. And as pointed out in the May 1998 UNESCO *Courier*, natural regulation does not absolve managers (or policy makers) from setting objectives, because change is going to take place regardless of their decision to intervene. The quandary becomes one between biocentric and utilitarian goals, and if humans can be a part of ecological sustainability.

Another aspect to take into account with natural regulation implementation is its feasibility, when arguably nothing left on the earth is untouched by humans. If everything is connected, then some human-related development can eventually be found to have initiated a domino effect on what was even thought to still be natural. Many wilderness designations, which the Wilderness Act of 1964 describes as lands to be protected in their "natural condition, untrammeled by man," have been made after (and contingent upon) the destruction of historic buildings.

Discussion of natural regulation also highlights dramatic differences in what people view as acceptable ecological conditions based on what initiated the changes that shaped the character of a place. For example, a lightning-caused wildfire that burns 500 acres of marketable timber would be beneficial according to an environmentalist, but a tragedy to a logger. But if arson were identified as bringing about the same result, the two would likely agree it was a crime. Similarly, the appropriate response to such an incident could range from nothing, to harvesting any salvageable trees that remain.

Environmental philosopher Ernest Partridge speaks to such distinctions in his analysis of what he calls the old and new ecologies. In his successful 1998 proposal to the National Science Foundation on "Implications of Disequilibrium Ecology for Environmental Ethics and Policy," Partridge cites Aldo Leopold's belief, published in 1949, that "a thing is right when it tends to preserve the integrity and stability and beauty of the biotic community; it is wrong when it tends otherwise" as an example of the traditional view, and Daniel Botkin's assertion that although this standpoint forms the basis of federal and state environmental laws and international agreements, it is inaccurate as an example of the current paradigm. New ecology contends that the environment is in constant change, and therefore there is nothing to preserve. Petitions for wilderness restoration are thus left with unfounded assumptions about what condition they are advocating.

Partridge's main contribution to this exploration of natural regulation lies in his rebuttal to the new ecologists about ecosystems being better or worse (that is, healthy versus degraded) than others, as correlated with their being natural or cultivated by human societies. His argument is based on the belief that undisturbed nature manages itself, which to him basically means remaining as is. He does not deny the new ecology claim that all is flux, but tempers it with the qualification that change within natural ecosystems is slow and self-healing, while anthropogenic effects are abrupt and damaging. Such reasoning, however, ignores cataclysmic natural events such as volcanic eruptions, hurricanes, fires, and asteroid impacts. Like most theories, there are some instructive points that remain in both old and new ecology concepts, even after considering their criticisms.

Within the natural regulation context, scientists need to be cautious about mixing science with their personal preferences when making formal recommendations on resource management. Which returns to Frederic Wagner's observation about the shortcomings of using the term *natural regulation*, in that it inextricably links questions of scientific fact that are subject to tests of evidence with sociopolitical value and policy questions: Specifically whether humans are a part of nature, and if so, what their role should be in shaping it.

SEE ALSO: Human Nature; National Parks; Nature, Social Construction of; Nature Conservancy; Policy, Environmental; Yellowstone National Park.

BIBLIOGRAPHY. D.E. Duff and J.D. Varley, "Natural Regulation in Yellowstone National Park's Northern Range," *Ecological Applications* (v.9, 1998); Greg Hanscom, "Is Nature Running Too Wild in Yellowstone?" *High Country News* (v.29, 1997); Karl Hess, "Ecological Threats to the Parks," *Different Drummer* (1995); Amy Hessl, "Aspen, Elk, and Fire: The Effects of Human Institutions on Ecosystem Processes," *BioScience* (v. 52, 2002); R. Noss, L. Westra, and D. Pimentel, eds., *Ecological Integrity: Integrating Environment, Conservation, and Health* (Island Press, 2000); Frederic Wagner, "Perspective: Frederic H. Wagner, National Center for Ecological Analysis and Synthesis," *Yellowstone Science* (Summer, 1999).

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Natural Resources Conservation Service (NRCS)

AN AGENCY OF the U.S. Department of Agriculture (USDA), the Natural Resources Conservation Service (NRCS) is a unique and rather poorly understood part of the U.S. government. It plays a major role in the management of the nation's rural lands, but unlike its more famous federal land management counterparts (e.g., the National Park Service, U.S. Forest Service, Bureau of Land Management, and U.S. Fish and Wildlife Service), the NRCS neither owns nor administers land. Indeed, it is generally disallowed from working on federal land, and it is the only federal agency specifically authorized to work on private lands. While its principal work activities involve agricultural extension, the NRCS also conducts soil and flood control surveys, inventories national land use and land cover, monitors snowfall to forecast water supplies, and administers grants to conserve wildlife habitat, soil and water, and agricultural land.

Although often perceived among environmentalists as "captured" by farmers and ranchers, the NRCS was never intended to be a regulatory agency. Rather, it was designed to work cooperatively with states and counties as well as private landowners, and in several ways it pioneered approaches to conservation that have more recently been "rediscovered," such as public-private partnerships, community-based conservation, and watershed-scale restoration.

Prior to October 1994, the NRCS was called the Soil Conservation Service (SCS), which was created in April 1935 under Public Law 46. The name change was intended to communicate a broader conception of the agency's mandate, but the mandate itself had always been far-reaching. Public Law 46 declared "that the wastage of soil and moisture resources on farm, grazing and forest lands of the nation, resulting from soil erosion, is a menace to the national welfare." It proclaimed "the policy of Congress to provide permanently for the control and prevention of soil erosion and thereby preserve natural resources, control floods, prevent impairment of reservoirs, and maintain the navigability of rivers and harbors." The SCS formalized and made permanent within the USDA the activities of the Department of the Interior's Soil Erosion Service, which had been formed on an emergency basis two years earlier in response to the combined effects of the Great Depression and the Dust Bowl.

The director of the Soil Erosion Service and first chief of the SCS, Hugh Hammond Bennett (1881–1960), is today regarded as "the father of soil conservation." Bennett joined the USDA's Bureau of Soils in 1903 and spent his early career producing county soil surveys. In the course of fieldwork in the southern United States, Alaska, and overseas, he became convinced that soil erosion was not only widespread and severe but also a peril that required coordinated government action. In 1928 he coauthored "Soil Erosion: A National Menace," a bulletin that popularized the issue and led to the formation of the Soil Erosion Service. Bennett worked from the premise that soil erosion was both a social and an ecological issue, one that required political organization as well as scientific information.

One of the first actions of the Soil Erosion Service was a watershed scale demonstration project in the Coon Valley of southwestern Wisconsin, where local farmers petitioned for technical assistance and agreed to lead the project. Erosion integrated the watershed, touching on everything from farming and grazing practices to land use patterns and wildlife. With input from an interdisciplinary team of technicians, over 400 farmers participated in a comprehensive analysis of the watershed's natural resources and implemented treatments on creeks, forests, and pastures as well as croplands.

This approach was institutionalized in conservation districts enabled by a federal law passed in 1937. Districts are technically units of state government, created and run by elected boards of local cooperators with support and technical assistance from the NRCS. Although the federal legislation permitted districts to assume jurisdiction over planning and zoning, very few states included these powers in their laws. Some 3,000 conservation districts exist at present, although their potential as vehicles for "new" ideas in conservation has scarcely been tested.

SEE ALSO: Community-Based Conservation; Dust Bowl, U.S.; Public-Private Partnerships; Soil Erosion.

BIBLIOGRAPHY. Natural Resources Conservation Service, www.nrcs.usda.gov (cited January 2007); W.D. Rasmussen and Gladys L. Baker, *The Department of Agriculture* (Praeger, 1972); Maxine Rosaler, *Department of Agriculture* (Rosen Publishing Group, 2005).

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Natural Resources Defense Council (NRDC)

THE NATURAL RESOURCES Defense Council (NRDC) is a nonprofit environmental advocacy organization. Originally funded by the Ford Foundation, it was founded in 1970 by public interest lawyers seeking to create an organization that would focus specifically on environmental protection.

The NRDC is one of several national environmental organizations to emerge in the 1970s. These groups are distinct from the conservation organizations that existed prior to this period, such as the Sierra Club and the Audubon Society. At the time these longer established organizations had more of a recreational and hobbyist orientation and were less engaged in political mobilization. The NRDC and other environmental organizations that formed during the 1970s emerged from the political mobilizations of the 1960s and took on a more explicitly political orientation. In later years these large national organizations would converge in terms of their political activities, although some differences in strategy are still evident.

Given that it was founded by public interest lawyers, the NRDC's main political strategy is to use litigation against public entities and private corporations in order to force compliance with and enforcement of environmental laws and regulations. The NRDC Action Fund is an affiliated organization with a different tax status that allows it to dedicate all of its resources to lobbying and political mobilization, while the main nonprofit organization carries out a combination of research, education, and political mobilization.

It its early years the NRDC played a role in the passage and enforcement of the Clean Air Act and Clean Water Act. The NRDC was also key in the fight against ozone depletion caused by the release of chlorofluorocarbons (CFCs) into the atmosphere. A 1978 lawsuit filed by the NRDC led to a ban on the use of CFCs as aerosol propellants. Under threat of further legal action, the U.S. Environmental Protection Agency (EPA) later restricted other uses of CFCs. Other issues on which the organization has focused include forest protection, acid rain, and the removal of lead from gasoline.

Some have criticized the NRDC and similar professional organizations for their close integration into the policymaking system and their relative lack of connection with grassroots activists, especially those from disadvantaged groups. In the 1970s, some NRDC leaders went on to assume positions in the Carter Administration. In the early 1990s the NRDC and other large national environmental organizations were criticized by civil rights organizations that claimed that large professional environmental groups failed to pay ample attention to issues of environmental justice.

Today the NRDC has over one million members and works on a wide range of issues, including global warming, forest preservation, and endangered species protection. It continues to use litigation as its primary strategy and it typically has over 100 lawsuits filed against polluters at any given time. The NRDC also seeks to involve members and activists in its lobbying activity primarily through online and direct mail appeals to write and telephone elected officials. The organization is headquartered in New York City and has offices around the United States. It employs a staff of over 100, including lawyers who carry out the litigation function of the organization and scientists who conduct research and provide technical expertise on environmental matters.

SEE ALSO: Chlorofluorocarbons; Clean Air Act; Clean Water Act; Justice; Lobbyists; Montreal Protocol; Movements, Environmental; Ozone and Ozone Depletion.

BIBLIOGRAPHY. Paul J. Allen, "The Natural Resources Defense Council," *Environment* (v.32/10, 1990); Robert Gottlieb, *Forcing the Spring* (Island Press, 1993); Natural Resources Defense Council, www.nrdc.org (cited April 2006).

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Nature, Social Construction of

MANY PEOPLE CONSIDER nature to be whatever it is they see through the window of an automobile while passing through rural areas. Looking out they see fields, forests, birds, and perhaps a mammal such as a deer. This common view of nature as whatever the individual happens to see of the world is without critical awareness. It can be considered a form of naïve realism that believes that what one sees is what one gets. However, questions about the accuracy of this picture of "reality" have been with us since the beginning of Western philosophy and continue to be raised in modern studies by sociologists.

The philosophic question "what is real?" is an issue because some human experiences are of things that appear to be real, but when examined are found to be only appearances or illusions. All humans have experienced appearances, perhaps as mirages or startling shadows. Distinguishing appearances from reality is a central question in metaphysics. Until the advent of the Copernican Revolution in astronomy, the general belief was that the solar system was geocentric: The sun moved and the earth was stationary. Certainly for an observer on earth the sun does appear to move every day of the year. However, this is now known to be an appearance, and reality is just the opposite. The discovery required major adjustments in thinking about the nature of the universe. It required, as Francis Bacon urged in his writings, a reorganization of knowledge.

The picture of "reality" that people carry in their heads is not just a response to a nature that is out there, but also an artificial construction in the human mind. Animals may be part of nature, but the names by which they are known are a human social construct. Interestingly, the first words used by babies are nouns for naming things, but this is a social act because the names are those given by the language of the society.

The knowledge of the names of the animals is not just that of an isolated person, because humans are by nature social. People may choose at some time to live isolated from human contact; they may die alone; but no human has ever been born alone. Children acquire a language that is filled with deep structures and images that carry the thinking and feelings of many people over generations. The deep structures will include ideas and feelings about nature.

Sociological theories of the "social construction of reality" say that the way in which humans act is a product of their life experiences. In other words, the perceptions of reality that people have are colored by their beliefs and backgrounds. Thus, the attitudes that someone would have about being lost in the deep forests of Canada would be different if that person had grown up on a farm in a rural area as opposed to having been reared in an apartment in New York City. The attitudes of people from rural areas on guns and hunting will differ from those who are from urban areas. The former may have eaten at times thanks to the game they shot and killed. The urbanite may never have handled a gun, and may have usually been fed from local grocery stores or restaurants where the prepared meat or fish is not recognizable as the animals they once were.

An example of the social construction of nature is in the attitudes that Americans have had toward wolves. These attitudes were shaped by European stories of the "big bad wolf," which have often been viewed as true depictions of reality, even though the origins of the story and the intentions of the storytellers may have been very different. In the American West wolves were hunted to extinction because of hostile attitudes shaped more by these images and attitudes than by reality. This occurred despite scientific studies showing that wolves do not live up to their bad reputations. The Thomas Theorem applies because in this case wolves are perceived as bad so their consequences were real.

The social construction of nature also affects scientists. While expected to have clear pictures of reality, studies of their theories have shown that since at least the pre-Socratic teachings of Heraclites of Ephesus, scientists have used images or metaphors to interpret their finding. These models of reality have on a number of occasions created enormous mischief.

Many students of the history of science believe that the Darwinian image of life as a struggle for survival was an interpretation of nature that reflected the savage manner in which society in England at the time operated. If life had been organized in another way, the theory of the mechanisms of nature would have been illustrated differently, and therefore the theory would also have been different.

The pictures of nature that humans carry in their heads are in part an eisegesis of nature. That is, part of human understanding of nature is "read into" nature from the social perspective of the viewer of nature.

SEE ALSO: History, Environmental; Human Ecology; Human Nature.

BIBLIOGRAPHY. Klaus Elder, *Social Construction of Nature: A Sociology of Ecological Enlightenment* (SAGE Publications, 1996); Roy Ellen et al., eds., *Redefining Nature: Ecology, Culture and Domestication* (Berg Publishers, 1996); Rik Scarce, *Fishy Business: Salmon, Biology and the Social Construction of Nature* (Temple University Press, 1999); I.G. Simmons, *Interpreting Nature: Cultural Constructions of the Environment* (Routledge, 1993); Philip E. Steinberg, *Social Construction of the Ocean* (Cambridge University Press, 2001).

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Nature Conservancy

THE TERM *nature conservancy* reveals the particular way that society relates to "nature," or what is thought of as the physical and natural environment that surrounds and hosts human activities and life on earth. The relationship between early societies and the natural environment was good, as societies made use of natural resources without causing large-scale depletion. As a whole, indigenous societies such as the Mayas in Peru didn't provoke great environmental conflicts; instead, many ancient societies developed sustainable ways of living.

However, during the early 18th and 19th centuries the relationship between humanity and nature became strained with the beginning of the Industrial Revolution. Nature was often seen as an endless source of raw materials to feed the increasing needs of industrial countries. At the same time the environment served as a container for industrial waste. In this way, industries grew based on natural resource exploitation at very large scales, which gradually depleted the resources.

Early conservation initiatives were led by naturalists in the United States who were worried about extensive land-clearing and the rapid loss of wildlife. As conservation ideas gradually gained support, results appeared. In 1872 Yellowstone National Park was established in order to protect an area of incredible natural beauty. Later on the Forest Reserve Act of 1891 authorized what would become known as National Forests, and the Lacey Act of 1900 established the first wildlife protection measures by restricting commercial hunting and the trade of illegally killed animals.

Throughout the 20th century many other initiatives appeared in the United States. The conservation movement had a high point in the 1960s as books such as *Silent Spring* by Rachel Carson raised public concern about the health and environmental hazards of pesticides and other toxic chemicals used by industry.

In 1972 the United Nations (UN) Environment Programme was formed to encourage international cooperation in conservation and development strategies. Collaboration on environmental conservation issues included the 1987 Montreal Protocol to protect the ozone layer; the 1992 UN Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil; and the 1994 UN Conference on Population and Development in Cairo, Egypt.

More recently, the idea of conservation has been closely connected to that of sustainable development. Conservation does not simply mean preservation anymore—it means the fostering of economic activities while taking into account and respecting the dynamics of natural ecosystems. That is the basic idea of sustainable development: a triangle between economics, society, and ecology.

Today there are hundreds of agencies, nongovernmental organizations, and other groups whose goals involve the conservation of nature. The biggest and most renowned ones are: the World Conservation Union or International Union for the Conservation of Nature (IUCN), the World Wildlife Fund (WFF), Greenpeace, Conservation International, and The Nature Conservancy (TNC). Some of these organizations have significant budgets. For instance, TNC had a 2005 budget of more than $600 million.

SEE ALSO: Carson, Rachel; Conservation; Greenpeace; Montreal Protocol; United Nations Environment Programme; World Conservation Union (IUCN); World Wildlife Fund.

BIBLIOGRAPHY. Noel Grove, *Earth's Last Great Places: Exploring the Nature Conservancy Worldwide* (National Geographic, 2003); Noel Grove and Stephen J. Krasemann, *Preserving Eden: The Nature Conservancy* (H.N. Abrams, 1992); Kim Heacox, *An American Idea: The Making of the National Parks* (Hi Marketing, 2001).

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Nature Writing

THE NATURE WRITING style of nonfiction prose about the natural environment often draws from scientific discoveries and facts about nature, commonly in a first-person narrative, and usually includes philosophical reflections on the natural world.

Some early writers mentioned animals in their texts; the descriptions of crocodiles by the Greek writer Herodotus (c. 485–25 B.C.E.) are probably the best-known in ancient literature. However, it was Gilbert White (1720–93) who was the first nature writer in the modern tradition. He was born in the village of Selborne, Hampshire, England. Trained as an Anglican clergyman, he returned to Selborne as the village curate. During his 20 years there he wrote a large number of letters about observations from his garden, from which 110 were collected and published as *The Natural History and Antiquities of Selborne* (1789). The book quickly became popular and has remained in print ever since.

The next nature writer was the American William Bartram (1739–1823), son of the Pennsylvanian botanist John Bartram (1699–1777). The father was hailed by Linneaus as "the greatest natural botanist in the world," and his son wrote *Travels* (1791) which influenced many English writers of the Romantic period. John James Audubon (1785–1851), worked on his famous *Birds of America*, which was published between 1827 and 1838 in 87 portfolios. At the same time, British ornithologist John Gould (1804–81) put together his multivolume books *Birds of Europe*, *Birds of Australia*,

This engraving of Rush Creek Glacier in the Sierra Nevadas accompanied an 1875 article by John Muir.

Birds of Asia, and *Birds of Great Britain*. However, the works of Audubon and Gould are better known for their pictures than their text.

Even though Bartram's work predates that of Henry David Thoreau (1817–62), Thoreau is recognized as the father of American nature writing. He was from Concord, Massachusetts, and as a teacher was fond of long walks studying nature. His book *Walden, or Life in the Woods* (1854), became an American classic, with further works, including his daily journal, being published posthumously.

A number of explorers also wrote about nature. German naturalist Alexander Humboldt (1769–1859) worked with Aimé Bonpland (1773–1858) with Humboldt's book *Kosmos* gaining him wide notice. Humboldt's work was largely technical in nature, and quite unlike the nature writing of Charles Darwin (1809–82) and Lord Alfred Russel Wallace (1823–1913). Darwin described his voyage around the world in his book *Journal of Researches into the Geology and Natural History of the Various*

Countries Visited by HMS Beagle (1839) and later put together his ideas about evolution through natural selection in *On the Origins of Species* (1859).

Although his books never sold as well as those by Darwin, Lord Alfred Russel's *Palm Trees of the Amazon and Their Uses* and *Narrative of Travels on the Amazon and Rio Negro* (both published in 1853), and *The Malay Archipelago: The Land of the Orang-Utan, and the Bird of Paradise* (1869), remain important in their descriptions of Latin America, the Malay Peninsula, and the Indonesian Archipelago.

Others associated with the concept of nature writing include U.S. writers Ralph Waldo Emerson (1803–82), Aldo Leopold (1887–1948), and John Muir (1838–1914). Edward Abbey (1927–89), author of *Desert Solitaire* (1968) and the novel *The Monkey Wrench Gang* (1975) about environmental guerilla warfare, specifically rejected the term *nature writer* for himself, although others give him that title.

Rachel Carson's (1907–64) early books *Under the Sea-Wind* (1941) and *The Sea Around Us* (1951) were nature writing, and she became famous for *Silent Spring* (1963). Another important nature writer was William Henry Hudson (1841–1922), who was born in Argentina to American parents. He wrote a number of books about South America, with a heavy emphasis on ornithology.

Other recent American nature writers include Rick Bass, Wendell Berry, Christopher Camuto, Annie Dillard, Gretel Ehrlich, John Elder, Bernd Heinrich, Sue Hubbell, William Kittredge, Barry Lopez, Bill McKibben, John McPhee, Sy Montgomery, Gary Paul Nabhan, Richard Nelson, Sam Pickering, Michael Pollan, Richard Proenneke, Robert Michael Pyle, David Quamme, Janisse Ray, Scott Russell Sanders, Gary Snyder, Edwin Way Teale, and Terry Tempest Williams.

SEE ALSO: Audubon Society; Carson, Rachel; Darwin, Charles; Muir, John; Thoreau, Henry David.

BIBLIOGRAPHY. Karla Ambruster, *Beyond Nature Writing: Expanding the Boundaries of Ecocriticism* (University Press of Virginia, 2001); Steven Gilbar, ed., *Natural State: A Literary Anthology of California Nature Writing* (University of California Press, 1998); Richard Kerridge and Neil Sammells, eds., *Writing the Environment: Ecocriticism and Literature* (Zed, 1998).

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Nauru

THE TINY OCEANIC island of Nauru was geologically endowed with unusually high phosphate deposits, a resource that would prove to be the island's ecological ruin. Starting in the early 20th century with the intervention of a German-British consortium, and onward for nearly 100 years, phosphates were regularly mined and aggressively removed. The result of a century of exploitation has been the virtual destruction of the island and its native ecosystem.

Nauru achieved independence in 1968, making it the smallest independent republic in the world; the island is only eight square miles (21 square kilometers). Nauru joined the United Nations (UN) in 1999. The climate is tropical with a monsoonal pattern. Periodic draughts pose significant threats to the island's ecosystems and accelerate the need for freshwater. The rainy season lasts from November to February. Nauru is relatively flat, and most of the island is covered by sandy beaches, with a fertile ring around the raised coral reefs. The phosphate plateau is located near the center of the island. The 30-mile (48-kilometer) coastline of Nauru is surrounded entirely by the South Pacific Ocean.

None of the land on Nauru is presently arable, and the only resources are phosphates and fish. The entire country is urbanized as there are no rural areas. Most essential items are imported from Australia. The island has a population of 13,048 people and a fertility rate of 3.19 children per female. With a per capita income of $5,000, Nauru is ranked 135th out of 232 nations in income. Ninety percent of the population are unemployed. The remaining 10 percent mine phosphates or work in public administration, education, and transportation.

The ecological devastation of the island has led to a number of stopgap economic measures. Following the depletion of most of the phosphate resources, the economy shifted during the 1990s to become an offshore tax haven for foreign individuals and firms, and a center for money laundering. Even more radically, in 2001 it became the offshore detention site for asylum seekers attempting to migrate to Australia. These efforts have yielded limited economic benefits and added to ongoing destabilization.

With phosphates virtually depleted, Nauru is facing a major economic dilemma. Although funds were set aside for this eventuality, the fund has been almost bankrupted by indiscriminate government spending. Consequently, the government has invoked a wage freeze, privatized government agencies, and reduced government staff. Australian subsidies currently keep the Nauruan economy afloat. The UN Development Programme Development Reports do not rank Nauru due to lack of data.

Without a natural source of freshwater, Nauruans use roof storage tanks to collect rainwater. However, most water is derived from the one aging desalination plant available on the island. The major environmental problem for Nauru is the aftermath of the intensive phosphate mining. This exploitation has turned 90 percent of the central section of the island into a wasteland and has caused some damage to the remaining land area.

The coastal area is generally filled with pandanus and coconut palms. In the area around the Buada Lagoon, Nauruans have managed to grow some bananas and vegetables. The island produces 23,810 pounds (10.8 metric tons) of carbon dioxide emissions per capita. The global warming trend that is affecting the rest of Oceania is also causing sea levels to rise on Nauru, leaving low areas exposed to flooding and tidal surges. The habitats of many birds have been destroyed by mining and other ecological damage. Consequently, some species, such as the bristle-thighed curlew and Finsch's reed warbler, are threatened. Other species have completely disappeared. The government plans to reclaim some former mining land for use in housing, public utilities, and recreation.

Nauru is divided into 14 districts, and the national government is composed of a president, an 18-member unicameral legislature, a Supreme Court, and various government agencies. There is no minister or agency exclusively assigned to the environment, and environmental laws are virtually nonexistent. Despite its small size, Nauru has committed itself to protecting the global environment by signing the following international agreements that impact on its own environment: Biodiversity, Climate Change, Desertification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, and Ozone Layer Protection.

SEE ALSO: Bananas; Endangered Species; Global Warming; Land Degradation; Mining; Sea Level Rise.

BIBLIOGRAPHY. Central Intelligence Agency, "Nauru," *The World Factbook*, www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Australia, Oceania, and Antarctica: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); K.R. Howe, *Nature, Culture, and History: The "Knowing" of Oceania* (University of Hawai'i Press, 2000); Carl N. McDaniel and John M. Gowdy, *Paradise for Sale* (University of California Press, 2000); United Nations, "Nauru Country Report," www.un.int (cited April 2006); United Nations Development Programme, "Human Development Reports: Nauru," hdr.undp.org (cited April 2006); United Nations Environment Programme, *Pacific Island Regional Report: Chemicals* (Global Environment Facility, 2002).

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Needs and Wants

OUR SOCIAL, ECONOMIC, and political arrangements are supposed to serve the fulfillment of human wants and needs; our concepts of wants and needs, and the methods by which we try to fulfill them, have profound environmental and social implications. We need those things without which we would suffer greatly; we want things that would be desirable, but that we can fairly easily do without.

The distinction between needs and wants can be very fuzzy and politically contentious, especially because degrees of suffering are not simply determined by external circumstances, but also by human psychological states. Furthermore, particular desires may point to underlying unacknowledged needs, for example, an eating disorder involving excessive food cravings or an obsessive desire to lose weight may be a response to an unmet need for love.

IS ENVIRONMENTALISM A LUXURY?

The science that most directly studies human needs is psychology. For example, Abraham Maslow, one of the founders of the subdiscipline of humanistic psychology, recognized a hierarchy of needs, beginning with physiological needs (such as for food) at the base, and progressing to needs for safety and security, love and belonging, esteem, and finally, self-actualization. He classified all but the last as "deficiency needs," the absence of which inhibits growth and development, and postulated that these deficiency needs had to be met before people could devote themselves to self-actualization, a "growth need." Other psychologists conceptualize needs somewhat differently, but it is important to note that "nonmaterial" needs are widely recognized as basic to healthy human development.

Much cruder hierarchical models of human needs than Maslow's are at the basis of claims that the desire for environmental protections is a "post-material" want that becomes important only once a society has reached a certain level of affluence. According to this conception, environmentalism is a luxury that the poor cannot afford; they are served best if pollution of air, water, and land is condoned as a necessary price of progress. Hence, the siting of polluting industries in poor countries and neighborhoods helps both the rich (who can indulge in NIMBYism) and the poor (who gain by an increase in employment opportunities).

Critics of this conception point out that even (and especially) the poorest people need such things as friendship, social solidarity, and a sense of identity. For example, Manfred Max-Neef developed a matrix of human needs for subsistence, protection, affection, understanding, participation, idleness, creation, identity, and freedom, each of which involves being (e.g., the subsistence need of being healthy), having (e.g., the need to have peace of mind as a part of idleness), doing (e.g., the need to participate by cooperating and dissenting), and interacting (e.g., the need for a setting in which one belongs as part of identity). He posits these needs to be nonhierarchical and finite. According to this conception, there is no necessary reason why "material" needs should be prioritized over "nonmaterial" needs; hence, for example, we should not wait until needs for food and shelter are met before talking about the need for a clean environment.

AN ENVIRONMENTALISM OF THE POOR

The very distinction between "material" and "nonmaterial" needs is erroneous, however, in the sense that material needs include natural resources that are not provided by the market. Thus, as argued by Ramachandra Guha and Juan Martinez-Alier, there is an "environmentalism of the poor," which focuses on the needs of the poor for access to resources such as clean water and air, fuelwood, fodder, medicinal plants, grazing land, and fertile soils. If these resources are taken away from them and managed for the benefit of elite interests (e.g., timber for the wood industry), the results typically include the intensification (or creation) of poverty and unsustainable resource management.

It is in the interest of the poor to ensure that their local resources are used sustainably, because they know that they and their children will not be able to move to another place in order to exploit resources there. This environmentalism of the poor may differ from that of the rich (which may focus on beautiful views, for example), but is no less real.

ECONOMIC GROWTH VERSUS LIVING SIMPLY

Neoclassical economics is based on a conceptualization of needs going back to late 19th-century positivist approaches, which treated needs and wants as beyond the reach of scientific inquiry because of their irrationality. It ignores any distinction between needs and wants by treating them both as wants. These wants are posited to be infinite, in the sense that a person's wants can always expand beyond the present capacity to fulfill them—and usually do. Hence, people are believed to live in a condition of perpetual scarcity.

Markets are believed to be capable of fulfilling most human wants—or at least, they are believed not to interfere with the fulfillment of any important wants. If a market transaction does interfere with the fulfillment of others' wants, this is considered an "externality," usually regarded as an exceptional occurrence. The problem of ranking different people's wants is to be performed by the market: the amount people are willing to pay for a commodity (its exchange value) is supposed to be an accurate indicator of their desire for that commodity (demand) balanced against the difficulties of supply. Political processes of ranking different people's needs and wants are regarded as an unnecessary and counterproductive interference in the workings of the invisible hand of the market. These claims help justify the universal "need" for continuous economic growth and for minimal government regulation either to protect the environment or to promote social welfare.

In opposition to these claims of neoclassical economics, various critics have pointed out that both wants and needs are constantly being created. The multimillion-dollar advertising industry exists solely to stimulate desires where they may not have existed before; likewise, shopping environments are designed in an attempt to stimulate wants of the customers.

Needs, and not mere desires, are being created by what Illich has called "radical monopolies." For example, urban environments are transformed to the point that people can no longer reach their destinations by walking or cycling, so that they need mechanized transport. If, furthermore, public transport is allowed to decay, people need cars and have lost important freedoms.

In the words of Peter Hershock, "the better we get at getting what we want, the better we get at wanting; but the better we get at wanting, the better we get at getting what we want, though we won't want what we get." According to such arguments, economic growth as we know it is incompatible with the satisfaction of people's most important needs and leads to senseless environmental destruction. Nonmarket mechanisms are needed in order to direct economic development in ways that actually allow people to reach their highest goals (such as for self-actualization).

On the basis of similar critiques of the concept of unlimited needs, sometimes based in religious ideas (for example, monastic traditions in Buddhism, Taoism, and Catholicism), some people seek freedom through the elimination of wants, either individually or collectively. Their goal is to "live simply so that others may simply live," such as in intentional communities that seek to live in harmony with their natural surroundings. Efforts to reduce people's needs may also focus on larger scales, such as the promotion of "livable cities" that reduce reliance on cars and other energy-demanding technologies.

SEE ALSO: Chipko Andolan Movement; Consumption; Economics; Externalities; First Nations; Indigenous Peoples; Justice; Markets; NIMBY; Poverty; Scarcity; Sustainability; Use Value versus Exchange Value.

BIBLIOGRAPHY. Paul du Gay and Michael Pryke, eds., *Cultural Economy* (SAGE, 2002); Stuart Ewen, *Captains of Consciousness: Advertising, the Social Roots of the Consumer Culture* (McGraw-Hill, 1976); Ramachandra Guha and Juan Martinez-Alier, *Varieties of Environmentalism: Essays North and South* (Earthscan Publications, 1997); Peter Hershock, "Changing the Way Society Changes: Transposing Social Activism into a Dramatic Key," *Journal of Buddhist Ethics* (v.6, 1999); Peter Hershock, *Reinventing the Wheel: A Buddhist Response to the Information Age* (State University of New York Press, 1999); Ivan Illich, *Energy and Equity* (Harper & Row, 1974); Ivan Illich, "Needs," in Wolfgang Sachs, ed., *The Development Dictionary: A Guide to Knowledge as Power* (Zed Books, 1992); Abraham H. Maslow, *Motivation and Personality* (Harper, 1954); Manfred Max-Neef, "Development and Human Needs," in Paul Ekins and Manfred Max-Neef, eds., *Real-Life Economics: Understanding Wealth Creation* (Routledge, 1992).

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Neem

THE NEEM TREE, or *Azadirachta indica*, has been used by people for centuries because of its many beneficial properties. This evergreen, which can reach up to 66 feet (20 meters) in height, originates in the Indian Subcontinent and Myanmar but has spread to Africa and the Caribbean. In addition to providing shade and firewood and halting desertification, neem has been highly valued for its pest-resistant properties. Neem's extremely bitter seeds and leaves can act as natural pesticides that do not kill pests but alter their behavior so that they do not feed on the tree. Even sprinkling neem extracts on certain crops can help these crops develop immunity to certain pests as they incorporate neem extracts into their system. Neem has helped protect farmers from losing crops to pests for centuries in India and is now used in various other parts of the world.

Neem also has benefited human health, especially since the seeds and leaves contain compounds with demonstrated antiseptic, antiviral, and antifungal activity. Neem also possesses anti-inflammatory, hypotensive, and antiulcer properties. It can disable fungi from producing aflatoxin, the most powerful carcinogen known. Its bark, leaves, flowers, seeds, and fruit pulp have been used to treat diseases and ailments such as malaria, leprosy, diabetes, ulcers, skin disorders, and constipation.

Neem has been used for dental hygiene because twigs of neem have antiseptic compounds in the bark that prevent tooth decay and inflammation of the gums. Oil from neem also has various purposes. It can be used for contraception because it is a spermicide. In addition, the oil has been used for heating, lighting, and crude lubricating jobs. Neem has been used in soaps, cosmetics, disinfectants, and other industrial products. The ability to have exclusive rights over neem have, however, been contested for a decade.

In 1994, W.R. Grace, a U.S.-based multinational agribusiness, fought to patent the intellectual property rights over neem oil. It was not until 2005 that they lost this patent with the aid of the Green Party of the European Union (EU) Parliament; Dr. Vandana Shiva of the India-based Research Foundation for Science, Technology and Ecology; and the International Federation of Organic Agriculture Movements. They challenged the European Patent Office by protesting W.R. Grace's claim to novelty over neem oil, which is required in order to patent an item under the Trade Related Intellectual Property Rights agreement. Those challenging the patent point out that neem oil has been part of public traditional knowledge for centuries in India. The success of the patent challenge of W.R. Grace is an example of how biopiracy, in which corporations from the North claim ownership of resources without permission or providing compensation, can be fought.

SEE ALSO: Biopiracy; Desertification; Genetic Patents and Seeds; Organic Agriculture; Pesticides.

BIBLIOGRAPHY. Board on Science and Technology for International Development, National Research Council, *Neem: A Tree for Solving Global Problems* (National Academy Press, 1992), www.nap.edu (cited July 2006); K. Das, "Combating Biopiracy—The Legal Way," *India Together*, www.indiatogether.org (cited July 2006).

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Nepal

THE KINGDOM OF Nepal adopted a cabinet system of government in 1951 after dispensing with a hereditary monarchy. Since 1996, however, Nepal has been threatened with political unrest resulting from a Maoist insurgency and a drug-motivated murder-suicide among members of the royal family in 2001.

At least 13,000 Nepalese have died in continuing political strife. In 2005, the new king dissolved the existing government and declared a state of emergency. The following spring, some 300,000 Nepalese took to the streets to protest the king's usurpation of governmental power, forcing the monarch to agree to reinstate Parliament, offering hope for Nepal's future.

The landlocked country is surrounded by China and India. Southern Nepal is made up of a flat river plain known as *tarai,* which gives way to the Himalayan Mountains in the north and the hills of the central region. Elevations range from 230 feet (70 meters) at Kanchan Kalan to 29,035 feet (8,850 meters) at the top of Mount Everest. Including Everest, Nepal is home to eight of the 10 highest peaks in the world.

Southern Nepal experiences subtropical summers and mild winters, but the mountainous northern areas are prone to severe winters and cool summers. When Nepal's summer monsoon season is intense, severe thunderstorms, flooding, and landslides occur. In 2003, 300 people died from such disasters. Conversely, drought and famine may result from lighter-than-normal rainfall in the summer months.

With a per capita income of only $1,500, Nepal is one of the poorest and least developed countries in the world. The high fertility (4.1 children per woman) and infant mortality (65.32 deaths per 1,000 live births) rates combine with a rising HIV/AIDS (0.5 percent) rate and high incidences of diseases such as malaria and tuberculosis to create low life expectancy (60.18 years) in Nepal.

The low literacy rate (45.2 percent), particularly among females (27.7 percent), makes it difficult to lower the poverty level (31 percent) and educate the people on how to care for themselves and their environment. While 84 percent of Nepal's population have access to safe drinking water, only 27 percent have access to improved sanitation. The United Nations Development Programme Human Development Reports rank Nepal 136th of 232 countries in overall quality-of-life issues.

Over a fifth of Nepal's land area is arable (21.68 percent), and more than three-fourths of the population is engaged in subsistence agriculture. In their struggle to survive, some Nepalese farmers have turned to producing cannabis and hashish for the domestic and international markets. The 6 percent of the population that is involved in the industrial sector are chiefly employed in agricultural-related manufacturing, including the jute, sugarcane, tobacco, and grain industries.

Political unrest presents a major threat to Nepal's essential tourist industry. Natural resources include quartz, water, timber, hydropower, and small deposits of lignite, copper, cobalt, and iron ore. A largely unskilled labor force has led to high unemployment (42 percent) in key areas and technological backwardness.

The practice of using wood for fuel has left Nepal with depleted forests and has contributed to the loss of wildlife among rich ecosystems, which range from tropical jungles to frozen valleys. Nepal is home to some 735 documented species of birds, 25 of which are endangered, and 500 species of butterflies. Of 181 endemic mammal species, 31 are endangered. Approximately 7,000 different species of plants have been identified in Nepal. In 2005, English scientists implemented a project in which samples of each plant species have been transplanted to Britain to ensure survival.

Although the Nepalese government has protected approximately one-fifth of the land area, political considerations continue to threaten the environment. Consequently, nongovernmental organizations (NGOs) play an essential role in conservation efforts. Problematically, the tourism upon which the economy of Nepal so heavily depends further exacerbates ecological problems, since trekking posts make heavy demands on wood fuel to accommodate cooking, baths, and other amenities for foreigners.

Severe water pollution has resulted from improper disposal of human and animal wastes, agricultural runoff, and industrial effluents. Although only 15 percent of Nepalese live in urban areas and carbon dioxide emissions are minimal when compared to industrial nations, urban residents in Nepal are exposed to unhealthy levels of vehicular emissions. In 2006, scientists at Yale University ranked Nepal 81st of 132 countries on environmental performance, above both its geographic and economic counterparts. The lowest scores were received in the categories of air quality and environmental health.

Climate change throughout the world is believed to have contributed to a thawing of snow and glaciers in the Himalayas, with at least 26 glacial lakes at risk. Scientists are especially concerned about the changes taking place at the Tsho Rolpa glacial lake near the capital city of Kathmandu, where the lake has expanded from 0.23 square kilometers to 1.7 square kilometers since 1950.

The Kawari glacial lake at the foothill of Annapurna II Mountain has also caused alarm after bursting in 2003 at a cost of five lives and $100,000 in property damage. Such climatic changes increase the intensity of natural disasters in Nepal. Additionally, the government has noted a haze that appears in the breadbasket of the southern plains during the winter, adversely affecting crops.

In 1956 Nepal began a program of environmentalism by passing the Ancient Monuments Protection Act. A series of acts followed, including the Aquatic Protection Act of 1960, the Plant Protection Act of 1964, the Soil Conservation and Watershed Management Act of 1982, the Wild Life Conservation Act of 1987, and the Environment Protection Act of 1996. Since 1993, the government has operated under the Nepal Environment Policy and Action Plan, with implementation and compliance assigned to the Ministry of Population and Environment. Nepal participates in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, Tropical Timber 83, Tropical Timber 94, and Wetlands. The Nepalese government has signed but not ratified the agreement of Marine Life Conservation.

SEE ALSO: Deforestation; Drugs; Everest, Mount; Global Warming; Himalayas; Life Expectancy; Monsoon; Pollution, Water; Poverty; Subsistence; War on Drugs; Wood.

BIBLIOGRAPHY. Central Intelligence Agency, "Nepal," *The World Factbook,* www.cia.gov (cited April 2006); Sanjaya Dhakal, "Alarming Consequences," Environment Nepal, www.environmentnepal.com.np (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); Ministry of Population and Environment, www.mope.gov.np (cited April 2006); Kate Ravilious, "UK Botanists Follow Victorian Trail to Save Threatened Plants in Nepal," *The Guardian,* November 22, 2005, www.guardian.co.uk (cited April 2006); United Nations Development Programme, "Nepal," hdr.undp.org (cited April 2006); World Bank, "Nepal," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Netherlands

BORDERING ON THE North Sea, the Netherlands has 280 miles (451 kilometers) of coastline. The country is also located at the mouths of the Rhine, Maase, and Scheld Rivers. The temperate and marine climates result in cool summers and mild winters. The Netherlands is chiefly comprised of coastal lowlands and numerous polders—land that has been reclaimed from the sea—with some hilly sections in the southeast.

The process of land reclamation began in the 17th century when windmills were used to drain lakes in the north. In the southwest, land was built up over time as tides deposited sand and silt on the shore, allowing the Dutch to reclaim the land with dikes. Around Groningen and Friesland, the government built dams out into the sea to promote the accumulation of sand and silt. In 1930, the government drained the first polder at Wieringermeer. Today, some 5,000 polders cover the Netherlands, and dikes and pumps maintain the water level at around three feet (0.91 meters) below ground level for purposes of cultivation.

As a result of its unique geography, the Netherlands is extremely vulnerable to flooding. This vulnerability was tragically illustrated in what became known as the "Battle of the Floods," which began on January 31, 1953, when a violent storm on the North Sea ravaged the country. The land where hundreds of people lived below sea level had been protected for centuries by 700 miles (1,127 kilometers) of dunes, dikes, and pumping systems, but none of these could withstand winds of 100 miles (161 kilometers) per hour and waves several feet high. In the middle of the night, as the raging tides reached shore, church bells rang and sirens wailed. Within a few hours, the country had been cut in two.

Some 100,000 people were successfully evacuated from low-lying areas, but 1,800 people died. The port city of Rotterdam was under water, and many small towns and villages became islands. Others were totally washed away. Ultimately 332,500 acres of cultivated land was under water, and tens of thousands of livestock drowned. Some 143,500 houses were flooded, and another 20,000 were damaged. Eighty breaks were identified in the dikes, some over 600 feet (183 meters) wide. Others simply crumbled away. To prevent a repeat occurrence, the government launched the Delta Project, constructing a series of dams, sluices, bridges, and canals and erecting a movable water surge near Rotterdam. Unfortunately, fisheries were negatively affected by these protective measures. With global warming expected to cause sea level rise by as much as a meter over the next century, further sea wall construction is ongoing. This climatological reality has also caused enhanced Dutch participation in climate change control treaties and alternative energy exploration.

Today the Netherlands is ranked as the 21st richest nation in the world, with a per capita income of $30,500. The United Nations Development Programme Human Development Reports rank the Netherlands 12th in overall quality-of-life issues. Chiefly located in the delta of the Rhine, 26.71 percent of the land area is arable, and the Netherlands is a major exporter of agricultural products. Other natural resources include natural gas, petroleum, peat, limestone, salt, and sand and gravel.

Some 16,407,491 Dutch live in an area of only 16,033 square miles (41,526 square kilometers). Nearly 66 percent of those live in urban areas, and there are 384 cars for every 1,000 people. The Netherlands produces 0.6 percent of the world's carbon dioxide emissions. Other environmental problems derive from heavy industrialization, with food processing, chemicals, petroleum refining, and electrical machinery enterprises dominating the industrial sector. Consequently, water sources are polluted with heavy metals, organic compounds, and various nutrients that include nitrates and phosphates. A 2006 study by Yale University ranked the Netherlands 27th of 132 countries in environmental performance, below the comparable income and geographic groups. The lowest ratings were received in the categories of biodiversity and air quality.

Environmentalism was first placed on the Dutch agenda in 1970 in response to public concern. In 1970, the Staten-Generaal passed the Surface Water Act and followed it up two years later with the Air Pollution Act. Both acts were designed to check pollution at the local level and force industries to be environmentally responsible. Despite these efforts, pollution remained widespread throughout the 1980s. Tests revealed that groundwater was polluted with nitrate from agricultural runoff, and soil samples contained high levels of chemicals. The entire ecosystem of the forests was threatened by acid rain.

In 1989 the Dutch conducted the Concern for Tomorrow study and identified problems at all levels, setting goals for combating each problem. Under the leadership of the Ministry of Agriculture, Nature and Food Quality, the government established the National Environmental Policy, the first comprehensive national plan geared toward a sustainable economy. The long-term plan, covering 1990 to 2010, established 10 targets that ranged from agriculture and industry to research institutions and consumers, charging each group with cutting pollution and/or developing new technologies for protecting the environment.

Under the 1990 Nature Policy Plan, the Dutch set up the National Ecological Network to promote biodiversity and protected 14.2 percent of the land area. The protected land includes 19 national parks, including the Hoge Veluwe, the Veluwezoom, and the island of Schiermonnikoog. Of 55 mammal species endemic to the Netherlands, 10 are endangered; however, only four of 192 endemic bird species are threatened.

The Netherlands supports the global environment by participating in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Acid Rain; Disasters; Endangered Species; Fisheries; Floods and Flood Control; Industrialization; Levees; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. *Battle of the Floods* (Netherlands Booksellers, 1953); Central Intelligence Agency, "Netherlands," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe:*

A Continental Overview of Environmental Issues (ABC-CLIO, 2003); George Thomas Kurian, *The Benelux Countries* (Facts on File, 1989); United Nations Development Programme, "Human Development Reports: Netherlands," hdr.undp.org (cited April 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); David Wallace, *Environmental Policy and Industrial Innovation: Strategies in Europe, the United States, and Japan* (Earthscan, 1995); World Bank, "Netherlands," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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New Caledonia

THE SEMITROPICAL ARCHIPELAGO of New Caledonia lies 930 miles (1,500 kilometers) east of Australia and 11,160 miles (18,000 kilometers) from Metropolitan France, of which it is an overseas possession. Just off the northeast coast of the main island, Grande Terre, lie the Loyalty Islands, raised coral atolls. Grande Terre is 248 miles (400 kilometers) long by 31 miles (50 kilometers) wide and is a piece of Gondwanaland that broke away from Australia 60–80 million years ago. This island contains great mineral wealth, including about 25 percent of the world's nickel reserves, and is the third-largest producer of nickel, which represents over 90 percent of its export revenues.

The rare plants that have managed to adapt to the soil's high mineral content are unique to New Caledonia. The archipelago therefore exhibits extremely high levels of floral and faunal (terrestrial and marine) endemism. There are 3,200 plant species, of which 79 percent are found only there, while the islands and surrounding lagoon are home to many species of bats, birds, and lizards, as well as the dugong and five species of sea turtle. New Caledonia is considered a conservation priority by the World Wildlife Fund (WWF), Conservation International, and the World Conservation Union (IUCN), for both its coral reef (the world's second largest) and its unique dry forests. Few fragments of the original habitat remain, however, due to uncontrolled fires; nonnative cattle, pigs, and deer; urban and industrial activities; and, of course, mining, which began in 1874 and intensified greatly in the 1950s. The environmental impacts of strip-mining, which include soil erosion, sedimentation of rivers and beaches, and coral reef damage, were virtually unregulated until the 1970s. Although mineral extraction is less damaging today, abandoned mines continue to undergo serious erosion and leaching into watercourses. Meanwhile, the archipelago's sole nickel refinery is its main source of atmospheric pollution, and two more are planned.

Melanesians reached New Caledonia around 3,000 years ago (as marked by the Lapita pottery site), and a complex system of exchange relations and chieftaincies emerged, supported by traditional yam farming and fishing. Captain James Cook and his crew landed on Grande Terre in 1774 and named the archipelago. However, France took possession in 1853, and over the next century the original inhabitants, the Kanak, saw their most fertile lands seized while they themselves were forced onto reserves, to the detriment of their culture and languages.

Today, Melanesians make up the main ethnic group, at 45 percent of the total population, estimated at only 231,000 in 2004. Another 34 percent of New Caledonia's inhabitants are people of European origin, many being the descendants of former French prisoners banished to Grande Terre in the late 19th century. Other minority ethnic groups originate from the Pacific and Asia. Due almost entirely to financial transfers from Metropolitan France, New Caledonia's high Gross Domestic Product (GDP) places it among the 20 wealthiest nations in the world. However, this wealth has traditionally been concentrated in the capital, Nouméa (home to over 60 percent of the population) and is skewed toward those of European descent. French is the lingua franca, although over 20 Kanak languages are still recognized.

Grievances over colonial dispossession of Kanak land rights and their economic disadvantage have persisted. Most recently an organized Kanak pro-independence movement emerged in the 1970s, and the 1980s saw violent uprisings against settlers and France. The Kanak leader, Jean-Marie Tjibaou, signed the Matignon Accords with the loyalist leader, Jacques Lafleur, in 1988, assenting to restitution of customary lands, promotion of Kanak culture, preparation for a future New Caledonian élite, rural development activities, and a referendum on independence after 10 years. Tjibaou was assassinated by a Kanak separatist in 1989, and the 1998 referendum did not sanction full independence. Instead, the Nouméa Accords gave further recognition of Kanak land rights and economic integration. It also provided for gradual devolution of some administrative powers to the territory, which—although remaining a part of France—became an "Overseas Country" (*Pays d'outre-mer*) in 1999. Kanak now have political majorities in two of the three provinces, and another referendum on independence is scheduled to occur between 2013 and 2018.

SEE ALSO: Biodiversity; Colonialism; Coral Reefs; Indigenous Peoples; Mining; Soil Erosion.

BIBLIOGRAPHY. L.S. Horowitz, "Toward a Viable Independence? The Koniambo Project and the Political Economy of Mining in New Caledonia," *Contemporary Pacific* (v.16/2, 2004): C. Jost, ed., *The French-Speaking Pacific: Population, Environment and Development Issues* (Boombana Publications, 1998); P. Labrosse et al., "New Caledonia," in C. Sheppard, ed., *Seas at the Millennium: An Environmental Evaluation* (Elsevier Science, 2000); R.A. Mittermeier et al., "New Caledonia—A Conservation Imperative for an Ancient Land," *Oryx* (v.30/2, 1996); T. O'Neill and P. Essick, "New Caledonia," *National Geographic* (v.197/5, 2000).

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New Urbanism

NEW URBANISM, A movement in architecture and planning, grew out of a belief that postwar suburban sprawl in the United States would not be able to sustain growth without adversely affecting the environment. It was a response to urban development accompanied by environmental degradation, a declining public realm, and the rise of edge cities. The principles of new urbanism were delineated by a group of architects, planners, developers, scholars, and elected officials between 1993 and 1996 and defined by the Congress of New Urbanism (CNU) Charter, which summarizes each of the 27 new urbanist design principles. These design principles are organized into three main categories that guide development at various scales: The region (metropolis, city, and town); neighborhood, district, and corridor; and block, street, and building.

The key idea behind new urbanist design principles is to promote organized development in the form of neighborhoods that are diverse, compact, mixed use, pedestrian-friendly, and transit-oriented. The neighborhood is a crucial building block within which there are different housing types, shops, services, and civic spaces and amenities. Buildings are low- to mid-rise and high densities create a compact urban form suited to pedestrians. This helps to reduce auto dependence and promote the use of alternative forms of transportation. Civic institutions and parks occupy prominent sites. In dense urban areas, the neighborhood center is usually the commercial corridor and residential areas are arranged in semicircular patterns radiating from the center. Such patterns are often modeled on traditional U.S. villages, towns, and cities, some of which were built before World War II, including historic sections of Annapolis, Maryland, and Savannah, Georgia. The principles also emphasize that it is essential for new developments to take into consideration the local history, culture, geography, and climate of a place so as to create a distinct architectural style that is unique to the place.

Many cities and counties in the United States are beginning to incorporate new urbanist design principles not only in new suburban developments but also in urban infill developments and urban transit-oriented developments. New urbanist design principles also resonate with environmental protection, sustainable development, historic preservation, smart growth, and pedestrian and bicycle planning programs. In the field of housing, new urbanism got a major boost when Henry Cisneros, former Secretary of the U.S. Department of Housing and Urban Development (HUD), signed the CNU Charter in

May 1996. Cisneros also initiated the Homeownership Zone program, which offered grants and loans to cities for redevelopment based on new urbanism. Principles of new urbanism have also been adopted in Hope VI, a HUD program that uses public and private development resources to replace distressed public housing with new mixed-income housing.

New urbanism may help minimize land consumption through increased density. Moreover, the emphasis on environmentally sensitive building techniques and on transit-oriented development may conserve energy. New urbanists point out that the combined effect of the two most important characteristics of new urbanist projects—pedestrian-oriented design and infill development—could have an ecological footprint that is almost 20–30 percent less than that of conventional suburban developments. Although such claims have yet to be proven by empirical research, studies have found new urbanist projects to protect and restore ecologically sensitive areas and reduce impervious surfaces, which have helped improve watershed protection.

Although the principles of new urbanism recognize that physical planning means going beyond just interesting architecture and good site planning, one of its major criticisms is that it tends to rely on the long-discredited concept of "physical determinism" and discounts the importance of developing social relationships for creating a sense of community. Other criticisms relate to social equity and gentrification of inner-city neighborhoods, which displaces low-income and minority households. For instance, critics note that celebrated new urbanist projects such as Seaside, Florida, have become gentrified, high-priced resorts for the rich. New urbanist projects also face opposition in the form of NIMBYism as high-density and mixed-use developments are contested by neighboring communities.

SEE ALSO: Ecological Footprint; Heat Island Effect; NIMBY; Suburbs; Sustainability; Sustainable Cities; Sustainable Development; Transportation; Urban Sprawl; Urbanization; Watershed Management.

BIBLIOGRAPHY. Peter Calthorpe, *The Next American Metropolis: Ecology, Community, and the American Dream* (Princeton Architectural Press, 1993); Congress for the New Urbanism, *Charter of the New Urbanism* (McGraw-Hill, 2000); Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* (North Point Press, 2000); Ajay Garde, "New Urbanism as Sustainable Growth? A Supply Side Story and Its Implications for Public Policy," *Journal of Planning Education and Research* (v.24, 2004); Peter Katz, *The New Urbanism: Toward an Architecture of Community* (McGraw-Hill, 1994).

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New Zealand

NEW ZEALAND COMPRISES two main and several smaller islands totalling 267,707 square kilometers. There are over 200 peaks in excess of 2,300 meters. Situated on the boundary of the Indo-Australian and Pacific plates, the land is tectonically active. It has been shaped by volcanism, glaciation, and subsequent erosion. Located in a zone of prevailing westerly winds, the climate is temperate. Prior to settlement the land was largely forested, and as a result of its long biogeographical isolation, New Zealand had many endemic species, including numbers of flightless birds. Apart from bats, it had no land mammals and few predators.

As one of the last islands to be occupied by humans, the rate of environmental change, particularly over the last 200 years, has been dramatic. Estimates of first settlement range from 600 to 1,500 years ago, though 1,000 years ago is widely accepted. Volcanic eruptions and related forest fires modified the vegetation, a process accelerated by the Maori people's burning and clearing. Even so, the Maori land ethic of *kaitiakitanga* approximated that of stewardship. Over half the country remained forested at the time of European colonization in 1840. Some 34 bird species including the Moa (Dinornithiformes order) had become extinct by 1840 from hunting. Another nine became extinct after 1840 under pressure from predators and habitat loss; forest cover was reduced to 25 percent of land area by 1900.

Navigator James Cook mapped the islands in 1769 when the Maori population totalled about

86,000. He noted forests of trees suitable for ships' masts. A sealing, whaling, and flax and timber gathering bonanza followed in the 1790s through 1810s. Britain incorporated New Zealand into its empire by way of treaty in 1840. British settlers privileged permanent occupation and cultivation of land and regarded apparently unoccupied spaces as lands going to waste. By 1858 the 59,000 settlers had exceeded the dwindling Maori population.

An export economy developed around extensive pastoralism based on wool production for British markets. On leasehold tussock grasslands in the South Island, regular burning was an environmentally-damaging management tool. Gold rushes in the 1860s provided addition revenues, but by 1890 the settlement focus shifted to the more heavily forested North Island. Government-purchased Maori land was rapidly transformed into small farms for dairying and livestock. Refrigeration technology became vital to the process of agricultural intensification and converted New Zealand into one of Britain's imperial farms. Subsequently, huge amounts of phosphates were imported from Nauru and along with the perennial rye grass and clover pastures enabled further gains in agricultural productivity in the 1920s and 1930s.

From 1840 to the present, 80 animal species and 1,800 plant species have been introduced to New Zealand. Some were for economic purposes, others became weeds, and rabbits introduced for sport quickly became noxious pests. A peak of forest destruction in the 1890s helped trigger the setting aside of national parks and reserves that totalled 8 million hectares, or just under 30 percent of the land area, by 2004. By 1911, 50 percent of the population was urban, although the Maori population remained predominantly rural until 1966. From one million in 1908, the population doubled by 1952, reached three million by 1973, and rose to over four million by 2006. The Auckland urban area constituted 29 percent of the total population by 2001, contributing to its transport infrastructure problems.

The government led the way in forestry and soil and water conservation from the 1920s to 1940s. By the 1980s neo-liberal reforms witnessed the privatization of forest plantations and left soil conservation to regional governments. The Resource Management Act of 1991, regulating on the basis of sustainable management and adverse environmental outcomes, replaced over 50 acts. At the same time, international tourism, promoted by slogans such as "100 percent pure," now contributes significantly to the economy. Agricultural exports remain important to the economy. New Zealand today is highly urbanized, with rural landscapes that have scenic qualities but are still the result of over 100 years of rapid and extensive environmental transformation.

The Lord of the Rings

In 1997, film director Peter Jackson acquired the rights to produce a film version of J.R.R. Tolkien's great work, *The Lord of the Rings*, which had originally been published in three volumes (1954–55). The bestselling books drew much from Tolkein's interest in Saxon England—he was a professor of Anglo-Saxon (Old English) at Oxford University.

Although present in the books, the environmental message of the story is much more obvious in the film version. The films were made in New Zealand in largely pristine wilderness. The Hobbit characters, who live in the green Shire, are pleasant, cheerful, and naïve, though some of their supporters are more worldly-wise. The enemies of the Hobbits, especially the Orcs, are warlike environmental vandals. In *The Two Towers* (2002), the second film of the trilogy, the Orcs saw down trees to build machines of war; their industry despoils the countryside, leaving a trail of environmental devastation in their wake. The Hobbits form an alliance with the Ents, who are tree spirits, a concept common in some Anglo-Saxon legends. The Ents attack the Orcs, whom they blame for the wanton destruction of the forests. The environmentally conscious are depicted as forces of good, while despoilers of the environment represent forces of evil. It is a statement made far more overtly in the films of the early 2000s than in the books of the 1950s.

SEE ALSO: Agriculture; Colonialism; Deforestation; Indigenous Peoples; Livestock; Nauru; Tourism.

BIBLIOGRAPHY: M. McKinnon, ed., *Bateman New Zealand Historical Atlas/*Ko Papatuanuku e Takoto Nei (Bateman, 1999); R. Newnham et al., "The Kaharoa Tephra as a Critical Datum for Earliest Impact in Northern New Zealand," *Journal of Archaeological Science* (v.25, 1998); E. Pawson and T. Brooking, eds., *Environmental Histories of New Zealand* (Oxford University Press, 2002); Statistics New Zealand, *New Zealand Official Year Book* (Bateman, 2004); R. Taylor and I. Smith, eds., *The State of New Zealand's Environment 1997*, (Ministry for the Environment, Wellington, 1997).

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Nicaragua

ROUGHLY THE SIZE of New York state and with 5.6 million people, Nicaragua is the largest country in Central America and its least densely settled. Paradoxically, it is also one of the poorest countries in the Western Hemisphere. Fifty percent of its population lives below the poverty line, and a third is younger than 15 years old. Nicaragua can be divided into three environmental regions: the tropical, dry Pacific coastal plain, the Central Highlands, and the Caribbean Coastal Plain. These regions share common social and environmental concerns but also have specific problems of their own.

Deforestation is an issue throughout the country. An expanding agricultural frontier east of the more densely settled Pacific region responds to ebbs and flows in markets and governmental priorities. In the 1960s relocation projects sought to "bring light to the jungle" by moving peasants into the rain forest. Ongoing road building and illegal timber extraction continue to bring colonists and speculators to the indigenous lands of the Caribbean Coastal Plain. Another important cause of deforestation is fuelwood gathering. At least 90 percent of Nicaragua's rural population and 60 percent of its urban population relies on wood or charcoal for cooking and heating. This unsustainable activity has no quick remedy in a country with no natural gas production.

Ninety percent of Nicaragua's watersheds drain to the Caribbean through 11 major rivers. Their silt loads maintain the Nicaragua shelf, one of the most productive marine environments in the hemisphere. Traditionally providing an abundant livelihood for indigenous peoples, Nicaragua's Caribbean fisheries have become big business. Poorly regulated exports of lobster averaged $25 million a year through the 1990s. Fishing canneries provide jobs but are not sustainable. Offshore coral reefs are noticeably declining.

Perhaps the biggest marine problem is the rapid decline of coastal mangrove forests, particularly along the Pacific coast. Here, shrimp farmers are clearing mangroves to make new ponds. In 2001, Nicaragua was the world's 17th largest producer of farmed shrimp. Mangroves in the Gulf of Fonseca and elsewhere have also been cleared for firewood.

Water pollution linked to agriculture and ranching, untreated sewage, and soil erosion plague the 10 percent of Nicaragua's fresh water that drains toward the Pacific, where two-thirds of the population lives. The most egregious water contaminants of lime, cyanide, and mercury associated with gold mining in Caribbean watersheds have been addressed, but problems of regulation and enforcement remain.

National parks and forest reserves abound in the Caribbean coast—on paper. The Bosawas Reserve in the northeast, home to Mayangna and Miskito Indians, is one of the largest contiguous areas of tropical rain forest north of the Amazon basin. Like its southern partner, the Sí-a-Paz (yes to peace) Biosphere Reserve, it is part of an innovative binational effort to protect shared borderlands. Both reserves are also central to the Mesoamerican Biological Corridor, a linked series of protected areas designed to spur isthmus coordination and reduce ecosystem fragmentation. Nicaragua is the linchpin in the corridor.

Environmental awareness is growing in Nicaragua, but meanwhile, poverty demands solutions. One project designed to deal with poverty is the so-called dry canal, a high speed rail and port system that would offer cargo ships willing to unload and reload an alternative to the Panama Canal. The

The "Volcano" Stamp

The idea of a canal through Central America goes back to 1534. Charles V, the Holy Roman Emperor and King of Spain, felt that a canal would open up new lands and provide a faster route between Spain and Lima, Peru, the Spanish capital in Latin America. However, the nature of the task meant that it was not until the 19th century that the idea could be seriously entertained. Various surveyors plotted out possible routes for a canal. The two that seemed easiest were either through the narrowest part of Central America in what is now Panama, or through Nicaragua, making use of Lake Nicaragua and the San Juan River. It was partially in support of the latter scheme that William Walker tried to seize parts of Central America in the 1850s.

In the 1880s the French tried to build a canal in Panama, then a part of Colombia, but failed to see it through. As a result, in 1887 a U.S. surveying team went to Nicaragua to see whether a route through that country was more feasible. Two years later the U.S.-based Maritime Canal Company decided the Nicaraguan option was preferable. However, when the company's share price collapsed in 1893, work ceased. Still, Congress chose the Nicaraguan route in 1897, and again in 1899.

On January 1, 1900, Nicaragua brought out a series of postage stamps, printed by the American Bank Note Company of New York, that depicted Mount Momotombo, a volcano in Nicaragua close to the city of Léon. It had erupted several times in the past; in 1610 it buried a nearby Spanish settlement. When Congress had to vote on the route of the canal again in 1902, supporters of the Panamanian route circulated the Nicaraguan postage stamps to all members of Congress to warn them of the danger of a volcanic eruption so soon after the eruption at Martinique in the Caribbean, in which 30,000 people died. Congress changed its mind and voted for the Panamanian route. Work began in 1904 and the Panama Canal was completed in 1914.

proposed route cuts through the Sí-a-Paz Reserve and Rama Indian lands on the Caribbean coast—it is a desperate gambit intended to clear some forest to save the rest.

SEE ALSO: Deforestation; Fisheries; Nietschmann, Bernard Quinn; Pollution, Water.

BIBLIOGRAPHY. Anne M. Larson, "Natural Resources and Decentralization in Nicaragua: Are Local Governments Up to the Job?," *World Development* (v.30, 2002); Jerry Mueller, *A Canary for the World: A Nicaraguan Environmental Primer* (Nicaragua Network, 2000); Thomas W. Walker, *Nicaragua*, 4th ed. (Westview Press, 2003).

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Nietschmann, Bernard Quinn (1941–2000)

BERNARD Q. NIETSCHMANN was a pioneering environmental scholar and indigenous rights activist. Throughout a professional career that spanned three decades, Nietschmann demonstrated that cultural and biological diversity are inextricably linked, but that the future of both was under threat from global markets and state-centered geopolitics.

Born in Peoria, Illinois, in 1941, Nietschmann received a doctorate in geography under the guidance of William Denevan at the University of Wisconsin at Madison in 1970. After teaching at the University of Michigan for seven years, Nietschmann moved to the University of California at Berkeley in 1977 and remained there until his death from esophageal cancer in 2000.

The publication of Nietschmann's 1973 book *Between Land and Water: The Subsistence Ecology of the Miskito Indians, Eastern Nicaragua,* and his follow-up marine work among both the Miskito and indigenous peoples in Torres Strait, Australia, brought him to the attention of society-environment scholars around the world. Based initially on his doctoral field study in the late 1960s, Nietschmann's seminal work examined how the Miskito adapted seasonally and spatially to resource availability. His scholarship was ground-breaking and contributed greatly to the vibrant field of cultural ecology.

Nietschmann's study of the Miskito and their coastal-marine habitats made at least five important contributions to our knowledge of society-environment dynamics. First, while some societies might be remote, neither they nor their ecosystems have been isolated from world market forces for at least several centuries. Second, subsistence groups respond to social and environmental change by making cultural adaptations to remain viable; indeed, many social practices result from successful cultural adaptation. Third, subsistence ecologies exploit a diverse resource base that makes them efficient, flexible, risk averse, and sustainable. Fourth, for the Miskito—and by extension all subsistence peoples—social relationships and economic exchange are inseparable. And fifth, it follows that accelerated market integration disrupts adaptive dynamics and social obligations, and can lead people into an economic and ecologic cul-de-sac that they are powerless to influence directly. As Nietschmann described it, many subsistence societies have had to "change to remain unchanged," to alter some lifeways in order to retain others.

"MAP OR BE MAPPED"

Beginning in the 1980s, Nietschmann's work tended toward human rights, geopolitics, and participatory mapping among indigenous, or what he called Fourth World, peoples. During the civil conflict in Nicaragua in the 1980s, for example, he wrote passionately about how Miskito ideas of their past underscored their armed resistance to the Sandinistas. His work advocated indigenous autonomy in Nicaragua's Caribbean half, and while rarely popular, this position proved to be the solution to the conflict in 1987. After the war, he promoted what he called "conservation through self-determination." To these ends, he helped Miskito turtlers map their marine territories and establish baseline environmental data on their fisheries. An outspoken environmentalist, Nietschmann became vocally opposed to top-down and outsider-led conservation initiatives that disregarded local indigenous knowledge and resource management practices.

In the 1990s, Nietschmann helped form GeoMap, a small group of Berkeley cartographers, to assist Mayan communities of Southern Belize to produce a first-ever indigenous atlas. In writing about this mapping experience, Nietschmann argued that indigenous peoples must "map or be mapped." Through his fieldwork and writing, Nietschmann sought to empower indigenous people by helping them to defend their ancestral homes and sustain their ecosystems and livelihoods.

SEE ALSO: Cultural Ecology; Geography; Indigenous Peoples; Livelihood; Maps; Nicaragua.

BIBLIOGRAPHY. Bernard Q. Nietschmann, *Between Land and Water: The Subsistence Ecology of the Miskito Indians, Eastern Nicaragua* (Seminar Press, 1973); Bernard Q. Nietschmann, "Hunting and Ecology of Dugongs and Green Turtles, Torres Strait, Australia," *National Geographic Society Research Reports* (v.17, 1976); Bernard Q. Nietschmann, *Caribbean Edge: The Coming of Modern Times to Isolated People and Wildlife* (Bobbs-Merrill, 1979); Bernard Q. Nietschmann, *The Unknown War: The Miskito Nation, Nicaragua, and the United States* (Freedom House, 1989); Bernard Q. Nietschmann, "Protecting Indigenous Coral Reefs and Sea Territories, Miskito Coast, RAAN, Nicaragua," in Stan Stevens, ed., *Conservation Through Cultural Survival. Indigenous Peoples and Protected Areas* (Island Press, 1997); Toledo Maya Cultural Council, ed., *Maya Atlas: The Struggle to Preserve Maya Land in Southern Belize* (North Atlantic Books, 1997).

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Niger

AFTER ATTAINING INDEPENDENCE from France in 1960, the Republic of Niger was subjected to three decades of single-party military rule until Nigeriens propelled their country toward democracy and multiparty elections in 1993. However, a military coup in 1996 plunged Niger into political turmoil until democracy was restored three years later. With a per capita income of only $800, Niger is the 12th poorest country in the world. Ninety percent of the population is engaged in the agricultural sector, which is concentrated in the savanna of the south.

The uranium deposits of Niger are among the largest in the world. Other natural resources include coal, iron ore, tin, phosphates, gold, molybdenum, gypsum, salt, and petroleum. Frequent droughts and fluctuating uranium prices have slowed the economy, and in 2000 Niger qualified for the Highly Indebted Poor Countries initiative and was approved for participation in the Fund on Poverty Reduction and Growth Facility. Over 60 percent of the population lives in poverty, partly in response to food shortages that resulted from drought and locust infestation in 2005. Consequently, 34 percent of Nigeriens are severely undernourished. The United Nations Development Programme's Human Development Reports rank Niger 177th in the world in overall quality of life issues.

Landlocked Niger has only 300 square kilometers of inland water resources. Borders are shared with Algeria, Benin, Burkina Faso, Chad, Libya, Mali, and Nigeria. In northern Niger, four-fifths of the land is desert plains with sand dunes and hills. The southern area is savanna, with flat to rolling plains. Elevations range from 200 meters at the Niger River to 2,022 meters at Mont Bagzane. Niger's dry, dusty desert climate is one of the hottest in the world. In the extreme south, the climate is tropical. As part of the Sahel region of Africa, Niger is prone to prolonged droughts.

In large part because of poverty, Nigeriens are susceptible to a number of factors that affect environmental health. Approximately 46 percent of the population has sustained access to safe drinking water, but only 12 percent has access to improved sanitation. The population of 12,525,094 faces a very high risk of food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, typhoid fever, and the respiratory disease meningococcal meningitis. In some areas, there is a high risk of contracting malaria. There is also concern about the 1.2 percent HIV/AIDS adult prevalence rate that has killed at least 4,000 Nigeriens. Around 70,000 others are living with this disease.

As a result of health factors, Nigeriens have a life expectancy of only 43.76 years. Infant mortality is a major indicator of environmental health, and Nigeriens have an extremely high rate, with 118.25 deaths occurring among every 1,000 live births. Likewise, fertility rates are indicative of the standard of living, and Nigerien women give birth to an average of 7.46 children each. Niger has one of the lowest literacy rates in the world (17.6 percent). Less than 10 percent of adult women and only one-fourth of adult men are literate. Less than one-fifth of children attend school regularly. Consequently, disseminating health and environment information is difficult.

Large areas of vegetation have been destroyed by fires to clear land for agricultural purposes, and mismanagement has led to overgrazing and soil erosion. Deforestation is occurring at a rate of 3.7 percent each year, and the desert is encroaching on other lands. The rich biodiversity of Niger that includes elephant, hippopotamus, giraffe, and lion populations has been threatened by poaching and the destruction of habitats. Only 1 percent of Niger's land area is forested.

The government has protected 7.7 percent of the land area. Of 131 identified mammal species, 11 are endangered, as are three of 125 bird species. A study by scientists at Yale University in 2006 ranked Niger near the bottom of all countries ranked on environmental performance, with a score that was roughly half that of comparable income and geographic groups. Low scores were received in the areas of air quality and biodiversity and habitat, and Niger received only a single point in the category of environmental health.

In large part because of its status as a poor nation and its weak infrastructure, the government of Niger has made slow progress toward promoting sustainable development. In 1998 Niger adopted the National Environmental Plan for Sustainable Development and began working with the World Bank to rehabilitate its infrastructure and establish a framework for environmental policy. The Ministry of Hydraulics is involved with the battle to check desertification, and the Ministry of Health is responsible for dealing with environmental health issues. Niger has partnered with Benin and Burkina Faso to establish the "W" National Park that encompasses 826,254 acres of Nigerien land. Several game reserves have also been established.

Niger participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Ozone Layer Protection, and Wetlands. The Law of the Sea agreement has been signed but not ratified.

SEE ALSO: Biodiversity; Deforestation; Desertification; Infant Mortality Rate; Malnutrition; Poverty; Wildlife.

BIBLIOGRAPHY. Central Intelligence Agency, “Niger,” www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, “Human Development Report: Niger,” hdr.undp.org (cited April 2006); World Bank, “Niger” lnweb18.worldbank.org (cited April 2006); Yale University, “Pilot 2006 Environmental Performance Index,” www.yale.edu/epi (cited April 2006).

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Nigeria

DESPITE HAVING ONE of the world's largest petroleum reserves and a wealth of natural resources—or perhaps because of it—the Federal Republic of Nigeria is plagued by dire poverty, poor governance, and environmental crises. Although the country adopted a new constitution in 1999 as part of a peaceful transition to civil government after almost 16 years of military government, the flow of resources out of the country continues unabated, while corruption and mismanagement plague the state. Attempts to rebuild damaged infrastructures and provide political stability have been threatened by ongoing tensions, as portions of the largely disenfranchised population turn to radicalized religious and political action. This volatile situation was much in evidence in 2006 when repercussions from a Danish caricature of the Prophet Muhammad led to the deaths of 100 Nigerians as Christians and Muslims attacked one another. Militants in the Niger River delta, protesting the massive poverty amidst resource wealth, have attacked pipelines and kidnapped workers.

Nigeria's natural resources include natural gas, petroleum, tin, iron ore, coal, limestone, niobium, lead, and zinc. Industry remains focused on oil, which accounts for 20 percent of the Gross Domestic Product, 95 percent of foreign exchange earnings, and around 65 percent of government revenues. Nigeria's other valuable resource is arable land (33.02 percent); and 70 percent of the workforce is engaged in mostly subsistence agriculture, which provides only 26.7 percent of the Gross Domestic Project. Nigeria's population has outstripped agricultural production, however, and much of the food supply is imported.

Major economic reforms were instituted in 2003 that nationalized four oil refineries and implemented International Monetary Fund reconstruction and growth measures. In 2005, initial debt relief from the Paris Club paved the way for billions more. At present, however, Nigeria remains a poor country with a per capita income of only $1,000, which places the country 211th of 232 countries in world incomes. Sixty percent of Nigerians live in poverty. Nigeria is ranked 50.6 on the Gini Index of Inequality, with the richest 10 percent holding 40.8 percent of wealth, and the bottom 10 percent sharing 1.6 percent of resources. The United Nations Development Programme's Human Development Reports rank Nigeria 158th in the world in overall quality of life issues. This is despite the fact that oil exports have earned revenues in excess of $340 billion over the last four decades; roughly nine percent of U.S. oil imports originate in Nigeria.

Bordering the Gulf of Guinea and the Bight of Benin in the Atlantic Ocean, Nigeria has a coastline of 853 kilometers and 13,000 square kilometers of inland water resources. A good deal of this water comes from the Niger River, which flows southward through tropical rain forests and swamps on its way to the Gulf of Guinea. Nigeria shares land borders with Benin, Cameroon, Chad, and Niger.

The southern lowlands give way to hills and plateaus in central Nigeria and to mountains in the southeast and plains in the north. Elevations range from sea level to 2,419 meters at Chappal Waddi. The climate of Nigeria is varied. Southern Nigeria is equatorial, and the north is arid, while central Nigeria is tropical. Nigeria is prone to periodic droughts and flooding.

Nigeria's population of 131,859,731 is experiencing a major HIV/AIDS epidemic. With a 5.4 percent adult prevalence rate, 3.6 million Nigerians are living with HIV/AIDS, which has killed 310,000 people since 2003. Forty percent of Nigerians do not have sustained access to safe drinking water, and 62 percent do not have access to improved sanitation. Consequently, Nigerians have a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, typhoid fever, the vectorborne disease malaria, and the respiratory disease meningococcal meningitis.

Nigeria is also a highly endemic area for Lassa fever, which is contracted from contact with contaminated aerosolized dust or soil. Through the efforts of the Carter Center of Emory University, founded by former President Jimmy Carter, Nigeria is almost free of Guinea worm disease. In the 1980s, Nigeria was reporting 650,000 cases. By 2005, only 121 new cases were identified. In 2006, the Carter Center finally traced those cases to the Sacred Pond of Ogi in Nigeria, paving the way for eradication of the disease worldwide. High disease rates in Nigeria have led to low life expectancy (47.08 years) and growth (2.38 percent), and high infant mortality (97.14 deaths per 1,000 live births) and death (16.94 deaths per 1,000 population) rates. Nigerian women bear an average of 5.8 children each. A female literacy rate of 60.6 for females makes disseminating birth control and disease prevention information somewhat difficult.

ENVIRONMENTAL ISSUES

Nigeria is the most populous country in Africa and the tenth most populous country in the world. Rapid urbanization has led to a severely overburdened environment, particularly in the area of waste management. Soil degradation has occurred as a result of ill-advised agricultural practices that are compounded by natural disasters such as flooding. Deforestation is occurring at a rate of 2.6 percent per year due to logging and slash-and-burn agriculture. Desertification is extensive. Nigeria is experiencing air, water, and soil pollution that is derived in large part from the polluting practices of the oil and mining industries and from the overuse and misuse of pesticides. Biodiversity is at risk because of habitat loss and the practice of poor Nigerians eating bush meat to supplement diets poor in protein.

Oil spills have created major environmental damage, and gas flaring in Nigeria is affecting climate change throughout sub-Saharan Africa. Toxic chemicals released in the flaring process have created major health hazards, such as cancer. The Nigerian Senate ordered Shell Oil to compensate local residents who had been affected by the pollution, but Shell challenged their authority to do so. In 2005, the Federal High Court of Nigeria entered the fray, declaring that Shell had violated the constitutional rights of Nigerians and ordered the oil giant to cease all gas flaring in Nigeria.

In 2006, scientists at Yale University ranked Nigeria 123rd of 132 countries on environmental performance, below the relevant income and geographic groups. The lowest scores were received in the categories of environmental health and biodiversity and habitat. Around 15 percent of Nigeria's land remains forested, but the government has protected only 3.3 percent of land. One of these areas is the Afi Mountain Wildlife Sanctuary set up to protect the Cross River Gorilla and other primate species.

In 1978, the Nigerian legislature passed the Land Use Act. A decade later, the government created the Federal Environment Protection Agency and the Natural Resources Conservation Council and charged them with implementing and monitoring environmental laws geared toward sustainable development. The following year, the Council Act initiated legal conservation measures and overturned traditional ownership practices, placing ecologically important land under the guardianship of federal and state governments. In 1992, the legislature enacted the Environmental Impact Assessment Act and instituted the Acacia Tree Plan Experiment to check the spread of deforestation. In 1999, the Nigerian government revised existing environmental laws and broadened their application.

Nigeria participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Marine Life Conservation, Ozone Layer Protection, and Wetlands.

SEE ALSO: Desertification; Fossil Fuels; Life Expectancy; Movements, Environmental; Oil Spills; Urbanization.

BIBLIOGRAPHY. Central Intelligence Agency, "Nigeria," *World Factbook* www.cia.gov (cited March 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Toyin Falola and Ann Genove, *The Politics of the Oil Industry* (Praeger, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); Valentine Udoh James, *Environmental and Economic Dilemmas of Developing Countries: Africa in the Twenty-First Century* (Praeger, 1994); Donald G. McNeil, Jr., "Dose of Tenacity Wears Down a Horrific Disease," *New York Times Online* (cited March 2006); One World, "Nigeria: Environment," uk.oneworld.net (cited March 2006); United Nations Development Programme, "Human Development Report: Nigeria," hdr.undp.org (cited March 2006); World Bank, "Nigeria," lnweb18.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited March 2006).

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Nile River (and White Nile)

THE NILE RIVER is the longest river in the world and flows northward from its sources in eastern Africa toward the Mediterranean Sea. It spans 4,000 miles (6,700 kilometers), beginning at Lake Victoria, which is perched in the highlands of east Africa on the equator and is just one of the three sources of the Nile. The branch of the river that starts from Lake Victoria is known as the White Nile. This branch provides the greatest volume of water to the Nile River as it flows year round. However, not much of the Nile's waters reach Egypt due to evaporation across the desert.

As the Nile passes through the Sudan, the gradient, or slope, becomes so gradual that the water spreads out to form swamps called *sudd*. Millions of years ago, long before the Nile found its way out to the Mediterranean Sea, it is believed that there was an inland lake in the Sudan into which the White and Blue Nile used to flow. However, once this lake filled up, the Nile found itself flowing north on its present course to the Mediterranean Sea.

For Egypt, the most important tributary is the Blue Nile, whose source is Ethiopia's Lake Tana. This tributary, swollen by monsoon rains in the highlands of Ethiopia, has for centuries been the main source of floods to the surrounding valley of the Nile every year between June and September. These floods were heralded by the people along the Nile in Egypt as they brought in rich silt and water for irrigation. It is due to these floods and rich soils that the ancient Egyptian civilization achieved its grandeur. A lesser tributary of the Nile is the Atbara River, which flows from a source in the Ethiopian highlands; it joins the Nile in the vicinity of Khartoum, like the Blue Nile. The Atbara flows only when there is rain in Ethiopia and dries very fast.

The word *nile* comes from the Greek word *neilos*, which means "river valley." The ancient Egyptians called the Nile *iteru*, meaning "big river." Indeed, its large size is signified by the expanse of its drainage basin, which covers an area of 1.26 million square miles (3.25 million square kilometers), about 10 percent of the area of Africa. On its flow from Khartoum northwards, the river experiences a series of rapids, or cataracts, as it meets hard igneous rock beyond Aswan in Egypt.

Nubia, the region from Khartoum to Aswan, was the home of the Nubian civilization, which rose thousands of years ago alongside the Egyptian Pharaonic civilization. In Egypt, the river divides the country into two sections, Upper and Lower Egypt. Upper Egypt, also known as southern Egypt, is in the desert plateau from Aswan to Qena. Here, the Nile has dug a deep, wide gorge in the desert

Stanley and Livingstone

Henry Morton Stanley (1841–1904) was a British-American explorer who was best known for his search for the Scottish explorer David Livingstone and his famous phrase, "Dr. Livingstone, I presume." Stanley served as a soldier in the American Civil War, and then worked on merchant ships and in the U.S. Navy. After a short time as a journalist, he volunteered himself as a war correspondent for the New York *Herald,* eventually ending up in the Middle East. In 1869 he heard of the disappearance of Dr. David Livingstone, who had gone in search of the source of the River Nile three years earlier.

Stanley sailed for Zanzibar, gathered together a small group, and headed for Lake Tanganyika, which was the last place Livingstone was reported to have visited. There, at Ujiji, on the shores of the lake, he found Livingstone, ill and short of supplies. The two became friends and seem to have planned further exploration, but Livingstone died a year later. In the meantime Stanley had made his name as a journalist with *How I Found Livingstone,* which was published in 1872 and won the Patron's Gold Medal of the Royal Geographical Society.

Stanley later returned to Africa to continue Livingstone's search for the source of the Nile. With money from the New York *Herald* and the London *Daily Telegraph*, he led an expedition into modern-day Uganda. He mapped Lake Victoria, but killed a number of local tribesmen in a skirmish, an action heavily criticized in the British press. Livingstone had believed that there was a link between the Nile and the Congo, but this was found to be untrue. Stanley described his travels in his 1878 book *Through the Dark Continent*.

plateau. Downstream from Qena the Nile flows northward into the Nile Delta on the Mediterranean Sea. This upstream region (the northern portion of Egypt) is known as Lower Egypt. The Nile Valley's floodplain covers a total area of 4,250 square miles in a wide canyon before it reaches the Nile Delta, which itself measures some 8,500 square miles.

The delta represents 63 percent of the inhabited area of Egypt, extending about 120 miles (200 km) from south to north and roughly 250 miles (400 km) from east to west; the area supports about 72 million people. Almost all of Egypt's population is crowded along the Nile Valley and the delta, which comprise only five percent of Egypt's land. This area is exceptionally productive from the rich alluvial soils, controlled irrigation, and a long tradition of advanced farming practices.

The flow of the Nile is controlled by numerous 20th-century dams. The intense dependence of the Sudan and Egypt on the waters of the Nile has resulted in the building of two large dams, the Sennar Dam on the Blue Nile in the Sudan and the Aswan High Dam in Egypt. The Sennar Dam and others account for 80 percent of the Sudan's power supply. The Sennar Dam also delivers water to the Gezira plain, irrigating over 2 million acres of land. The Gezira Scheme, one of the most successful agricultural schemes in Africa, was begun in the 1920s under British colonial rule. It was later nationalized by the post-independence Sudanese government in 1956 and the area is now famous for the production of high quality cotton, wheat, and animal feed crops.

Egypt built its own huge dam, the Aswan High Dam, just north of the border between Egypt and the Sudan, which has resulted in the creation of a sizable lake christened Lake Nasser. This lake provides much-needed energy and water for irrigation and ensures that Egypt has some control over the flow of Nile waters toward its more fertile delta near the Mediterranean.

The fact that the Nile flows through several countries, including Uganda, the Sudan, Ethiopia, and Egypt, is a source of both conflict and cooperation. Ethiopia's population is on the increase and it too wishes to harness the waters of the Blue Nile; Uganda needs the waters of the Nile to generate much-needed energy. Demands on the waters of the Nile are increasing, not only by these four countries but also by others in this region. The fear is that these pressures might result in interstate armed conflict. Already there have been a number of posturing statements and numerous skirmishes between Sudanese and Egyptian troops over the waters of the Nile.

SEE ALSO: Aswan High Dam; Egypt; Ethiopia; Irrigation; Rivers; Sudan; Uganda.

BIBLIOGRAPHY. Bruce Brander, *The River Nile* (National Geographic Society, 1966); Hagai Erlikh, *The Cross and the River: Ethiopia, Egypt, and the Nile* (Lynne Rienner, 2002); Walter Ashlin Fairservis, *The Ancient Kingdoms of the Nile and the Doomed Monuments of Nubia* (Crowell, 1962); Mark Lehner, *The Complete Pyramids: Solving the Ancient Mysteries* (Thames and Hudson, 1997); Miriam Lichtheim, *Ancient Egyptian Literature: A Book of Readings* (University of California Press, 1973–1980); Alan Moorehead, *The White Nile* (Harper, 1960); Alan Moorehead, *The Blue Nile* (Harper, 1962); Ian Shaw, *The Oxford History of Ancient Egypt* (Oxford University Press, 2000); Miroslav Verner, *The Pyramids: The Mystery, Culture, and Science of Egypt's Great Monuments* (Grove Press, 2001).

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NIMBY

NIMBY STANDS FOR "not in my backyard," a term used to describe the reaction people have to the possibility of a "locally unwanted land use"—known as a LULU—being located in their communities. The term gained currency in the late 1970s and early 1990s.

Episodes like Love Canal and Times Beach created considerable fears that, if similarly unwanted uses for land were pursued in their communities, the community would suffer greatly. As the *Christian Science Monitor* noted in the first published reference to the term *NIMBY*:

> People are now thoroughly alert to the dangers of hazardous chemical wastes. The very thought of having even a secure landfill anywhere near them is anathema to most Americans today. It's an attitude referred to in the trade as NIMBY—"not in my backyard."

Wealthy communities often resist LULUs; the environmental justice movement seeks fairer distribution.

This logic was then extended to any sort of facility that might lower property values, from factories, to airports, to group homes for the disabled.

The 1960s and 1970s saw remarkable social change. One of those changes was the greater likelihood that people would at least temporarily join together to fight against an undesirable change in the character of their communities. This sense of empowerment has been translated into much more active community participation in planning and zoning—but only when a community senses a threat. There is considerably less mobilization when an opportunity is presented to a community to build desirable land uses, like parks or other open space (indeed, some people consider these kinds of developments LULUs as well).

Thus, any LULU can be a "negative externality." In economics, an externality is a benefit or a cost that accrues to nonparticipants in a transaction. For example, buyers and sellers of gasoline benefit, the buyer from having motor fuel available, the seller for being able to produce and sell the product profitably. However, a refinery in a residential neighborhood may also emit pollution, pose safety hazards, or just be too loud. The refinery therefore creates a negative externality, and the plant's neighbors benefit from being able to buy gasoline at less than the neighbors' cost—but pay the price of lower house values, impaired health, or the lessened enjoyment of their property—from the operation of the undesirable land use.

The challenge is in finding a way to fix the value of the externality to internalize the costs in the transaction and to compensate those suffering from the negative externality. It is often hard to find the right price to compensate people for having a prison, a factory, an airport, or a group home for disabled people located near their homes or businesses.

Another argument runs that people need to accept these facilities in their neighborhoods as other people do, as part of the costs involved in being part of a complex, interdependent society. The problem with this argument is that neither NIMBYism nor LULUs are evenly distributed. Usually, people of wealth and other means are able to successfully resist LULUs in their community, which then often are forced into lower income, often racially segregated communities. Indeed, this phenomenon is at the heart of the "environmental justice" movement, which seeks to more fairly locate or distribute LULUs so that poorer, less powerful people and neighborhoods do not disproportionately bear the costs of these facilities.

The terms NIMBY and LULU have spawned some colorful and often highly descriptive terms, such as BANANA (build absolutely nothing anywhere near anything), NOPE (not on planet earth), and even YIMBY (yes in my backyard), a term that applies either to the positive benefit of a particular type of development in one's "backyard" or the position taken by people who understand that the societal benefit of a LULU may be more important than the locally-felt costs.

SEE ALSO: Development; Justice, Environmental; Love Canal; LULU; Nuisance Law.

BIBLIOGRAPHY. Denis J. Brion, *Essential Industry and the NIMBY Phenomenon* (Quorum Books, 1991); Don Coursey and Sangheon Kim, *An Examination of Compensation Mechanisms to Solve the NIMBY Problem* (University of Chicago, 1997); Herbert Inhaber, *Slaying the NIMBY Dragon* (Transaction Publishers, 1998); Emilie Travel Livezey, "Hazardous Waste," *The Christian Science Monitor* (November 6, 1980); Gregory E. McAvoy, *Controlling Technocracy: Citizen Rationality and the Nimby Syndrome* (Georgetown University Press, 1999); Bryan Meadows, *N.I.M.B.Y. (Not In My Back Yard)* (Borealis Press, 2000); Barry George Rabe, *Beyond Nimby: Hazardous Waste Siting in Canada and the United States* (Brookings Institution, 1994).

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Nitrogen Cycle

THE NITROGEN (N) cycle describes the transformation of nitrogen into its various organic and inorganic forms and its movement between different deposits in the atmosphere, soils, vegetation, and living organisms of the micro and macro fauna. The nitrogen cycle is one of the most important nutrient cycles within the world's ecosystems, since nitrogen is indispensable for the constitution of living organisms, which synthesize proteins, peptides, amino, and nucleic acids from nitrogen. However, the nitrogen cycle has to be managed carefully, since abundance of nitrogenous forms like nitrates in water or food can cause adverse effects on human health. Reactive nitrogenous gases in the atmosphere can contribute to climate warming and the destruction of the ozone layer. The terrestrial nitrogen balance of the nitrogen cycle with its major components can be described by the following equation:

$$dN/dt = N(R) + N(F) + N(bio) + N(H) + N(M) - N(P) - N(L) - N(D) \pm N(Er) - N(fix).$$

t = time
N(R) = nitrogen content in precipitation
N(C) = nitrogen input through combustion
N(bio) = nitrogen fixed by the nodules of leguminous plants and autotrophic bacteria
N(F) = nitrogen in organic and inorganic fertilizers
N(M) = mineralized nitrogen from soils
N(P) = nitrogen uptake by plants
N(Er) = nitrogen in- and out-flow by erosion
N(L) = leached nitrogen
N(D) = gaseous losses of nitrogen through denitrification
N(fix) = nitrogen fixed in clay minerals

Nitrogen (N) constitutes 78 percent of the atmosphere, and the whole atmospheric store is about a million times larger than all other N stocks. Atmospheric nitrogen inputs into the nitrogen cycle enter the soil-plant-water system through electrical processes, fires, combustion, and precipitation, processes by which molecular nitrogen, N_2, is combined with H_2 or O_2. The main natural nitrogen input from atmosphere to soil is induced by biological nitrogen fixation, which refers to the fixation and incorporation of atmospheric N_2 by the nodules of leguminous plants through a symbiosis with bacteria of the species rhizobium, as well as by nonsymbiotic fixation by autotrophic microorganisms as blue-green algae.

Nitrogen mineralization is the transformation of organic nitrogen mainly located in the topsoil into inorganic forms as ammonium NH_4^+ through the process of ammonification, frequently followed by the subsequent process of nitrification, which means the oxidation of the ammonium ions into nitrate, NO_3^-. The processes are mainly performed by species of *Nitrosomonas* and *Nitrobacter* and its kinetics are mainly dependent on the soil temperature.

The reverse process is immobilization, which refers to the transformation and subsequent incorporation of inorganic nitrogen forms into proteins, peptides, and amino acids of micro- or macroorganisms in the soil fauna. Mineralization is also frequently considered as the resulting net rate of all these processes. The highest mineralization rates in the history of soil ecosystems have been created by large-scale transformations of virgin land into arable land due to population pressure. In general this releases about 50 percent of the nitrogen that has been organically bound in soils.

Transport of nitrogen-containing soil matter through erosion can add to or reduce the amount of nitrogen cycling in a system. Further reduction of nitrogen in soils occurs through the fixation of ammonium in a biologically unavailable form in certain expanding clay minerals and, in higher quantities, through nitrogen uptake by plants. In natural ecosystems, the nitrogen uptake by plants is adjusted to the mineralization rate, which is the same if fertilizers are added to soils in combination with agricultural crops. If nitrogen in the soil solution is below the demands of the plant cover, the plants will be undernourished; if it exceeds the demands of the plants, it will either be leached into the groundwater or be denitrified. It can also be enriched in the plant solution.

All nitrogen that is not absorbed by sinks as vegetation, soils, and micro- and macro-faunae is available for leaching into groundwaters. From there, dependent on physical conditions, it flows into adjacent aquifers that determine the general water flow in soils. Denitrification involves the metabolic reduction of nitrate (NO_3^-) into nitrogen (N_2) or nitrous oxide (N_2O) gas. Both of these gases then diffuse into the atmosphere. Soluble carbon is used as an energy source; therefore the denitrification rate is limited by its amount and favored by anaerobic conditions. Denitrification can take place in every part of the soil profile where these conditions prevail and also in groundwater. Similar processes occur in marine ecosystems; however, there are still uncertainties about them, and estimates of N fixation by organisms vary, ranging from less than 30 to more than 300 teragrams (million tons) per year.

Human activities have interfered with the natural nitrogen cycle, which was in a dynamic equilibrium in preindustrial times. Then, annual fluxes of nitrogen from the atmosphere to the land and aquatic ecosystems were 90–130 teragrams per year. This was balanced by reverse denitrification, since the C and N ratio necessary for denitrification was also in equilibrium because almost all inputs were from organic origins.

Industrial combustion increases the emission of reactive N gases (NO_x) to the atmosphere, where they contribute to the production of tropospheric ozone before depositing either as a gas in the form of nitrate or ammonia ions, a nitric acid dissolved in precipitation, or as dry aerosols on land or sea.

Production and use of synthetic nitrogen fertilizer, produced by the Haber-Bosch process, together with expanded planting of nitrogen fixing crops and the deposition of nitrogen-containing air pollutants, have created an additional flux of about 200 teragrams a year, only part of which is denitrified. The addition of a major new flux from atmosphere to land, by way of industrial and crop nitrogen fixation, has created an imbalance leading to increased flows to the ocean. In the process this contributes to eutrophication of rivers and lakes. Some of the nitrogen oversupply leads to increased emissions of N_2O and NO_x, which are increasing in the atmosphere and contributing to global warming, tropospheric pollution, and stratospheric ozone depletion.

SEE ALSO: Eutrophication; Fertilizer; Global Warming; Nitrogen Fixation; Nitrogen Oxides; Pollution, Water.

BIBLIOGRAPHY. J.N. Galloway, "The Global Nitrogen Cycle: Changes and Consequences," *Environmental Pollution* (v.102/S1, 1998); Hans Jenny, *The Soil Resource: Origin and Behaviour* (Springer, 1980); W.V. Reid et al., *Millennium Ecosystem Assessment: Ecosystems and Human Well-Being* (World Resources Institute, 2005); S.L. Tisdayle et al., *Soil Fertility and Fertilizers* (Macmillan, 1997).

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Nitrogen Fixation

NITROGEN FIXATION IS the process by which nitrogen, a gas at atmospheric temperatures that represents approximately 80 percent of the total atmosphere of the earth, becomes a chemical compound that is somewhat more reactive than the almost-inert gas form. Fixation takes place through atmospheric phenomena such as lightning, ultraviolet rays, and microscopic soil organism activity.

As agricultural science began to reveal the importance of fixed nitrogen in the soil as a fertilizing agent, the efforts of farmers and technicians to increase and control nitrogen fixation have also multiplied. Intensive agricultural systems rely on artificially fixated nitrogen, and this intensive use has created a number of new problems. This has added chemical forms of fixation to atmospheric and biological fixation processes.

The majority of natural nitrogen fixation—more than 90 percent—comes about as the result of microbial soil organisms. Two principal groups of organisms are involved: the first is nonsymbiotic or free-living bacteria, such as cyanobacteria (blue-green algae); the second are the symbiotic bacteria that are commonly associated with cereal grasses and legumes. Symbiotic organisms live in contact with certain plants and encourage free atmospheric nitrogen to become fixed as nitrates; the plant then uses these as nutrition. Considerable efforts have been made to understand and document the processes involved in nitrogen fixation, and to determine ways to reduce unpredictability and increase yields. This has led to various attempts to stimulate nitrogen fixation, the creation of nitrogen-rich fertilizers, and the development of inoculation techniques to ensure that food plants grow in optimal ways rather than organism-driven growth patterns.

In some fruit and vegetable markets in the developed world, marketing motivations require almost perfectly identical specimens, and this has implications for the removal of organisms that affect specimen growth and nutritional value. The majority of plants, even important food plants, have not been fully investigated for the nodule-creation process by which symbiotic organisms fix nitrogen. Consequently, it is possible that major breakthroughs in reducing world hunger are possible, as well as less welcome side effects. There are known to be three sets of factors that affect the process: climatic factors, management factors, and edaphic (soil-related) factors.

Although less well-known than the soil-based version, nitrogen fixation also takes place in water, primarily through the actions of lake or river plants that convert gaseous forms of nitrogen into solid forms, which are then attached to plants in a symbiotic fashion. Artificially stimulated waterborne nitrogen fixation might become important in increasing the food yield of water resources and in helping to remove pollution. This may be of increasing utility as freestanding sources of clean water decline as a result of global warming, and the amount of edible fish may fall drastically.

Human involvement with nitrogen fixation is an example of the significant yet largely unnoticed ways in which humanity has converted the planet into an engine intended to be more conducive for human habitation.

SEE ALSO: Fertilizer; Nitrogen Cycle; Nitrogen Oxides.

BIBLIOGRAPHY. *Technical Paper 2: Biological Nitrogen Fixation* (Food and Agriculture Organization, undated); John Postgate, *Nitrogen Fixation* (Cambridge University Press, 1998); Barry E. Smith, Raymond L. Richards, and William E. Newton, eds., *Catalysts for Nitrogen Fixation: Nitrogenases, Relevant Chemical Models and Commercial Processes* (Springer, 2004).

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Nitrogen Oxides

NITROGEN OXIDES ARE a group of chemical compounds involving the elements of nitrogen and oxygen in different configurations. They include nitric oxide (NO), which usually takes a gaseous state and is the most stable of the oxides. Nitric oxide and other oxides are created when vehicle fuel is burned at high temperatures and they are significant pollutants. The oxides can be highly mobile and may be responsible for creating smog and ozone.

The other nitrogen oxides that can be formed include nitrogen dioxide (NO_2), nitrous oxide (dinitrogen monoxide N_2O), and the unstable compounds dinitrogen trioxide (N_2O_3), dinitrogen tetroxide (N_2O_4), and dinitrogen pentoxide (N_2O_5). The amalgamation of oxides created by the internal combustion process is referred to in entirety as NO_x. The oxides are not all dangerous or useless: nitrous oxide, for example, is better known as laughing gas and has important medicinal uses, even if it is poisonous in uncontrolled quantities.

Various types of technology have been employed to try to reduce the creation of nitrogen oxides. One of the most successful and influential of these has been the catalytic converter, which is now compulsory to have fitted onto most forms of automobile at manufacture. However, this is inappropriate for the alternative sources of NO_x production, which include factory and industrial plants burning coal or natural gas. The rapid industrialization of China is of particular relevance in this case because large numbers of Chinese factories rely upon Chinese-sourced coal for power. The nitrogen oxides produced contribute to such phenomena as acid rain, the production of toxic chemicals, and global warming. The compounds can hurt living creatures directly by leading to respiratory problems and illnesses, such as asthma. Climatic conditions and industrialization patterns mean that certain urban areas are particularly potent threats to health. Some claims have been made for clean coal consumption, which offers much lower NO_x production.

The Kyoto Treaty and other international agreements address the worldwide production of nitrogen oxides as a pollutant. Most developed countries have state-level regulatory agencies to monitor the level of atmospheric pollutants and take actions of some sort against heavy polluters. In the United States, the Environmental Protection Agency is the body responsible for this task.

SEE ALSO: Catalytic Converters; China; Coal; Environmental Protection Agency (EPA); Kyoto Protocol; Nitrogen Cycle; Nitrogen Fixation.

BIBLIOGRAPHY. Mark Z. Jacobson, *Atmospheric Pollution: History, Science, and Regulation* (Cambridge University Press, 2002); John H. Johnson, *Diesel Nitrogen Oxide Emissions: Landmark Research 1995–2001* (Society of Automotive Engineers, 2002); Sanford Sillman, Jennifer A. Logan, and Steven C. Wofsy, "The Sensitivity of Ozone to Nitrogen Oxides and Hydrocarbons in Regional Ozone Episodes," *Journal of Geophysical Research* (v.95/D2, 1990).

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Nixon, Richard Administration

RICHARD MILHOUS NIXON (1913–84) was the 37th president of the United States, serving from 1969 to 1974. A member of the Republican Party, he previously served as vice president under President Dwight D. Eisenhower. Nixon defeated his Democrat opponent Hubert Humphrey in a narrow vote by mobilizing a coalition of southern social conservatives organized by Strom Thurmond. In 1974 Nixon became the only U.S. president to resign from office.

In office, Nixon's administration was widely, and somewhat unfairly, believed to be primarily motivated by foreign affairs and to have little interest in domestic policies. Nixon inherited the American involvement in Indochina and this ended during his administration. Another notable event occurred when he visited Chairman Mao Zedong, leader of the Chinese Communist Party, in Beijing.

Nixon's environmental legacy is remarkable, and perhaps unmatched by any later presidential administration. Most of these policies were forced on Nixon's administration by an environmentally active Congress and a growing environmental movement, but his presidency presided over some of the strongest and longest lasting reforms of federal legislation regarding environmental issues. While he was reluctant to sign some environmental legislation, many experts suggest that, for a conservative Republican administration in the midst of domestic and international crises, the political costs appeared to outweigh the benefits.

Most notably, in 1970 Nixon established the Environmental Protection Agency (EPA), the first coordinated federal agency to manage the mounting crises of the period. Consumer and environmental groups had been lobbying for years on behalf of many different environmental and health issues and this had resulted in a mishmash of laws at several levels of government. The complexity added to legal costs and also provided loopholes and inconsistencies that could be exploited.

The EPA was established to harmonize these different laws and regulations and to determine a suitable method of policing them. The EPA has been responsible for a significant proportion of the reduction of pollution in and from the United States. Nixon also signed the Clean Air Act of 1970, the Clean Water Act of 1972, and the Endangered Species Conservation Act of 1969. He also oversaw the introduction of catalytic converters for automobiles, perhaps the first serious federal intervention into industrial production for consumer health and air quality. Nixon also oversaw the creation of the Organizational Health and Safety Administration (OHSA), which extended environmental protection to workers in the workplace, ranging from exposure to hazardous materials to dangerously high levels of noise pollution.

The decline of the Nixon administration was rooted both in the drawn-out end to the war in Vietnam and in the Watergate scandal, in which the President and members of his administration were accused of the breaking and entering of Democratic Party headquarters, illegal wiretapping, and other criminal acts. Threatened with impeachment, Nixon eventually resigned and was succeeded by Vice President Gerald Ford, as his previous Vice President, Spiro Agnew, had already resigned after another scandal. Nixon's administration eroded trust in politicians and in the political process.

Nevertheless the environmental agencies and laws established during the Nixon presidency remain the bedrock of contemporary environmental management in the United States. While the effectiveness, funding, and commitment of later administrations to these innovations would wax and wane, the Nixon legacy for U.S. environmentalism is undeniable. In the years following his resignation until his death, Nixon produced extensive writings on the presidential process and on foreign policy. However, some critics maintain that in doing so he revealed his indifference toward the details of public policy and obscured his administration's important role in helping protect and improve the environment.

SEE ALSO: Clean Air Act; Clean Water Act; Environmental Protection Agency (EPA).

BIBLIOGRAPHY. J. Brooks Flippen, *Nixon and the Environment* (University of New Mexico Press, 2000); Richard Nixon, *RN: The Memoirs of Richard Nixon* (Simon & Schuster, 1990); Richard Nixon Presidential Museum and Library, nixon.archives.gov (cited November 2006); Richard Reeves, *President Nixon: Alone in the White House* (Simon & Schuster, 2002); Melvin Small, *The Presidency of Richard Nixon* (University Press of Kansas, 2003).

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Noble Savage Myth

NOBLE SAVAGE IS a concept that idealizes the virtues of the primitive "other" who dwells in nature according to the doctrine of natural law and without the burdens of civilization. Innocent and free from corruption, the noble savage was seen as a romanticized ideal representing the innate goodness of natural man in contrast to the artificial goodness of civilized man. While the notion of the noble savage is most commonly attributed to Jean-Jacques Rousseau, anthropologist Ter Ellingson traces the origin of the noble savage to Marc Lescabot, a French lawyer and ethnographer who invented the concept in 1609, nearly a century and a half before Rousseau's writings.

THE ECOLOGICALLY NOBLE SAVAGE

A contemporary expression of the noble savage emerged in the late 20th century as the "ecologically noble savage." Environmentalists, in their critique of the unsustainable nature of capitalist growth, focused their attention on indigenous people who were seen as natural conservationists who used resources in ways that were nondestructive, sustainable, and attentive to the needs of future generations. By the 1980s indigenous people living low-impact lives in remote areas were portrayed as far more civilized than people in the industrialized world whose lifestyles had resulted in unprecedented species extinction and disruption of ecosystem processes. Environmentalists were able to marshal evidence from ecological anthropology to support their views of indigenous people as effective guardians of valuable habitats, highlighting the richness of traditional ecological knowledge and the efficacy of local resource management systems.

Embedded in the search to prove the ability of indigenous people to sustainably manage their own resources is a critique of Western capitalism. The environment has been damaged by the growth of global capitalism, and many of the world's regions of high biodiversity remain in areas occupied by indigenous people. This critique of capitalism, coupled with a romanticization of indigenous people, gave rise in the late 1980s to new alliances between indigenous people, eco-activists, and socially conscious "green" businesses such as Ben and Jerry's ice cream, Shaman Pharmaceuticals, and the Body Shop. These businesses promoted images of Amazonian Indians and their environmental knowledge as embodying qualities of purity, simplicity, and living in harmony with nature. The alliance between indigenous people and green companies was a politically potent critique of Western cultural dominance. However, this simplified representation of indigenous people had negative repercussions when it was shown that many native people are just as eager to reap short-term benefits from their natural resources as their neighbors in the industrialized world. Indigenous people had been placed on a moral and ecological pedestal that ultimately crumbled, resulting in a backlash against native people and their ability to manage their lands.

Conservationists Kent Redford and Allyn Stearman sparked an academic debate in the early 1990s by questioning whether indigenous people have a conservation ethic or whether their historically low impact on the land stems from low population density and lack of access to technology. This debate prompted a flurry of research aimed at objectively testing the hypothesis that indigenous people possess an intimate knowledge of their environment, resulting in effective conservation. Research showed that there is abundant evidence that indigenous people can be successful stewards of their resources.

However, for every example of indigenous knowledge with positive conservation outcomes, there is a counterexample of other indigenous practices that have resulted in loss of biodiversity. As a result, many conservationists see national parks as the only places where biodiversity can be preserved. For them, indigenous people should not be expected to conform to a preconceived stereotype of being natural guardians of the forest. Yet the process of protecting biodiversity in national parks almost inevitably results in the removal of indigenous peoples from their lands. As such, this debate over the conservation ethic of indigenous people glosses over the long history of oppression in which indigenous people have struggled for self-determination and recognition of traditional land rights.

While conservationists and scientists devote energy to proving or disproving the ability of indigenous people to conserve their own resources, the debate has not advanced the cause of conservationists or indigenous people. Critical opportunities for collaboration are lost when indigenous people are not given equal authority or negotiating power in decisions regarding their lands, making the possibility for fruitful and critical partnerships between indigenous people and conservationists difficult to achieve.

SEE ALSO: Conservation; Indigenous Peoples; National Parks; Sustainability.

BIBLIOGRAPHY. Janis Alcorn, "Indigenous People and Conservation," *Conservation Biology* (v.7/2, 1993); Beth Conklin and Laura Graham, "The Shifting Middle Ground: Amazonian Indians and Eco-Politics," *American Anthropologist* (v.97/4, 1995); Ter Ellingson, *The Myth of the Noble Savage* (University of California Press, 2001); Thomas Headland et al., "Revisionism in Ecological Anthropology," *Current Anthropology* (v.38/4, 1997); Kent Redford and Allyn Stearman, "Forest-Dwelling Native Amazonians and the Conservation of Biodiversity: Interest in Common or Collision?" *Conservation Biology* (v.7/2, 1993).

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Nongovernmental Organizations (NGOs)

WHILE COMMON PARLANCE now, the term *nongovernmental organization* (NGO) was not officially coined until 1945 when the United Nation's (UN) Economic and Social Council (ECOSOC) clarified its relationship with intergovernmental specialized agencies and international private organizations in the UN Charter. ECOSOC decided that an "international NGO" (INGO) was "any international organization that is not founded by an international treaty." The UN also determined that NGOs should be given suitable arrangements to be consulted on key issues. The status of NGOs was confirmed in the three conventions arising from the UN Earth Summit in Rio in 1992.

It is important to distinguish between NGOs and not-for-profit agencies. Unlike NGOs—which tend to emerge specifically to address certain issues, offer specific services, or advance a cause—nonprofit agencies may also include other organizations, such as museums, universities, and hospitals, service-based organizations that are not necessarily independent of government or campaigning for a cause. An NGO should not be mistaken as a social movement *per se*, despite the fact that it may perform an important functional role within such movements.

The term *nongovernmental organization* implies independence from government, which often enables NGOs to promote, or expose, activities and events in ways a government cannot. NGOs rely heavily on fundraising, grants, and sponsorships to fund their activities. To some NGOs it is important to maintain financial independence from government at all times; Greenpeace does not accept donations from governments or corporations but relies on contributions from individual supporters and foundation grants. Nonetheless, many NGOs depend in part on government funding. For example, the British government and the European Union donated a quarter of Oxfam's budget (U.S. $162 million) for famine relief in 1998. Medecins Sans Frontieres (MSF) operates with almost 50 percent of its budget coming from government sources.

There are thousands of active NGO organizations operating at local to international scales. According to one estimate, some 37,000 organizations now qualify as international NGOs (with programs and affiliates in a number of countries), up from less than 400 a century ago. Active international organizations include the Red Cross, CARE, and the World Wildlife Fund (WWF). Most NGOs operate within a single country and often function within a purely local setting. Many are essentially neighborhood groups established to promote local issues such as community improvement or street safety.

The 2002 United Nations Development Programme's Human Development Report notes that nearly one-fifth of the world's NGOs were formed in the 1990s. A 1995 United Nations report found that the United States has an estimated 2 million NGOs, Russia has 65,000 NGOs, and that in countries such as Kenya, up to 240 new NGOs come into existence every year. NGOs are significant employers. In 1995, CONCERN, which is an international NGO campaigning against poverty, employed 174 expatriates and over 5,000 national staff across ten developing countries in Africa, Asia, and Haiti.

NGOs have wide scope and appeal. Lesser-known acronyms for the different types of NGOs include:

INGO: International NGO; BINGO: Business NGO; RINGO: Religious NGO; QANGO: Quasi Autonomous NGO; and ENGO: Environment NGO. Religious NGOs include Caritas International, the World Jewish Congress, and the International Muslim Union; examples of political NGOs include the Inter-parliamentary Union and Socialist International. There are active cultural groups as well, such as International PEN, a literary organization. The activities of Amnesty International in the human rights field, as well as those of Greenpeace in the field of environmental protection, are well known. Many NGOs, such as the WWF and Friends of the Earth (FoE), investigate issues that affect human and environmental welfare, and often the nexus between the two.

In the human rights and environmental field, NGOs have served as agents of change and forces for the public good for the protection of human and environmental welfare. Amnesty International and WWF, while international NGOs, operate by working locally to achieve specific goals in specific regions. FoE recognizes that human rights and social justice and environmental issues are intertwined and need to be addressed together. FoE operates as a federation of autonomous environmental organizations from all over the world, and has a membership of 1.5 million in 70 countries. While FoE campaigns on many issues, it is currently focusing on climate change, which it identifies as the biggest environmental threat to the planet.

While NGO activity is often thought of as picketing, protests, and demonstrations, and some NGOs, such as Greenpeace, do employ spectacular and unilateral actions in order to broadcast their message, many NGOs focus on education, research, or diplomatic work to achieve their goals. NGOs are active on committees, in meetings, and in undertaking detailed studies that help inform and promote policy debate. For example, Earthwatch promotes community involvement and awareness of environmental issues with field research trips.

NGO collaboration, lobbying, and public awareness-building methods, including the effective use of media and scientific research, helped ensure that the Australian Government rezoned the Great Barrier Reef World Heritage Area to protect 33 percent of the Great Barrier Reef Marine Park (GBRMP) in a network of no-fishing sea sanctuaries, or "green zones." This was a major achievement, as previously only 4.5 percent of the GBRMP was fully protected from fishing.

NGOs are powerful players in the international policy arena and leverage their access to policy makers to good effect. The NGO-led International Campaign to Ban Landmines (ICBL), first initiated in 1992, laid the groundwork for the UN 1997 International Mine Ban Treaty. Over 140 countries throughout the world have since ratified the treaty. Scholars have also argued that NGOs were "particularly effective in hardening the European Union's position on genetically modified food," and that NGOs had a major influence on the WTO meeting in Seattle by affecting the negotiating positions of governments. The formation of the Kyoto Protocol on Climate Change (1997) is often credited to the pressure brought to bear on governments by environmental NGOs. Many argue that NGOs have been successful in ensuring that policy debate is now framed in environmental terms and have changed the status of environmental issues from being the domain of a politicized few to being in the general interest of civil society.

Some NGOs are developing partnerships with industry. The Marine Stewardship Council initiative has brought together the WWF and the multinational company Unilever PLC, one of the world's biggest buyers of frozen fish. Together they have worked to address the global issues of overfishing, and have developed an eco-certification scheme for major fisheries. Over 40 fisheries are part of the MSC program, which constitutes about 3 million tons of seafood. Fourteen of these fisheries, such as the Pacific cod fishery, are now certified by the MSC as having attained a sustainable eco-standard.

CRITIQUES

The NGO movement, however, has significant critics. Many question the accountability and effectiveness of NGOs. For example, World Vision's coordination of the relief effort for countries impacted by the December 26, 2004, tsunami in Southeast Asia has been attacked by critics arguing that the millions of dollars of donated monies were not reaching the intended victims.

Many NGOs working in developing countries are partly funded by their own government and have been criticized as being a front for foreign government policy. Critics argue that this makes NGOs accountable to their funders, not the people they work with. This issue has often been characterized within a debate about "Northern" (i.e., Western) versus "Southern" (developing world) NGOs. For example, many African governments see NGOs from Western countries as Trojan Horses, designed to promote neo-colonialist agendas.

Many developing countries also resent the fact that international NGOs will enter their countries and establish programs, rather than funding local NGO groups to undertake the same work. As such, the arrival of NGOs can be perceived to actually deny local individuals, councils, and industries of employment—and other opportunities that now flow to and from the foreign NGO—while creating upheaval in local power relations in culturally inappropriate ways. Some countries such as Zimbabwe, Eritrea, and the Sudan have gone so far as to pass laws that effectively limit the operations of foreign-funded NGOs within their borders.

In some cases, NGOs have been accused of ignoring the effects of their activities on other areas. For example, environmental NGO work can focus on biodiversity imperatives at the expense of cultural heritage or social justice needs. In Australia, the biodiversity work of environmental NGOs has been called blinkered in relation to cultural heritage priorities, constituting another form of indigenous dispossession.

NGO dependence on donors also exposes them to criticisms that they are not able to be independent, and thus may be inappropriately partisan. CARE International came under attack for not acting to oppose the war in Iraq, with critics claiming this was due to CARE's dependence on funding from the U.S. government. Oxfam has been accused of diluting its campaign against poverty in Africa as a result of being too close to the British government.

Overall, while NGOs rarely have formal powers within international or local decision-making structures, they have successfully advanced many human rights, social justice, and environmental agendas. This has included promoting and developing core environmental agreements and policies; strengthening the rights of women, children, and the disabled; advancing indigenous rights; establishing programs to address health, education, and poverty; and significant measures in the area of disarmament and peace negotiations.

SEE ALSO: Greenpeace; Kyoto Protocol; Mass Media; Movements, Environmental; United Nations Conference on Environment and Development (Earth Summit 1992); World Wildlife Fund (WWF).

BIBLIOGRAPHY. Alert Net, *African NGOs Urge More Aid Through Local Agencies* (Alert Net, 2004); N. Bayne, "Why Did Seattle Fail? Globalization and the Politics of Trade," *Government and Opposition* (v.35, 2005); S. Bernstein and B. Cashore, "Globalization, Four Paths of Internationalization and Domestic Policy Change: The Case of EcoForestry in British Columbia, Canada," *Canadian Journal of Political Science* (v.33, 2000); T. Carroll, *Intermediary NGOs: The Supporting Link in Grassroots Development* (Kumarian Press, 1992); A. Cockburn, "Beat the Devil: NAFTA and the Shameful Seven," *The Nation* (v.256, 1993); A. Drabek, ed., "Development Alternatives: The Challenge for NGOs," *World Development* (v.15, 1987); M. Edwards and D. Hulme, eds., *Beyond the Magic Bullet: NGO Performance and Accountability in the Post-Cold War World* (Kumarian Press, 1996); J. Fernando and A. Heston, "Introduction: NGOs Between States, Markets and Civil Society," *Annals of the American Academy of Political and Social Science* (v.554, 1997); A. Baker Fox, "Environment and Trade: The NAFTA Case," *Political Science Quarterly* (v.110, 1995); M. Fuentes and A. Frank, "Ten Theses on Social Movements," *World Development* (v.17, 1989); D. Korten, *NGO Strategic Networks: From Community Projects to Global Transformation* (Asian Regional Workshop on Strategic Networking for Sustainable Development and Environmental Action, 1990); D. Korten, *Getting to the 21st Century: Voluntary Action and the Global Agenda* (Kumarian Press, 1990); T. Princen and M. Finger, eds., *Environmental NGOs in World Politics: Linking the Local and the Global* (Routledge, 1994); P. Willets, *What Is a Non-Government Organisation?* (City University, 2002).

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Nonpoint Source Pollution

POLLUTION IS THE release and spread of contaminants that degrade the environment and impair human health. Point source pollution has a discrete source, like an effluent pipe or smokestack, while nonpoint source pollution cannot be traced to a specific point of origin. Examples of nonpoint source pollution are pesticides from a farm field washing into a stream and soil erosion at a construction site. Controlling this type of pollution is challenging because there is no specific location to target and because inputs of nonpoint pollution are often intermittent.

Sources of nonpoint pollution are varied: streets and highways, farm fields and pastures, construction, logging, mining, lawns, and even pet wastes. Most pollutants from these sources are carried in runoff following a rainstorm or snowmelt. Nutrients, sediments, toxins, and pathogens are pollutants prevalent in runoff.

Phosphorus and nitrogen—essential nutrients for plant growth—become pollutants when excessive amounts of either enter an ecosystem. Sources of nitrogen and phosphorus pollution are agricultural and lawn fertilizers and animal wastes. In the United States and Europe, approximately 30 percent of phosphorus and 18 percent of nitrogen in agricultural fertilizers are taken up by crops. The remainder builds up in soils, washes into surface water, or leaches into groundwater.

Under naturally occurring conditions, nitrogen and phosphorus are relatively scarce in aquatic systems, thus limiting the growth of algae and plants. Populations of algae or of cyanobacteria (blue-green algae) often proliferate following increases in nutrient levels. These algal blooms cloud water and limit light to submerged plants. Then, when these populations of algae die, the decomposition process uses much of the water's dissolved oxygen. Lack of oxygen kills fish and clams, and alters the microorganism and invertebrate composition of the community. In marine ecosystems, nutrient enrichment leads to loss of biodiversity in seagrass beds and kelp communities. These ecosystems, when healthy, provide spawning ground and nurseries for many fish species as well as shelter and food for many marine mammals, so damage impacts many species.

Blooms of some microorganisms produce toxins. Red tides are overgrowths of aquatic microorganisms, so-named because they turn the water red or brown. These organisms synthesize toxins that damage the nervous system, can kill marine mammals and fish, and contaminate seafood. Some cyanobacteria responsible for freshwater algal blooms also produce toxins.

Excessive phosphorus is the primary cause of eutrophication, or premature aging, of lakes in the United States. Nitrogen is responsible for eutrophication in most estuaries and coastal waters. Marine areas that are highly impacted by eutrophication include the Gulf of Mexico, Chesapeake Bay, Long Island Sound, and the Florida Keys in North America, and the Adriatic, Baltic, Black, and North Seas in Europe. Extreme nitrogen enrichment in coastal waters results in what are called "dead zones," or areas with very low oxygen that no longer support the life once found there. The Gulf of Mexico, which receives nutrient inputs from the Mississippi River, has a dead zone that expands to about 4,800 square miles (20,000 square kilometers) in the summer, an area the size of New Jersey.

Particles of silt, clay, and sand particles transported by water are called sediment. These soil particles are washed from fields, construction sites, and logging operations. As with algal blooms, sediment clouds water, blocks light, and limits plant growth. Some sediment particles block the gills of fish and aquatic insects, and bury clams, oysters, and other bottom dwelling organisms. Deposition of sediment in waterways and ports interferes with boat traffic and fishing. In addition, sediments often contain nutrients, which enrich the waters, as previously discussed.

Sediment deposition in Chesapeake Bay has increased four- to fivefold since the 1800s due to urban development, timber harvest, and agriculture. Research in the Chesapeake Bay watershed revealed that the most sediment is produced in the agricultural portions of the watershed, while the lowest input comes from the forested portions. In urban parts of the watershed, sedimentation is highest during building, but established developments continue to contribute sediments.

Pesticides usually enter surface water through runoff, but drifting spray from pesticide application also contributes to water contamination. Mining operations expose sulfur-containing rock to water and air, and this leads to the formation of sulfuric acid. The acid dissolves heavy metals, including mercury, lead, and copper, introducing these materials to runoff. These heavy metals are toxic to humans and wildlife.

Disease-causing bacteria and viruses enter water from manure, pet waste, and improperly treated human waste. These pathogens can contaminate seafood and render water unfit for human use. According to the National Resources Defense Council, 75 percent of U.S. beach closings in 2005 were due to unacceptable levels of bacteria.

Economic and social costs of nonpoint source pollution are high: fisheries are less productive, tourism is damaged, public health can be impaired, water treatment costs increase, and property values decrease.

Monitoring, at both the local and national levels, can provide vital information for water quality management. The National Water Quality Assessment (NAWQA) program is run by the U.S. Geological Survey (USGS). This long-term project monitors nutrients and pesticides in rivers and aquifers. The data gathered helps municipalities, agencies and scientists make management decisions for specific watersheds. Another monitoring program, run by the National Oceanic and Atmospheric Administration (NOAA), is the National Estuarine Eutrophication Survey.

Managing nonpoint pollution requires a variety of methods, depending on the source of pollutants. Vegetated buffer strips along water bodies trap sediment and remove nutrients from runoff. Efforts by farmers to determine levels of nutrient in their soils, then applying fertilizers only to meet current needs, reduces nutrients inputs. Construction site erosion is managed by silt fences to trap sediment and straw and hay mulches are used to hold soil in place until grass is established.

SEE ALSO: Estuaries; Eutrophication; Fertilizer; Marine Pollution; Pesticides; Pollution, Water.

BIBLIOGRAPHY. Stephen Carpenter et al., "Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen," *Issues in Ecology* (Summer, 1998); Robert Howarth et al., "Nutrient Pollution of Coastal Rivers, Bays and Seas," *Issues in Ecology* (Fall, 2000); National Oceanic and Atmospheric Administration, "Nonpoint Source Pollution," oceanservice.noaa.gov (cited December 2006); Natural Resources Defense Council, "Testing the Waters 2006: A Guide to Water Quality at Vacation Beaches," www.nrdc.org (cited December 2006); U.S. Department of Agriculture, "National Management Measures for the Control of Nonpoint Pollution from Agriculture" (Department of Agriculture, 2003); U.S. Geological Survey, "The Impact of Sediment on the Chesapeake Bay and Its Watershed," chesapeake.usgs.gov (cited December 2006); U.S. Geological Survey, "The National Water-Quality Assessment Program—Entering a New Decade of Investigations," pubs.usgs.gov (cited December 2006).

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Nontimber Forest Products

ALSO CALLED SPECIAL forest products and minor forest products, nontimber forest products (NTFPs) are renewable forest resources that can be sustainably extracted. Typical NTFPs include gums, resins, oils, sap, nuts, wicker, rattan, bamboo, dyes, incense, fungi, mushrooms, fruits, berries, bark, roots, plants, insects, honey, and eggs. Human beings have relied upon and managed NTFPs for fuel, fodder, food, fiber, medicine, art supplies, and building materials for millennia.

Even today, NTFPs are gathered seasonally and across the spectrum of tenure possibilities by a diversity of people in all countries. Indeed, they play an essential economic and cultural role in the livelihoods of about one-fourth of the world's population, not counting those who retail and consume NTFPs in metropolitan areas.

Regional and global trade in NTFPs is in the hundreds of millions of dollars. Many environmentalists and human rights advocates seek to link global demands for NTFPs in ways that promote forest conservation through sustainable extraction and meet the economic needs of forest peoples and neighboring communities.

Forest peoples worldwide developed ways to manage and regulate access to NTFPs to ensure sustained yield. By their nature, most NTFPs are common property resources, or resources held in common by a defined collectivity. Traditional knowledge of desired NTFPs and their ecologies both shaped and reflected the customary rules of forest access and harvesting practices.

As more distant markets for NTFPs developed, and colonial and state regimes expanded their authority into ever more remote areas, customary rights of forest access blended with or gave way to the imposition of codified rules and regulations enacted in cities. In addition, many NTFPs were purposefully moved to facilitate their production under private, scientific, and colonial control. The most famous example of this was when the British naturalist Walter Bates smuggled the seeds of natural rubber (*Hevea brasilensis*) out of the Brazilian Amazon in the 19th century. Passing through botanical gardens, the seeds facilitated plantation rubber production in British colonies in south and southeast Asia, temporarily ending the demand for the Amazon's wild rubber.

Beginning in the 1970s awareness of new and alarming rates of tropical deforestation prompted thinking about alternative forms of rain forest development. By the 1980s two issues moved NTFPs to center stage in a search for unorthodox solutions. In 1985 the Rubber Tappers National Council of Brazil proposed extractive reserves, or collective long-term land-use rights to forested areas. This plan sought to defend rubber tapper livelihoods against expanding timber and ranching interests in the Amazon basin. The high-profile 1988 murder of Chico Mendes, the charismatic leader of the National Council, by a rancher opposed to his activism only served to galvanize the institutionalization of extractive reserves in Amazonia. By 2006 there were over 120 extractive reserves in Brazil cared for by 200,000 people.

A benchmark 1989 article demonstrated that a hectare of tropical rain forest contained a variety of NTFPs of approximately equal value to timber from the same hectare. The implication was that the sustainable extraction of NTFPs would be worth more over time than a one-time timber clearing. If given the opportunity, rain forests could pay for their own protection by giving forest peoples and national governments an economic incentive to protect them—this was before the growth of ecotourism, which has a similar objective. Recognition of the economic viability of healthy forests strengthened governmental willingness to grant usufruct rights to forest peoples dwelling on ostensibly "national lands."

By the 1990s one important outcome of this convergence was global awareness about the problem of tropical deforestation, and a willingness of industrial-world consumers to buy products that supported or collaborated with NTFP producers. By the early 1990s, however, scholars were already documenting the limits of NTFP extractivism for achieving environmental, economic, and social objectives, as extractors continued to live in poverty and had limited abilities to confront colonists or traditional extractive enterprises, including bioprospectors.

Nontimber forest products play important social and environmental roles in temperate countries as well. For example, it is estimated that up to one-quarter of the entire population of Scotland collects wild edibles. Meanwhile, recent Latino and Southeast Asian immigrants to the Pacific Northwest region of the United States are actively involved in NTFP extraction from National Forests. Permits for a single plant, beargrass, suggest that the activity is worth $10 million annually. Mushrooms, floral greens, evergreen plants, ginseng, and berries are also sought from national and private forests across the United States. The economic importance of NTFPs in industrialized countries will likely continue to grow as rural logging economies restructure and new legislation is passed intended to improve NTFP management.

SEE ALSO: Bioprospecting; Deforestation; Mendes, Chico; Rain Forest; Rubber.

BIBLIOGRAPHY. Marla R. Emery and Rebecca J. McLain, eds., *Non-Timber Forest Products: Medicinal Herbs, Fungi, Edible Fruits and Nuts, and Other Natural Products from the Forest* (Food Products Press, 2001); Charles M. Peters, Alwyn H. Gentry, and Robert O. Mendelsohn, "Valuation of an Amazon Rainforest," *Nature* (v.339, 1989); Mark Plotkin and Lisa Famolare, eds., *Sustainable Harvest and Marketing of Rain Forest*

Products (Island Press, 1992); Nick Salafsky, Barbara L. Dugelby, and John W. Terborgh, "Can Extractive Reserves Save the Rain Forest?," *Conservation Biology* (v.7, 1993).

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Nontraditional Agricultural Exports (NTAEs)

NONTRADITIONAL AGRICULTURAL exports (NTAEs) are agricultural products that have not previously been consumed or planted as cash crops in a country. NTAEs include fruits, vegetables, flowers, nuts, and spices. NTAEs are growing in importance globally because of their economic value; they make up the overwhelming majority of trade taking place in the horticultural and floricultural sectors of both producer and consumer countries. Fruits, vegetables, and flowers have formed the bulk of this new trade. Traditional agricultural exports (TAEs) vary from country to country as do the value of NTAEs. However, NTAEs are growing in great volume and value while TAEs are growing at stable rates. For example, between 1997 and 2001, soybean and sugar exports from Brazil, which are TAEs, grew 55 percent. In this same time period, however, Brazilian NTAEs of cantaloupes, grapes, mangos, and other crops grew 145 percent.

In recent years, most agricultural production in Central America and the Caribbean has been consumed locally. However, new crops of NTAEs in these areas have grown enormously. For example, the production of asparagus, eggplants, onions, shallots, green peas, green beans, and tomatoes have exploded in volume and value as trade items. Many of the NTAEs produced today are not traditional foods in the areas in which they are produced. This means that these foods are exported to urban markets in some of the wealthier, industrialized countries of the Northern Hemisphere. The positive result is that Third World countries have a new source of income that does not compete with foods consumed locally.

East Asia is a region new to the production of NTAEs. Historically Japan, Korea, China, and the Philippines have been large producers of fruits and vegetables for local consumption. However, great volumes of fruits such as pineapples, cantaloupes, citrus fruits, and vegetables such as asparagus are now being grown for export.

Countries in Southeast Asia, including the Philippines, Thailand, and Malaysia, are great producers of mangos, which were once not considered a fruit for the wider market. However, the introduction of the mango into colder regions of the world has created a new export market; as a result, a common and traditional fruit has become a new NTAE.

In Central and South America, many new crops that were never grown in the area before are now being grown as NTAEs. NTAEs have a limited market appeal in these regions. As a result, trade links between these nations and the United States and Europe are growing exponentially. The impact of NTAE production in Central America is noteworthy as local farmers have profited from the growth significantly. For example, Mayan Indians, who had no exports previously, are growing broccoli, snow peas, cauliflower, and berries in the Guatemalan central highlands.

Researchers have studied the production of NTAEs and have found that despite some problems, local farmers are positive about the opportunity to produce for export. South America is now a growing center of NTAEs that are counter-seasonal. Apples, pears, grapes, and other fruits are grown in the spring-summer-autumn, which is opposite to the autumn-winter-spring of the Northern Hemisphere. As a result, many traditional foods consumed in the Northern Hemisphere are available fresh during normally off-seasons. The health benefits of fresh produce available counter-seasonally is a significant factor in their marketability.

NTAEs are often the subject of import regulations and tariff restrictions. As long as traditional fruits, such as apples, are imported counter-seasonally, import tariffs are kept low unless they are opposed by domestic producers who want to protect their own production centers. The export of fresh, cut flowers has evoked some opposition from Northern Hemisphere growers who produce cut flowers in hothouses. For example, Colombia is now the world's second-largest exporter of flowers after the Netherlands. Because floriculture is labor intensive, the higher labor costs in the Netherlands are challenged by lower cost floriculture production in Mexico, Costa Rica, Honduras, Peru, Bolivia, and various African and Asian countries.

The Uruguay Round of Agricultural Agreement (URAA) discussions sought to limit the growth of trade restrictions on NTAEs, as many countries have developed complex, restrictive trade policies. To reduce restrictions so that freer markets can exist has been the subject of many international discussions. The European Union has been a leader in restricting imports or in creating trade barriers such as import quotas.

Other concerns expressed by many interest groups in the Northern Hemisphere are fears that exploitative labor practices or the unregulated use of pesticides and herbicides will affect the conditions of production in Third World countries. Testing for residual levels of pesticides or herbicides in accordance with the standards set by the *Codex Alimentarius* is being used to restrict the importation of NTAEs in some instances. Many countries are applying sanitary and phytosanitary (SPS) measures to food imports. More than 270 SPS measures were adopted for fruits and vegetables between 1995 and 2000. The basic rules for using these heath standards have been established by the World Trade Organization (WTO).

In an unusual move, in many countries the public laws on food safety are being surpassed by importing companies. Grocery stores have a vested interest in food safety. A single outbreak of an infectious agent sold in their stores could have a devastating business impact in the near future and the long term. Resulting liability suits can also be very expensive. Therefore, private agencies are creating inspection standards far exceeding those followed by public authorities.

While many observers predict a bright future for NTAE growth, some critics of capitalism and globalization argue that NTAEs have negative social consequences. The "market friendly" orientation of increasing export conditions has led to domination by small numbers of international export companies in many NTAE sectors. The flood of these products simultaneously onto global markets has also resulted in dramatic price declines. While this is a boon for the relatively wealthy consumer in the developed world, to a farmer in the underdeveloped world, it means more effort and energy in export-oriented production for less return. Whether a boon or bane, NTAE expansion has definitely resulted in the ubiquity of historically unusual products stocking supermarket shelves.

SEE ALSO: Bolivia; China; Colombia; Costa Rica; Herbicides; Honduras; Japan; Korea; Mexico; Netherlands; Peru; Pesticides; Philippines; Uruguay; World Trade Organization.

BIBLIOGRAPHY. Sheldon Annis and Anne M. Byers, eds., *Poverty, Natural Resources, and Public Policy in Central America* (Transaction Publishers, 1991); L.O. Copeland and R.H. Leep, *Nontraditional Field Crops: Canola/Rapeseed and Lupins* (Michigan State University, 1992); Philip McMichael. *The Global Restructuring of Agro-Food Systems* (Cornell University Press, 1994); Peter G. Veit, *Africa's Valuable Assets: A Reader in Natural Resource Management* (World Resource Institute, 1998); Joachim Von Braun, David Hotchkiss, and Maarten D. C. Immink, *Nontraditional Export Crops in Guatemala: Effects on Production, Income and Nutrition* (International Food Policy Research Institute, 1989).

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North American Free Trade Agreement

IN 1947, IN the aftermath of World War II, 23 nations signed the General Agreement on Tariffs and Trade (GATT). Over time the number of signatory nations grew and by 1986, the year of GATT's eighth round of trade negotiations (known as the "Uruguay" round), there were 75, including Mexico, which joined that year.

In 1989, at a time when market-based, low-tariff trade of goods and services between countries was being touted as a driver of investment and economic growth, the United States and Canada negotiated the U.S.-Canada Free Trade Agreement (CFTA). Soon after, Mexico, then governed by newly-elected, neoliberal president Carlos Salinas de Gortari, signaled a strong interest in enlarging the U.S.-Canada agreement.

After four years of tripartite negotiations, the expanded North American Free Trade Agreement (NAFTA) became law on January 1, 1994. NAFTA thus established the world's largest free trade area—comprising the United States, Mexico, and Canada—populated by some 440 million people and producing about U.S. $12 trillion worth of goods and services.

As a commercial treaty, NATFA's goals were to remove tariffs and nontariff barriers; enhance fair competition; promote investment; protect intellectual-property rights; institute practical procedures for resolving disputes; and facilitate trilateral, regional, and multilateral cooperation.

But while the agreement itself was intended as an economic instrument, NAFTA's legacy may rest in its innovation in another domain: environmental protection. Prior to U.S. congressional approval, U.S. environmental groups, most of which initially resisted the accord, argued for institutional safeguards for the continent's environment and especially the fragile, water-scarce U.S.-Mexico border region. To placate this influential sector of civil society, the signatories agreed to soften the potential environmental impacts of the expected growth in trade and economic activity by chartering three new environmental institutions: the trinational Commission for Environmental Cooperation (CEC), created through a side agreement amending NAFTA; and two binational institutions, the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBank), negotiated between the United States and Mexico. This "greening" of a trade treaty was a novel idea in 1993 and it remains the most prominent instance of such a procedure.

The new triad of CEC, BECC, and NADBank was meant to fill significant lacunae in protecting the North American environment. In this, they joined a host of existing international institutions (treaties, organizations, and cooperative agreements) already addressing certain aspects of environmental protection. Most prominent among these are: the International Boundary Commission (IBC), created in 1889 and changed to the International Boundary and Water Commission (IBWC) in 1944, to resolve boundary issues between the United States and Mexico; the International Joint Commission (IJC), an analogous organization established in 1909 to deal with U.S.-Canadian water-related issues; the Colorado River Compact of 1922, which allocates use of that river and forms the basis of what has become known as the "Law of the River"; the 1944 United States–Mexico Water Treaty, governing the Colorado, Rio Grande, and Tijuana Rivers; the 1983 La Paz Agreement (or "Reagan–de la Madrid Accord"), the first comprehensive environmental treaty between the United States and Mexico; the Border XXI Program (1996–2000), a binational cooperative workplan designed to implement the terms of the La Paz Agreement; and Border 2012 (from 2003), the successor to Border XXI.

Among the three new institutions, CEC was the only one that was officially part of NAFTA (and is sometimes referred to as the "NAFTA Environmental Commission"). It was created under the North American Agreement for Environmental Cooperation (NAAEC) to address regional environmental concerns, help prevent potential trade and environmental conflicts, and promote effective enforcement of environmental law. Officially directed by the three participating nations' environmental ministers, CEC operates via a secretariat based in Montreal, Canada, and is guided by three governmental advisory committees, three national advisory committees, and a trinational joint public advisory committee (JPAC).

Since 1994 CEC has addressed the state of the North American environment, the relation between trade and environment, and specific issues such as pollutant releases and registries and eco-regions. In its early years, its greatest influence was achieved through its judgments on enforcement matters under Articles 14 and 15 of the NAAEC, which allow nongovernmental organizations or individuals to file submissions claiming that one of the three countries is failing to enforce an environmental statute.

The Border Environment Cooperation Commission (BECC), headquartered in Ciudad Juárez, Chihuahua, and the North American Development Bank (NADBank), based in San Antonio, Texas, were designed to operate in tandem to improve environmental infrastructure—especially with regard to water—in the U.S.-Mexico border region (defined as a zone 100 kilometers on each side of the boundary). BECC was to encourage needy border communities to submit proposals for projects and then certify those projects meeting the commission's criteria. NADBank's role was to facilitate financing, that is, provide loans for the development, execution, and operation of BECC-certified environmental-infrastructure projects.

BECC has been managed binationally and, until 2006, directed by a board comprising representatives of each government and at-large community members. By its first year of operation, it had devised progressive criteria that required binationality; openness and transparency; bottom-up operation, with requirements for public participation at all levels; and assurances of environmental and financial sustainability. Although by some accounts the BECC process was initially slow, as of July 2006 it had certified 113 border environmental infrastructure projects—a total investment valued at $2.5 billion (not all these funds became available, however), affecting some 11 million residents.

Like BECC, NADBank is managed binationally, but its board—prior to 2006—consisted of the secretaries of the treasury, external affairs, and environment of Mexico and the United States. When the bank was created, it was capitalized at up to $3 billion in financing, with $2.55 billion in "callable" capital and $450 million in "paid-in" capital; but needs for border environmental infrastructure were estimated to be far higher. NADBank has provided about $350 million for projects providing cleaner water, land, and air in border communities. The bank also has administered $500 million in funds from the U.S. Environmental Protection Agency (EPA) through its Border Environment Infrastructure Fund (BEIF).

But while many residents benefited from the projects, the amounts expended remained well below the bank's initial capitalization and far short of perceived needs. Thus, beginning in the late 1990s and accelerating in early 2001, during the first months of the George W. Bush and Vicente Fox administrations, many in Washington and Mexico City considered NADBank to be unsuccessful and BECC less than optimally effective. In September 2001, Presidents Bush and Fox agreed that "immediate measures were needed to strengthen the performance" of the bank and its sister commission. In March 2004, over the objections of environmental interests who feared that the called-for "reforms" would deemphasize BECC's progressive features, the U.S. Congress enacted a bill, H.R. 254, which altered the mandate and structure of the bank and the commission. The zone of operation was expanded from 100 kilometers on each side of the border to 300 kilometers in Mexico; projects would no longer be restricted to the original charter of air, water, and waste; and most significantly, the two boards were to be replaced by a single one with representation from the two federal governments, the border states, and the public.

The changes were effected soon after but the new joint board did not meet until June 2006; the last time the NADBank board met was October 2003, and the last time the BECC board met was June 2004. In the meantime, hostility to the newly-reconstituted NADBank continued, especially in the U.S. Department of the Treasury and Mexico's Secretaría de Hacienda y Crédito Público. During the first half of 2006, rumors of NADBank's demise were rife. But the bank, and by extension, BECC, seemingly survived following strong expressions of support by the "Border Caucus" of the U.S. Congress, Texas and New Mexico federal senators, influential border-states governors, and advisory councils such as the Good Neighbor Environmental Board.

SEE ALSO: Bush (George W.) Administration; Canada; Clinton, William Administration; Mexico; Trade, Free.

BIBLIOGRAPHY. Diana Liverman et al., "Environmental Issues Along the U.S.-Mexico Border—Drivers of Change and Responses of Citizens and Institutions," *Annual Review of Energy and the Environment* (v.24, 1999); Gary Martin, "U.S., Mexican Officials Abandon Discussions to Close NADBank," *San Antonio Express News* (March 2, 2006); Silvia Olvera, "*Avala el NADBank Plan para Frontera*" (NADBank plan for the border guaranteed), *Reforma/El Norte* (March 20, 2006); Alicia Salgado, "*¿A quién interesa el NADBank?*" (Who is interested in NADBank?), *El Financiero, La Chequera,* (March 20, 2006); United States Environmental Protection Agency, "Reforming the North American Development Bank (NADBank) and the Border Environment Cooperation Commission (BECC)," www.epa.gov (Border

XXI Archive, Public Fact Sheet, 2001); U.S. House of Representatives, H.R. 254, 108th Congress, "To authorize the President of the United States to agree to certain amendments to the Agreement between the Government of the United States of America and the Government of the United Mexican States concerning the establishment of a Border Environment Cooperation Commission and a North American Development Bank, and for other purposes," *Congressional Record* (v.150, March 24, 2004); United States of America, The White House, Office of the Press Secretary, "Joint Statement by the Presidents of The United States and Mexico, Monterrey, Mexico," www.whitehouse.gov (March 22, 2002); Robert G. Varady et al., "The U.S.-Mexico Border Environment Cooperation Commission: Collected Perspectives on the First Two Years," *Journal of Borderlands Studies* (v.11/2, 1996).

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It is difficult to assess whether positive NAO index values since 1980 reflect human influence or random variations.

North Atlantic Oscillation (NAO)

THE NORTH ATLANTIC Oscillation (NAO) refers to a large-scale oscillation of atmospheric mass observed across the North Atlantic Ocean. The NAO was first identified in the 1920s by Sir Gilbert Walker. This oscillation is between the two prominent North Atlantic pressure centers: the Azores high, centered in the North Atlantic, and the Icelandic Low, centered between Greenland and Iceland.

It is now firmly established that fluctuations in the NAO influence weather and climate variations around the world, especially in the North Atlantic region. The NAO is a major controlling factor in basic meteorological variables such as surface wind, temperature, and precipitation, which have large socioeconomic impacts on energy, agriculture, industry, and human health across Europe and eastern North America. Changes in the NAO also significantly impact North Atlantic ecosystems through its influence on oceanic convection, deep-water formation, food availability, plant phenology, and the distribution patterns of fish and shellfish. Although this pattern is evident throughout the year, it is most pronounced during the winter months.

The phase of the NAO can be determined using a simple index, defined as the difference in sea level pressure between Lisbon, Portugal, and Stykkisholmur, Iceland. Instrumental station pressure, temperature, and precipitation measurements along with paleoclimate indicators have been used to construct a monthly times series of the NAO index dating back several hundred years. Depending on the direction of the pressure intensification, a NAO event is considered either positive or negative. Positive values of the index indicate a stronger-than-average Icelandic Low and Azores High, while negative index values signify weaker-than-average pressure centers.

Positive values of the NAO index are associated with stronger-than-average westerly winds across the middle latitudes of the Atlantic onto Europe, with anomalous southerly flow over eastern North America and anomalous northerly flow across western Greenland, the Canadian Arctic, and the Mediterranean. The positive phase of the NAO reflects below-normal heights and pressure across the high latitudes of the North Atlantic and above-normal heights and pressure over the central North Atlantic, the eastern United States, and Western Europe. During times of a high NAO index, the axis of maximum moisture transport shifts to a more southwest-to-northeast orientation across the Atlantic and extends much farther to the north and east onto northern Europe and Scandinavia.

Strong positive phases of the NAO tend to be associated with above-average temperatures in the eastern United States and across northern Europe, while northern Canada, Greenland, and oftentimes southern Europe and the Middle East experience below-average temperatures. Storm systems travel on a more northerly track across the North Atlantic, resulting in drier-than-normal conditions over much of central and southern Europe, the northern Mediterranean countries, and west North Africa. At the same time stronger westerlies result in wetter-than-normal conditions from Iceland to Scandinavia. Wetter winters in the southeastern United States and more frequent cold, dry air outbreaks from the Labrador Sea have also been found to be associated with the positive phase of the NAO.

When the NAO index is negative the westerly winds are weaker than normal, resulting in fewer and weaker winter storms crossing the North Atlantic on a more west-east pathway. North Atlantic sea surface temperature anomalies are above average while steering winds shift southward during low NAO index phases. More frequent and longer-lasting atmospheric blocking patterns across the North Atlantic are associated with low NAO index values.

The negative phase of the NAO brings moist air into the Mediterranean and cold air to northern Europe. As a result northern Europe usually experiences colder winters while wet and mild conditions prevail from the Mediterranean eastward into the Middle East. Greenland experiences milder winter temperatures when the NAO index is negative. The negative phase of the NAO is associated with colder winters and increased snowfall across eastern North America. The southern United States usually experiences colder winters and more variable weather during times of a low NAO index.

The NAO exhibits considerable variability across various time scales. The NAO oscillates week to week as much as it does from year to year or decade to decade, and does so unpredictably. An average of two to three NAO events occur per winter, and prolonged periods of both positive and negative phases of this pattern are common. Variability of the NAO dominates the climate of the North Atlantic and surrounding continents on interannual to decadal time scales.

The NAO has displayed considerable long-term variability since the late 19th century. From the turn of the century until about 1930, with the exception of the 1916–1919 winters, the NAO index was high. Decadal variability in the NAO has become especially pronounced since about 1950, although the causes for such variability are not clear. The NAO was generally low from the early 1940s until the mid 1970s and then abruptly switched to the positive phase. The strong positive NAO index values that have been observed since 1980 have contributed much to the observed warming in the Northern Hemisphere surface temperatures.

The NAO is currently generating intense scientific interest because of its climatic importance. It is difficult to assess whether the observed changes in the NAO reflect a human influence or random climatic variations. Observations suggest there is some predictability in the early winter NAO, which may be of considerable socioeconomic benefit. These sea-level pressure variations may be predictable, provided the sea surface temperature anomalies themselves are predictable.

SEE ALSO: Climatology; El Niño—Southern Oscillation (ENSO); Global Warming; Weather.

BIBLIOGRAPHY. James W. Hurrell, “Decadal Trends in the North Atlantic Oscillation: Regional Temperature and Precipitation,” *Science* (v.269/5224, 1995); James W. Hurrell and Harry Van Loon, “Decadal Variations in Climate Associated with the North Atlantic Oscillation,” *Climatic Change* (v.9/36, 1997); Richard A. Kerr, “A North Atlantic Climate Peacemaker for the Centuries,” *Science* (v.288/5473, 2000); Mojib Latif, Klaus Arpe, and Erich Roeckner, “Oceanic Control of Decadal North Atlantic Sea Level Pressure Variability in Winter,” *Geophysical Research Letters* (v.27/5, 2000); Vikram M. Mehta et al., “Oceanic Influence on the North Atlantic Oscillation and Associated Northern Hemisphere Climate Variations: 1959–93,” *Geophysical Research Letters* (v.27/1, 2000).

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Northern Spotted Owl

THE NORTHERN SPOTTED owl (*Strix occidentalis caurina*) became the focal point of a singular struggle in the annals of North American environmentalism when it was listed as threatened under the U.S. Endangered Species Act (ESA) in June of 1990. The listing signified and drew widespread attention to the conversion of old-growth forests to younger, ecologically simpler forests, and to a brewing scientific and political controversy. This controversy raised questions about the legitimacy of industrial forestry and state forest policy dedicated to ecological conversion and simplification for the purposes of commodity production. Yet, it also threw into sharp relief the scientific, political, and cultural underpinnings of Western environmentalism. The fight over whether or not to save the owl should in these respects be seen as a crucial episode in the politics of biodiversity conservation, and as an important case study of environmental regulation in liberal capitalist societies.

The northern spotted owl is found primarily in the so-called Douglas-fir region, running west of the Cascade Mountains, and south from southern British Columbia, Canada into northern California. Until the mid-1970s, very little was known to science about the owl, yet early surveys suggested its nearly unique dependence on relatively large, contiguous areas of old-growth forest. A key reason the owls require this habitat is that they tend to nest in the broken tree tops and snags that form in mature stands (stands with a preponderance of trees 175–250 years old or more).

State-sponsored and independent biological research in the 1980s tended to confirm that the owl was highly dependent on old growth, and also that populations were declining in parallel with the loss of old-growth forests due to industrial logging. This science, together with the naming of the owl as an "indicator species" by the U.S. Forest Service in the mid-1980s, provided the basis on which a sustained campaign was mounted by a loose coalition of environmental groups aiming to reign in logging and thereby preserve remaining stands of old growth.

This campaign gained considerable momentum when the owl was listed as officially threatened in 1990, but also from key judicial decisions forcing changes in the management of extensive federal forest lands in the U.S. Pacific Northwest where most of the remaining old growth was and is located. In 1993, a Forest Summit was convened by then U.S. President Bill Clinton and Vice-President Al Gore to attempt to resolve the pervasive stalemate, widely if somewhat erroneously framed as a jobs versus environment issue. A resulting federal plan prescribed reductions in annual timber sale quantities in affected federal forests by approximately 75 percent, while at the same time embracing ecosystem management principles.

The economic and ecological implications of this episode are still unfolding, and the fight is by no means over. While Canada has no comparable federal endangered species legislation to the American ESA, the owl is considered in peril in southwestern British Columbia. More broadly, the fight over the spotted owl in the 1990s precipitated considerable soul searching in academic and policy circles about the approach to environmental regulation institutionalized by the ESA, and the cultural politics of nature that underpin it.

Champions of strong biodiversity protections argue that mandatory preservation with real legal teeth, as evidenced by the 1973 ESA, provides the only means of arresting species and habitat loss. Critics argue such measures put nature—particularly charismatic creatures like the owl—before people (and jobs), denigrate work, and reflect dualistic views of nature and culture. These may be valid critiques. But it is also important to note that saving the owl was prescribed not only by the ESA, but by prior federal forest policy that designated it as an indicator species, a canary to the coal mine of Pacific Northwest temperate, old-growth forest ecosystems. This has been somewhat lost by the emphasis on individual species retention institutionalized by the ESA, and is ironic given that the longer term fallout from the owl's listing has been a more substantive embrace of ecosystem management in federal forest policy.

It also bears noting that the ESA, for all its shortcomings, provides one of the few ways in which commercial exploitation of biophysical nature for the purposes of commodity production may be checked. Nevertheless, a search for ways to transcend the dichotomies of commodification and preservation is ongoing in the aftermath of the spotted owl crisis in the Pacific Northwest, and beyond.

SEE ALSO: Biodiversity; Endangered Species Act (ESA); Forest Service (U.S.); Old Growth Forest.

BIBLIOGRAPHY. A.B. Carey, "A Summary of the Scientific Basis for Spotted Owl Management," in R.J. Gutierrez and A.B. Care, eds., *Ecology and Management of the Spotted Owl in the Pacific Northwest* (United States Department of Agriculture Forest Service PNW-185, 1985); E.D. Forsman, "Habitat Utilization by Spotted Owls in the West-Central Cascades of Oregon," Dissertation, Biology (Oregon State University, 1980); J.F. Franklin et. al., *Ecological Characteristics of Old-Growth Douglas-Fir Forests* (U.S. Department of Agriculture Forest Service General Technical Report PNW-118, 1981); A.L. Hungerford, "Changing the Management of Public Land Forests: The Role of the Spotted Owl Injunctions (1993 Ninth Circuit Environmental Review)," *Environmental Law* (v.24/3, 2002); Shannon C. Petersen, *Acting for Endangered Species: A Statutory Ark* (University Press of Kansas, 2002); W.S. Prudham, *Knock on Wood: Nature as Commodity in Douglas-Fir Country* (Routledge, 2005); T. Satterfield, *Anatomy of a Conflict: Identity, Knowledge, and Emotion in Old-Growth Forests* (University of British Columbia Press, 2002); D. Simberloff, "The Spotted Owl Fracas: Mixing Academic, Applied, and Political Ecology," *Ecology* (v.68/4, 1987); United States Forest Service Scientific Analysis Team and J. W. Thomas, *Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest* (U.S. Department of Agriculture, National Forest System, and Forest Service Research, 1993); R. White, " 'Are You an Environmentalist or Do You Work for a Living?' Work and Nature," in W. Cronon, ed., *Uncommon Ground: Toward Reinventing Nature* (W.W. Norton, 1995).

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Norway

AFTER REMAINING NEUTRAL in World War I, Norway underwent a five-year German occupation during World War II and joined the North Atlantic Treaty Organization (NATO), subsequently developing close political and economic ties with other Western nations. Norway has refused to join the European Union (EU) but voluntarily contributes large sums to the EU budget.

Oil and gas were discovered in Norway in the late 1960s and Norway is now the third-highest oil producer in the world; oil and gas comprise one-third of all Norwegian exports. Other natural resources include iron ore, copper, lead, zinc, titanium, pyrites, nickel, fish, timber, and hydropower. With a per capita income of $42,400, Norway is the third richest nation in the world. Planning for a time when oil and gas reserves run out, the government has placed over $150 billion in the Government Petroleum Fund.

Despite its wealth and high quality of life, Norway suffers from extensive water pollution that threatens marine life.

North Sea Oil

The oil reserves in the North Sea are one of the largest non-OPEC oil production areas in the world. Much of the oil lies beneath waters that belong to Norway and the United Kingdom, with some fields belonging to Denmark, the Netherlands, and Germany. North Sea Oil was discovered in the early 1960s but it was not until 1971 that it came on line, being piped ashore to the northern English industrial town of Teeside. Soon afterward oil was also pumped ashore in the Norwegian sector.

The Norwegian government administers licenses to the North Sea through their Norwegian Petroleum Directorate, and North Sea oil forms a major part of the economy. Norway has also located and tapped large fields of natural gas. It produces about 3.33 million barrels of crude oil per day, as well as 65.4 billion cubic meters of natural gas.

The North Sea is rough and dangerous throughout the year, but especially in winter. Extracting oil from the North Sea has been extremely expensive, pushing oil industry technology to its limits. However, the oil price rises experienced during the 1970s made Norwegian North Sea oil commercially viable, and the money earned by the Norwegians led to a massive boom in their economy during the late 1970s and the 1980s, although a recession in 1981 did lead to an election defeat for the Norwegian Labor Party, the DNA.

With recent increases in the price of oil, the British government signed a major agreement by which it would buy up to 20 billion cubic meters of natural gas from the Ormen Lange field in the Norwegian sector of the North Sea starting in 2006—bolstering an otherwise flagging Norwegian economy.

The United Nations Development Programme Human Development Reports rank Norway first in the world on quality-of-life issues, in part because of extensive social welfare programs.

Bordering on the North Sea and the North Atlantic Ocean, Norway has 15,592 miles (25,148 kilometers) of coastline, including those along fjords (steep-sided inlets), minor indentations, and more than 50,000 islands. This coastline is one of longest and most rugged in the world. Along the coast, Norway's climate is temperate, with rain occurring all year on the western coast. The rest of the country is colder, even in summer; the north is arctic tundra. Because the land was formed from glaciers, around two-thirds of Norway is made up of mountains interspersed with high small valleys and scattered plains. Rockslides and avalanches are common. Around 97 percent of the land is nonarable.

As a heavily industrialized nation, Norway suffers from extensive water pollution that threatens marine life. Oil discharges from petroleum production have risen recently, particularly in 2003 when discharges from the Draugen field increased substantially. Because of intense urbanization (78.6 percent) and vehicle emissions, air pollution is also a chronic problem. With 417 cars per 1,000 people, Norway produces 0.2 percent of the world's carbon dioxide emissions. Acid rain has damaged forests and upset the ecosystems of lakes. In 2006, a study by Yale University ranked Norway 18th among 132 nations in environmental performance, slightly below income and geographic group averages.

The Minister of Environment works with a number of departments and agencies to promote environmental responsibility in Norway. As a result, discharges of plant nutrients in the North Sea have decreased, along with acidifying substances. Improved methods of dealing with large amounts of domestic and industrial waste have also been instituted. Air quality has improved in Norway due to technological improvements, stricter emission standards, and the closure of some chemical and metallurgical plants.

Despite the use of more environmentally friendly vehicles and fuels, emissions of greenhouse gasses have increased because the number of vehicles on Norway's roads has multiplied and drivers are traveling greater distances. Norway continues to explore the use of alternate sources of energy such as hydropower and wind production. While production of hydropower has declined, two new wind farms were opened in Møre og Romsdal and Finnmark in 2003.

The Norwegian government has protected 6.8 percent of the land. Of 54 mammal species endemic to Norway, 10 are threatened with extinction, and two of the 241 endemic bird species are in a similar situation. In the North Sea, the stock of cod is rapidly depleting, and the capelin stock in the Barents Sea has collapsed. On the other hand, the stock of spring-spawning herring is considered biologically safe, and the spawning stock of the Northeast Arctic Sea is increasing.

Norway promotes the health of the global environment through participation in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Seals, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Acid Rain; Fisheries; Industrialization; Natural Gas; Petroleum; Pollution, Air; Pollution, Water; Urbanization; Whales and Whaling.

BIBLIOGRAPHY. Central Intelligence Agency, "Netherlands," *The World Factbook*, www.cia.gov (cited March 2006); Toyin Falola and Ann Genova, *The Politics of the Oil Industry* (Praeger, 2003); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Pollution Control Authority, "State of the Environment Norway," www.environment.no (cited March 2006); Arne Selbyg, *Norway Today: An Introduction to Modern Norwegian Society* (Norwegian University Press, 1986); Statistics Norway, *Natural Resources and the Environment 2004*, www.ssb.no/english (cited March 2006); United Nations Development Programme, "Human Development Reports: Norway," hdr.undp.org (cited March 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); David Wallace, *Environmental Policy and Industrial Innovation: Strategies in Europe, the United States, and Japan* (Earthscan, 1995); World Bank, "Norway," *Little Green Data Book*, lnweb18.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited March 2006).

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No-Till Agriculture

NO-TILL AGRICULTURE IS a farming method in which crops are cultivated without plowing, thus minimizing disturbance to the soil. Instead, the farmer plants seeds in a slot created by equipment that uses disks or chisels to create a narrow furrow in which the seed can be injected and then covered. This method of farming yields a number of environmental benefits relative to conventional farming. It preserves soil and, in most cases, generates higher crop yields than conventional farming.

Conventional tilling loosens and disturbs the soil, which allows for greater erosion. Plowing breaks up clods that naturally form from organic matter, such as roots and plant remnants, left in the soil. As this organic matter is churned up, it is exposed to the atmosphere where it quickly decomposes, releasing nutrients such as nitrogen and phosphorus that are easily carried away by wind and rain. The no-till method not only prevents soil erosion but also helps with the retention of nutrients, thus reducing the need for additional fertilizer. Fertilizer use can be further reduced by equipment that injects fertilizer in with the seeds as they are planted, thereby eliminating the need to fertilize the entire field. Naturally forming clods in the soil also help to retain water, which reduces the need for irrigation.

No-till methods also offer promise for reducing global warming, an increase in the temperature in the earth's atmosphere caused in part by the release of carbon dioxide into the air. Elevated carbon dioxide levels are caused primarily by the burning of fossil fuels, but conventional agricultural practices also contribute to this problem in other ways. Plants remove carbon dioxide from the air, but the carbon accumulates in plants and decomposition of the plant returns some of it to the atmosphere. The remainder is sequestered in the soil as organic matter. This is significant as soils contain roughly twice as much carbon as land plants or the atmosphere. The amount of carbon sequestered in the soil is greatly reduced when forests and grasslands are converted for agricultural purposes. Carbon in the soil is easily transferred into the air. Conventional plowing disturbs the soil and allows organic matter to decompose more quickly as it is regularly exposed to the atmosphere into which the carbon dioxide is then released. The no-till method allows the undisturbed soil to retain much of that carbon. No-till methods also greatly reduce the use of fossil fuels by limiting the need for fertilizers and reducing the number of times farmers must go over their fields. Fewer trips across the fields also decreases soil compaction caused by tractors.

Although extensive testing of no-till practices is ongoing, the environmental and economic benefits of no-till agriculture appear to be significant. Higher yields, and savings in terms of labor time, fuel, fertilizers, and irrigation mean fewer costs and higher returns for farmers using this method. Ecologically, no-till methods prevent soil erosion, pollution runoff, the use of synthetic fertilizers, and carbon dioxide releases.

On the other hand, no-till methods still require herbicide usage for weed control and there is some evidence that demand for herbicides may actually increase under a no-till regime. The use of no-till methods in the United States is increasing significantly. By one estimate, in 1990 seven million acres were farmed using the no-till method; by 2002 that number had increased to over 50 million.

SEE ALSO: Carbon Dioxide; Farming Systems; Fertilizer; Global Warming; Runoff; Soil Erosion.

BIBLIOGRAPHY. Megan M. Gregory, Kathleen L. Shea, and Eugene B. Bakko, "Comparing Agroecosystems: Effects of Cropping and Tillage Patterns on Soil, Water, Energy Use and Productivity," *Renewable Agriculture and Food Systems* (v.20/2, 2005); Rattan Lal et al., "Ecology: Managing Soil Carbon," *Science* (v.304/5669, 2004); Northern Virginia Soil and Water Conservation District, "No-Till Agriculture: Good for the Soil and the Bottom Line," *Conservation Currents,* www.fairfaxcounty.gov (cited April 2006); Pacific Northwest National Laboratory, "Less Is More: No-Till Agriculture Helps Mitigate Global Warming," *Breakthroughs Magazine,* www.pnl.gov/breakthroughs (cited April 2006).

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Nuclear Power

NUCLEAR POWER IS electrical power generated from a nuclear reactor. Electricity is produced by the heat released from the atomic core though a controlled nuclear chain reaction. Waste products include heat and spent nuclear materials.

Nuclear power plants use a nuclear reactor, which is also called an atomic reactor or an atomic pile. Nuclear reactors have seven primary parts. Some of these are systems and some are protective parts. These primary parts are the atomic core, the moderator, control rods, a coolant system, a pressurized vessel, and a biological shield. In addition there are safety systems and a containment unit to house the reactor.

The atomic core is the center of the reactor. It is where nuclear fission takes place. Nuclear fission, which is also called atomic fission, occurs naturally when atoms that are high in the scale of chemical elements decay or split into smaller elements and at the same time give off energy. Albert Einstein's famous formula $E = MC^2$ says that energy is equivalent to mass times the speed of light squared. The splitting of atoms involves the transformation of small portions of the matter into energy in the nuclear reaction.

When the nucleus of an atom splits, its component protons and neutrons are released. The atom that is split separates into nuclei; free neutrons, photons, and gamma rays are also usually generated. Of the photons, gamma rays are usually the most common form. There may be other particles generated, such as alpha particles and beta particles. The atomic reaction produces energy in the form of gamma rays and kinetic energy in the form of heat. The amount of heat released is millions of times the amount of energy released from chemical reactions that occur from the burning of fossil fuels such as coal, gas, or oil.

Radioactive atomic materials release neutrons naturally. There are radioactive materials that are not used as nuclear fuel in nuclear reactors. Some of these are the waste products of nuclear power plants, while others, such as radium, are used in medicine. Atomic energy was recognized shortly after the discovery of radioactivity. In the case of radium, it was noticed that its decay created heat that naturally surrounded quantities of it. In 1939 the discovery of uranium fission made possible the development of the atomic bomb and, after World War II, the development of nuclear power.

The radioactive material used in atomic reactions is generally referred to as special nuclear material (SNM). The term comes from a definition used in the United States Atomic Energy Act. The special nuclear materials used most commonly in nuclear reactors are plutonium, uranium 233 (U233) and uranium 235 (U235). Uranium is widely distributed in the earth. It was originally formed in a star that was a part of the material that formed the earth. About 99 percent of the uranium on earth is uranium 238 (U238). Less than one percent is U235.

UNCONTROLLED REACTIONS

A nuclear reaction, if uncontrolled in a unit of special nuclear materials, will cause a chain reaction. The neutrons that are causing radioactive decay naturally will continue to increase rapidly so that as a neutron strikes the nucleus of an individual atom the split atom also releases free neutrons. These increase rapidly in number releasing increasing quantities of energy.

Creating an uncontrolled chain reaction of nuclear fission is the principle used to create an atomic explosion. Oddly, a nuclear weapon is designed so that a controlled set of induced atomic reactions is used to create an uncontrolled chain reaction in unstable U235 resulting in a huge explosion with its attendant atomic blast, radiation, and enormous heat.

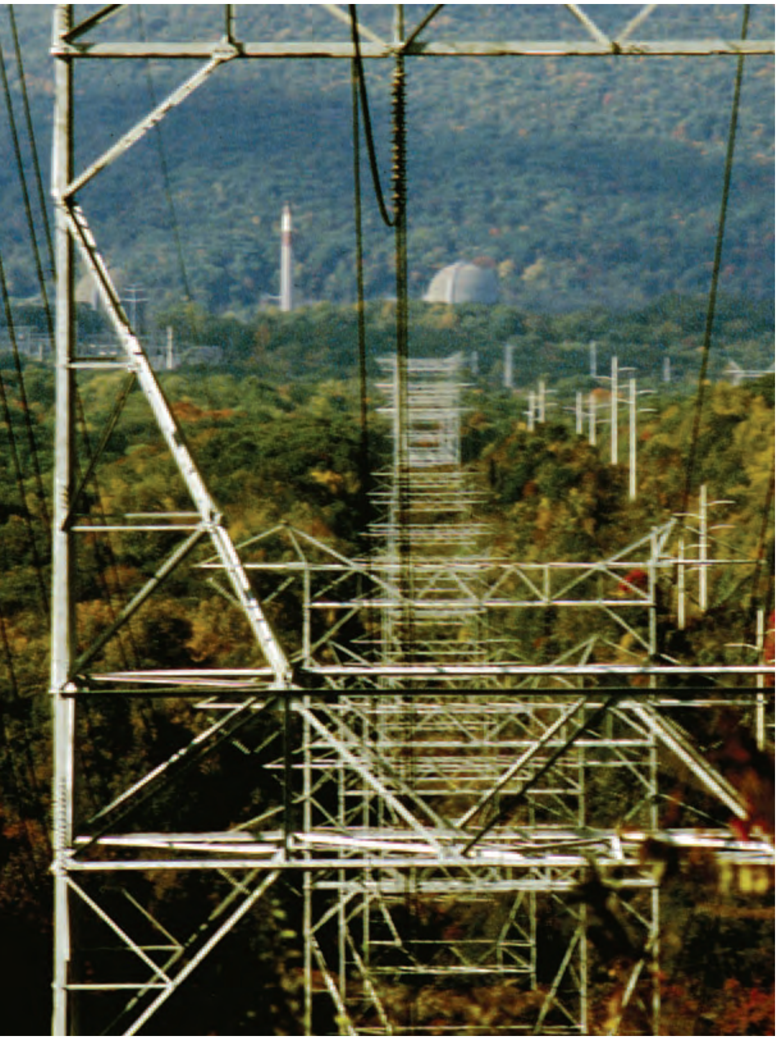
If an uncontrolled reaction occurs in a nuclear power plant an atomic meltdown can occur. The atomic core of the reactor becomes so hot that it melts. If the pressure vessel is not able to contain all of the heat and steam produced, then a terrible accident can occur. This happened at Chernobyl in the Ukraine in 1986. The radioactive materials released were spread over northern Europe. The area around the Chernobyl nuclear power plant for some miles distant, including the city of Chernobyl, had to be abandoned. The health consequences since have been very serious: A much higher rate of cancers, birth defects, and other illnesses caused by exposure to high amounts of radiation.

CONTROLLED REACTIONS

The nuclear reactions generated in an atomic core are controlled. The core is part of a nuclear power plant that contains the nuclear fuel; nuclear fission reactions take place in the core. The core is composed of nuclear material—usually pellets of uranium oxide (UO_2). These are put into tubes to form fuel rods, and the fuel rods are then arranged into fuel assemblies in the reactor's core.

The core's reactions are managed by control rods, which regulate the rate of chain reactions. Control rods are usually made of boron, cadmium, cobalt, europium, gadolinium, hafnium, indium, silver, or other materials that can absorb neutrons without becoming fissionable. These elements capture neutrons at different rates so their use as control rods is guided by the spectrum of the kind of nuclear fission reactions the atomic core is designed to generate. The reaction is started, slowed, and stopped by means of the control rods. The rods are slowly removed from their positions in the core. Nuclear reactors are designed so that the rods effectively cover the top and sides of the fuel rods. The fuel rods rest on a floor of neutron absorbing material.

As the control rods are pulled upward from covering the fuel rods, the nuclear reaction begins to take place. The neutrons are no longer absorbed by the moderator material in the control rods. This allows free neutrons to create fission reactions and more neutrons, which then drive the reaction. By manipulating the control rods the reactor is turned on or off. The effect is like that of allowing more oxygen to enter a fire so the fire burns hotter. The removing of the control rods allows the atomic reaction to occur. The further the rods are removed the faster the reaction increases.



In the United States 20 percent of the electrical supply comes from nuclear power plants.

Nuclear power plants are operated with a large number of monitors that measure the heat being generated. Special instruments measure radiation levels in the core as well. The moderator in mater reactors is a material used to stimulate nuclear chain reactions. Moderators may be composed of several different types of materials. Most moderators have used graphite or heavy water. Water is hydrogen oxide (H_2O); however, heavy water is the common name of an uncommon isotope of hydrogen called deuterium.

The moderator material captures the free neutrons and allows them to be evenly available to the fissionable material. U238 is not atomically unstable like U235 so it will normally absorb the free neutrons. The principle is that when an atom of U235 is hit by a neutron it creates a high probability of fission. The U235 atom splits, and on average produces about two or more neutrons. The effect is to create a self-sustaining chain reaction. No additional neutrons are needed.

The fissionable reactions can be held constant if the surplus neutrons escape from the system. However, if they are allowed to increase, the reactions diverge. In nature the probability that a high energy neutron will directly cause fission in another atom is low. To create the fission reactions in a nuclear core, enriched uranium is used. An increased amount of U235, which is expensive to produce, is consolidated in the nuclear fuel. What the moderator materials do is slow down fast neutrons so that slower neutrons have a better opportunity to be captured in the core's fuel. The moderator becomes a medium for reducing the velocity of fast neutrons so that they are changed into thermal neutrons that can sustain nuclear chain reactions.

Nuclear power plants are built and named after the kind of moderator material used. The most common forms of moderators are water and heavy water. Light water reactors use water; heavy water reactors use deuterium. To be useful as a moderator a material should have the lowest atomic number possible and resist absorbing neutrons to a very high degree. Besides deuterium and graphite, beryllium and hydrocarbons have been studied for possible use. Deuterium has the disadvantage of being expensive; huge quantities of water have to be processed to capture the deuterium atoms.

TYPES OF REACTORS

Another way of naming nuclear power plants is after the type of reactor used. Nuclear fission reactors use a critical mass of fissionable material. There are currently several types of these reactors: Generations I, II, and III, and other subtypes. All of these types use a reactor cooled by pressurized water. The water is under immense pressure, which allows it to absorb greater quantities of heat than if it were at open atmospheric pressure. Most nuclear power plants have pressurized water reactors. In the opinion of nuclear experts, these are the reactors with the most reliable technology. Some of these are fast-spectrum and others are thermal-spectrum reactors.

Usually the fast-spectrum reactors produce waste with a shorter half-life (the time it takes for half of the radioactive material to completely decay).

Fast reactors can also be designed to act as breeders of even more radioactive material. Thermal reactors cannot produce reusable radioactive material. Most reactors in use in power plants are thermal-spectrum reactors and pressurized water reactors. These types of reactors have proved to be the safest and the most reliable, even though the Three Mile Island plant in Pennsylvania was the site of an accident.

Boiling water reactors are water pressure reactors, but the pressure is less and the water is allowed to boil in the reactor. A problem with this type of reactor is that the boiling water in the reactor stresses the components. This increases the risk of an accident that will permit radioactive water to escape. However, the use of this type of thermal reactor is widespread.

Another type of reactor is the Pressurized Heavy Water Reactor (PHWR). This type of reactor uses heavy water as a coolant and also as a moderator. This type of reactor uses hundreds of pressure tubes to hold the fuel, rather than housing it in a single large containment vessel. An advantage of the Pressurized Heavy Water Reactor is that it does not have to be taken off line to be refueled. Canada has developed this type of reactor and has sold units to a number of countries, including Argentina, China, India, Pakistan, Romania, and South Korea.

The former Soviet Union built a number of plutonium reactors. These have proven to be dangerous and unstable. They are water cooled, but use graphite as a moderator. An advantage is that they can be refueled while in operation. However, they are too large to have containment buildings. The Chernobyl plant was of this design. Gas Cool Reactors were been developed in Great Britain. They use a graphite moderator with carbon dioxide as a coolant and have high thermal energy efficiency.

Reactor designs have been advancing since the first reactor went on line in the 1950s. A Generation IV reactor design is being developed. This type of reactor will be like a light water reactor, but it will allow the water to be heated to a critical level so that the thermal efficiency is very high. The critical level is the point at which liquid water under pressure acts like a gas.

Some reactors are liquid metal fast breeder reactors. The liquid metal acts as both moderator and as coolant. There are two types—lead-cooled and sodium-cooled. Several reactors using liquid metal have been built in France. Another type of reactor is the radioisotope thermoelectric generator. It produces heat through passive radioactive decay. Space probes, unmanned lighthouses, some pacemakers, and other devices have been designed to use micro nuclear power plants.

The coolant system in a nuclear power plant distributes the heat generated in the nuclear reactions to where it can be used. The other systems of the nuclear power plant use the heat generated to cool the nuclear reactor and to produce electricity. Cooling the reactor is vital to avoid major accidents. Materials used as coolants in nuclear reactors include gases, liquids, and liquid metals. In light water reactors the moderator also functions as coolant. Heavy water reactors use a different system.

The pressure vessel or a set of pressure tubes hold the core in a nuclear power plant. The core is covered by a very strong vessel. Usually some kind of robust steel is used to contain the reactor core, the moderator, and in systems where the moderator is also the coolant, the coolant as well. Sometimes the pressure vessel is a series of pressure tubes. The tubes hold the fuel and move the coolant through the moderator.

The electrical production in a nuclear power plant comes from steam generation. The portion of the cooling system that diverts heat delivers it to sources of water that can be converted to steam. The steam is used to drive turbines. It can also be used to do mechanical work as well. The turbines in nuclear ships drive the ship's propeller blade as well as supplying electrical power. Nuclear power reactors have been used by several of the world's navies; submarines and aircraft carriers have been atomic powered since the 1950s.

SAFETY FEATURES

The containment structure surrounds the reactor core. It is designed to protect the core from outside intrusion. Storms or other invasive disruptions of the core's reactions could cause a major nuclear accident. Another important function of the containment structure is to act as a biological shield to protect the outside world from the deadly effects of radiation. The material used to make the containment is usually very thick concrete and steel. The structure is often more than a yard (meter) thick. This thickness is needed if a malfunction or accident should occur.

The safety system is really a series of systems to handle emergencies so that serious accidents can be prevented. In general the safety systems act to stop the atomic reaction or cool the core. Safety rods in the core are a very important feature. They will stop a reaction very rapidly and will be automatically inserted into the core if a rapid increase or abnormal amount of neutrons is detected.

Another safety action to stop the atomic reaction is the employment of samarium oxide balls. The balls are made of oxygen and samarium. If dropped into a core they will immediately stop the reaction by absorbing the neutrons. Emergency core cooling systems seek to prevent an accidental meltdown. If the normal coolant is lost or if the coolant system fails then the emergency cooling system can be employed. It floods the core with water that absorbs heat to prevent a nuclear core meltdown.

BENEFITS AND RISKS

Today a growing portion of the world's electrical supply is coming from nuclear power plants. Nuclear power plants are supplying 15 percent of the world's electricity. In the United States 20 percent of the electrical supply comes from nuclear power plants. In France the percentage is 80 percent.

The great benefit of nuclear power is that enormous quantities of electricity can be produced at a lower cost. They also have the benefit that they do not produce smoke or carbon dioxide, which contributes to global warming. However, the great drawbacks are the waste products and the threat of destruction posed by accidents and nuclear weapons.

The enormous quantities of heat generated by nuclear power plants can be handled with appropriate engineering. Uses of waste heat include cogeneration or supplying heat to winter agriculture in northern climates or other practical uses. The key problem is preventing any contamination by radioactive materials, because these can pose serious health problems.

The problem of storing nuclear waste is a major issue. Temporary sites where materials are buried must be supervised to prevent leakage of radioactive materials. Eventually a permanent site where radioactive materials can be kept for thousands of years has to be developed.

The fact that nuclear reactors can be designed to produce nuclear materials that can be used in nuclear weapons is a grave concern to the world. As the knowledge of nuclear fission spreads it is becoming easier for countries or even private corporations to develop these. Many supporters of nuclear power argue that the knowledge is now so widespread that to not use atomic power because it will allow nuclear fissionable materials to be created is folly.

SEE ALSO: Carbon Dioxide; Chernobyl Accident; Electricity; Fossil Fuels; Russia (and Soviet Union); Three Mile Island Accident; Yucca Mountain.

BIBLIOGRAPHY. Joseph A. Angelo and David Buden, *Space Nuclear Power* (Krieger Publishing Company, 1985); Robley D. Evans, *The Atomic Nucleus* (John Wiley & Sons, 2000); International Atomic Energy Agency Staff, *Advances in the Operational Safety of Nuclear Power Plants* (Bernan Associates, 1996); International Atomic Energy Agency Staff, *Energy, Electricity and Nuclear Power Estimates for the Period up to 2020* (International Atomic Energy Agency, 1999); Glenn Frederick Knoll, *Nuclear Power Radiation Detection and Measurement* (John Wiley & Sons, 2000); John N. Lillington, *Future of Nuclear Power* (Elsevier Science & Technology Books, 2004); Marcia Amidon Lusted and Greg Lusted, *A Nuclear Power Plant* (Thompson Gale, 2004); Gene Metcalf, ed., *Nuclear Power* (Thomson Gale, 2006); Neil Morris, *Nuclear Power* (Facts on File, 2006); David E. Newton, *Nuclear Power* (Smart Apple Media, 2007); Galen J. Suppes and Truman Storvick, *Sustainable Nuclear Power* (Elsevier Science and Technology Books, 2006); Neil E. Todreas and Mujid S. Kazimi, eds., *Nuclear Systems: Thermal Hydraulic Fundamentals* (Taylor and Francis, 1989).

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Nuclear Regulatory Commission (NRC) (U.S.)

THE NUCLEAR REGULATORY commission (NRC) is the federal agency charged with the regulation of nuclear power and other uses of nuclear energy in the United States. Five commissioners lead the NRC, one of whom is the chair, appointed by the president and confirmed by the senate for five-year terms. Its regulatory activities address three aspects: materials, reactors, and waste.

Materials include nuclear fuel, as well as nuclear materials used in industry, medicine, and academic settings. Reactors include power reactors and experimental reactors at research and academic institutions. Waste involves the containment, transportation, and disposal of nuclear waste products—the last phase in the nuclear fuel cycle. High-level waste products are often highly radioactive, and therefore require careful handling. The NRC is at the forefront of efforts to develop a high-level nuclear waste disposal facility in Nevada.

The NRC's history is rooted in the history of its predecessor, the Atomic Energy Commission (AEC). The Atomic Energy Act of 1946 established the AEC as the agency that would promote, develop, and regulate nuclear power. The Atomic Energy Act of 1954 clarified the AEC's role in promoting efforts to build and operate nuclear power plants. But the AEC was unable to gain the interest of utilities to build nuclear power plants until the enactment of the Price Anderson act in 1957; this act limited the liability of utilities in nuclear plant accidents. This overcame utility concerns that, in the case of a power plant accident, their liability would be unlimited, making insurance virtually impossible to obtain. With the passage of Price-Anderson, the first civilian nuclear power plant went on line in Shippingport, Pennsylvania, and, in 1959, the first civilian nuclear plant built without government funding began operations.

The AEC and Congress's Joint Committee on Atomic Energy (JCAE) governed civilian nuclear power until the mid-1970s. Because of concerns about one agency promoting and regulating nuclear power, and because of concerns about centralized power in the JCAE, the Energy Reorganization Act of 1974 abolished the JCAE and the AEC. It created the NRC, which began its functions on January 19, 1975. The parts of the AEC that were not incorporated into the NRC were formed into the Energy Research and Development Administration (ERDA), which became the core of the U.S. Department of Energy (DOE) when it was formed in 1977. DOE also encompassed many of the military programs of the former AEC, while the NRC focused on the civilian uses of nuclear power. Congressional oversight over nuclear power was distributed among several congressional committees.

Since Three Mile Island in 1979, there has been no major nuclear power plant accident in the United States.

The NRC was created during a period of turmoil in the nuclear power field. In 1975, the Tennessee Valley Authority's (TVA) Browns Ferry, Alabama, nuclear plant experienced an accident that led to continued calls to subject nuclear power to scrutiny.

In this accident, candles were used for illumination during an inspection of cables; the cables ignited, leading to a fire that cut off the control room from the reactor.

This incident was described on TV's *60 Minutes*, and motivated interest groups, led by the Union of Concerned Scientists (UCS), argued that government estimates of the safety of nuclear power plants had been inaccurate. As a result, and because of methodological problems with the original assessment, by 1979 the NRC had fully repudiated the AEC's primary document that described the risk and probability of a major nuclear accident, the Rassmussen or WASH-1400 report. Also in 1979, the NRC confronted the Three Mile Island nuclear accident, the most serious civilian nuclear power accident in the United States.

Since Three Mile Island, there has been no major nuclear power plant accident in the United States, due to experience with operating reactors, more aggressive regulation by NRC, and reminders, such as the Chernobyl accident in the Ukraine in 1986, of the hazards of nuclear power and the need for continued regulation.

Today, the NRC's major challenge is in finding a suitable site to secure highly radioactive waste from nuclear power plants and other facilities. The need has become acute as some power plants begin to run out of space for storing spent fuel, and as concerns have grown over maintaining security over any radioactive materials at power plants. Reactor licensing renewals are also important tasks, and sometimes engender considerable debate as local community members voice concerns over plant safety and security.

SEE ALSO: Nuclear Power; Nuclear Weapons; Three Mile Island Accident.

BIBLIOGRAPHY. Frank R. Baumgartner and Bryan D. Jones, *Agendas and Instability in American Politics* (University of Chicago Press, 1993); David Dinsmore Comey, "The Browns Ferry Incident," in Lee Stephenson and George R. Zachar, eds., *Accidents Will Happen: The Case Against Nuclear Power* (Harper & Row, 1979); Congressional Quarterly, "Nuclear Insurance Program," *Congressional Quarterly Almanac* (v.31, 1975); Stephen Hilgartner, Richard C. Bell, and Rory O'Connor, *Nukespeak: The Selling of Nuclear Technology in America* (Penguin, 1983); James R. Temples, "The Nuclear Regulatory Commission and the Politics of Regulatory Reform: Since Three Mile Island," *Public Administration Review* (v.42/4, 1982); J. Samuel Walker and U.S. Nuclear Regulatory Commission, "A Short History of Nuclear Regulation, 1946–1999" (U.S. Nuclear Regulatory Commission, 2000).

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Nuclear Weapons

NUCLEAR WEAPONS ARE among the most destructive devices ever created by humanity and continue to represent a significant threat to human security. Nuclear weapons are also occasionally referred to as thermonuclear weapons or atomic weapons, although all function in approximately the same way. Fission weapons are based on the principle that a sufficient mass of appropriately treated uranium or plutonium will, once it has reached a critical mass, spontaneously explode. Consequently, two masses of the appropriate metal are, to trigger the detonation, forced together by some means. Fusion weapons aim to create conditions in which a thermonuclear fuel such as deuterium will be ignited, through using a fission-based triggering detonation, in a similar process to that which takes place in stars (these are known as hydrogen bombs).

The enormously powerful explosions produced by nuclear weapons mean that it is necessary to project the weapon some distance away to strike against an enemy without endangering the home territory and assets. This means that nuclear weapons are mostly designed to launch via missiles, with the warhead in which the subcritical masses are contained riding this vehicle and programmed to explode at a distance.

Airplanes, submarines, or satellites launch missiles, and these are usually strategic in nature, which means they have a large payload (explosive capacity) and are designed to launch over thousands of miles. The American Cruise Missiles are archetypical strategic nuclear missiles. In addition to strategic weapons, tactical nuclear weapons have been designed that are intended for battlefield usage against hardened or fortified targets with a comparatively low destructive level, although still far more destructive than nonnuclear or conventional weapons systems. As of 2006, the only nuclear weapons that had been exploded in warfare were the two atomic bombs dropped by the United States on the Japanese cities of Hiroshima and Nagasaki during World War II. These weapons killed many thousands, both through the effects of the blasts themselves, but also subsequently from cancers and similar diseases resulting from radioactive fallout. Since then, fear of nuclear weapons has resulted as much from the threat of horrible wasting diseases as the possibility of instant death.

There has been a considerable amount of secrecy concerning which nations possess nuclear weapons and which do not. In addition to the United States, Russia (formerly part of the Soviet Union), France, the United Kingdom, and China also have the ability to launch nuclear weapons. India and Pakistan were permitted by U.S.-led world opinion to obtain such devices at the beginning of the 21st century. It is widely believed that Israel and South Africa also possess weapons, but neither has formally acknowledged this. Some concern exists as to the possibility that North Korea or Iran will pursue a nuclear weapons program.

The International Atomic Energy Authority (IAEA), part of the United Nations, manages regulation of nuclear energy and weapons programs around the world. In general terms, the IAEA permits states to pursue nuclear energy programs, but not nuclear weapons programs outside of exceptional circumstances.

The need to control the proliferation of nuclear weapons started during the Cuban missile crisis of 1962, in which the possibility that the Soviet Union would place nuclear weapons on the territory of its ally, very close to the continental United States, in response to American deployments of weapons close to Soviet territory, nearly brought about a nuclear war.

During the decades of the cold war, the prevailing ideology was that of mutually assured destruction (MAD), which was based on the understanding that, owing to the many thousands of warheads that had been stockpiled over the years, any attack by one side would inevitably lead to the annihilation of everyone concerned. During the 1970s, a series of bipolar negotiations managed to ease tension and provided for the reduction of nuclear warheads in some categories. This included the Strategic Arms Limitation Treaty (SALT) and the Strategic Arms Reduction Treaty (START). In 1986, after the ending of the cold war by Soviet Premier Mikhail Gorbachev and the dissolution of the Soviet system, the world has been moving toward a new ideology to minimize the likelihood of the use of nuclear weapons in an essentially unipolar world.

Much anxiety exists about the possibility of terrorists obtaining nuclear material that could be used as a weapon, which would be more likely to be left as a bomb to be exploded remotely rather than launched by missile. A missile would require a higher level of technology than it is imagined that terrorist organizations could deploy and it would provide more of a warning for potential targets. Nevertheless, there remain considerable concerns about the security of old and decommissioned weapons and the possible environmental impact of weapons new or old releasing radioactive material into the atmosphere.

SEE ALSO: Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); Wars.

BIBLIOGRAPHY. E. Fox and S. Orman, "Do We Still Live in a MAD World?" *The Journal of Social, Political and Economic Studies* (v.30/2, 2005); International Atomic Energy Authority (IAEA), www.iaea.org (cited October 2006); William K. Lambers, *Nuclear Weapons* (Lambers Publications, 2006).

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Nuisance Law

NUISANCE LAWS STARTED just after the Norman Conquest and have been heard in the English courts since the 12th century. The basic assumption is that everyone has the right to the use and enjoyment of his or her land. Nuisance laws were for centuries the major method of regulating land use. When an action or inaction affects that use or enjoyment, it can be identified as a nuisance.

A nuisance can be categorized as either private or public. A private nuisance is a situation that affects the enjoyment or use of an individual's property without a trespass or physical invasion. A public nuisance is a condition endangering public health, morals, safety, comfort, convenience, or welfare of community members. The same nuisance, however, may be enforceable in both situations.

Nuisance laws or ordinances are generally defined at the local government level with a broader description at the state or province level. In some situations, there may be a fine distinction between nuisance and pollution law relative to the definition of the activity, standards, amounts, and location.

Nuisance laws concerned with the environment can be classified into three general categories: public health and well-being, environmental protection, and land use. Public health nuisance laws are designed to protect and preserve the public and infractions can range from smoking in nonsmoking areas to maintaining a yard that could breed infectious insects or vermin.

Well-being is a broad term and has many definitions; however, it generally relates to the perception of safety, comfort, happiness, and convenience. Nuisance laws protect that perception in several ways; one example is by controlling the use of land and structures that conduct illegal activities. An example of impinging on our convenience is to regulate activities that obstruct traffic and thus create traffic congestion.

Nuisance laws that protect the environment are generally associated with land, water, and air pollution. The laws vary and may regulate the dust or erosion from a construction site, the limits of sediment in a stream, or the amount of light emittance skyward. Overall, the nuisance laws protecting the environment are the regulations that control activity at the local level and reflect the community's environmental concerns.

Production and services are needed to sustain a local economy and these activities are conducted in factories, processing plants, and power stations. In addition, food and livestock production are necessary to feed the population. Nuisance laws attempt to mitigate the impacts of factory and agricultural production to the surrounding landholders as these activities can cause discomfort, inconvenience, and visual blight to neighboring landholders.

Nuisance laws endeavor to support these activities and at the same time provide protection to residential and commercial lands. These land uses are generally not a nuisance if conducted in suitable locations and following proper management procedures.

Nuisance law pertaining to land use is a balancing act between economic activity and community quality of life. Each community defines its quality of life and what is a suitable area for different land use activities. Thus, there are no standards to define minimum or maximum for land use interactions.

A nuisance is an unreasonable interference with the use or enjoyment of land. A frequent paradigm for determining whether a nuisance exists is the weight of the gravity of the harm to the landowner or public against the utility of the use or the nuisance. The main points to consider are the character of the harm, the social value of the use, the suitability of that use to the character of the area, and the impracticality of avoiding the harmful invasion. In other words, is it reasonable for the action or inaction to take place in that location or does it impede the individual landowner or the public from using or enjoying the land?

SEE ALSO: Land Use; Land Use Policy and Planning; Policy, Environmental.

BIBLIOGRAPHY. D.L. Callies, R.H. Freilich, and T.E. Roberts, *Cases and Materials on Land Use* (West Group, 1999); J.C. Juergensmeyer and T.E. Roberts, *Land Use Planning and Control Law* (West Group, 1998); D.R. Mandelker and J.M. Payne, *Planning and Control of Land Development: Cases and Materials*, (Lexis Nexis, 2002); R.R. Wright and M. Gitleman, *Land Use in a Nutshell* (West Group, 2000).

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Nutrients (as contaminants of water)

NUTRIENTS IN WATER are chemicals such as calcium, oxygen, nitrogen, phosphorus, various trace minerals, salts, and even decomposing organic material. Some nutrients occur naturally in water in varying amounts. However, chemicals that can serve as nutrients that are due to runoff from farms, urban areas, industrial waste, or sanitation effluent can create significant pollution problems as well as long range health problems for both humans and the environment.

Natural nutrients are produced by the naturally occurring chemical action of water and other elements or compounds that leach into the watershed. The farther downstream it is from the watershed at mountain peaks, the more water is likely to contain oxygen, carbon dioxide, dissolved calcium compounds, and other substances. If the water in a stream begins in an area where it moves through petroleum seeps, coal beds, sulfur beds, iron bearing rocks, or other kinds of rocks with water soluble minerals, it will contain more naturally occurring nutrients.

The mineral content may make the water heavy in iron so that it clouds the bottom of ice water glasses in the summer as it combines with dissolved calcium carbonate to form a precipitate. Or it may be that the water is acidic, salty, or naturally fluorinated. If a strong basic solution is dissolved in the water, such as in the alkali waters of the western United States, the water will have an unpleasant taste.

As natural nutrients are cycled through natural ecosystems they have an important impact. If the ecosystem is naturally rich in nutrients then plants grow rapidly. Among the effects this has is the amount of carbon that is put into plant life and the amount of oxygen given off by plants. There may be consequences from this ecological balance that affects even the global climate.

All of the dissolved chemicals and organic material in water provide nutrients. Some, however, may be pesticides or herbicides that have an immediate and long term negative impact. These will ultimately be degraded in the environment; however, they are not the chemicals that are usually included when referring to nutrients.

Eutrophication occurs when increases in chemical elements lead to population explosions of microorganisms such as algae and blue-green bacteria. These become so thick that light is blocked. The light dependent organisms die, which creates a cultural eutrophication. As plants in nutrient deficient areas are exposed to polluting quantities of nutrients, their roots grow in response and their intake of other plant nutrients is increased. The varied growth rates of plants can produce situations in which some plants crowd out others that were a part of the natural system.

Vegetation that grows in rivers and in the waters that cover the continental shelves of the world respond to nutrient changes in several ways. The slower growing sea grasses, the phytoplankton, and other parts of the food chain change in quantity affecting the natural character of the ecosystem.

Nutrients can be readily consumed by a variety of microscopic plants and animals and cause their growth in watersheds. In effect, they act as fertilizers or food boosters that stimulate growth, which is often harmful to the environment's natural balance when some of these enter into the food chain. Consequently, of great importance to the health of water supplies, including the vast oceans, are the great quantities of industrial and urban wastes that enter water streams. Paper mills are a major source of nutrient chemicals. Their effluents often can be detrimental to riverine food webs and are also capable of reducing oxygen content, thus resulting in fish kills.

The presence of polluting chemicals that act as nutrients and come in large volumes from human sources poses a significant threat to human life. The volume of renewable fresh water on Earth is a small fraction of the total volume of water; about half of all fresh water is currently in use in some fashion around the globe. Fresh water supplies are basic to terrestrial life and to freshwater ecosystems. Great numbers of agricultural and industrial users of water depend upon clean fresh water. Among the chemicals that are of serious concern are ammonia, phosphates, and nitrates.

In 1991, the U.S. Congress directed the U.S. Geological Survey (USGS) to develop a National Water-Quality Assessment (NAWQA) Program. It works with federal, state, and local governments and agencies to examine the water quality in the United States. In its studies, the program has found that in some areas pollution has been a positive addition to a nutrient poor watershed. However, the reverse is more often the case.

One effect of dissolved organic matter in polluted water is that it acts to deplete both nitrogen and phosphorus from timberlands. Agriculture is a major source of polluting nutrients in watersheds. Farming and other agricultural activities take place on the best lands; the margins are usually less productive and are often adjacent to wetlands that connect with the watershed. Water, moving toward lower elevations, carries nutrients like fertilizer toward wet areas where the excessive nutrients will move into the watershed.

The effects of polluting nutrients are most observable when they produce dramatic toxic effects on the aquatic life. Watersheds can recover from occasional polluting, but long term damage occurs with prolonged exposure. As the polluting continues, the habitat traps and processes the nutrients. The buffering zones along riparian areas are overcome and the fauna and flora of an area are affected. The food chain is soon involved because chemicals are absorbed and passed up the chain with significant toxic effects.

When polluting nutrients affect an area, ecologists and conservationists may seek to restore the area to its natural state. This requires elimination of the nutrient pollution at its source(s), removal of excessive growth, and restoring native species. Elimination of nutrients that affect the food chain in systems in which sewage plays a role generally requires bacteria, molds, and other microscopic organisms. Sewage systems that use ponds for aeration will not become nutrient polluting sources if they are not overworked. If their systems are kept balanced then a healthy environment is the result.

SEE ALSO: Eutrophication; Food Webs (or Food Chain); Pollution, Water; United States Geological Survey; Water Quality; Watershed Management.

BIBLIOGRAPHY. J.P. D'Mello, *Food Safety: Contaminants and Toxins* (CAB International, 2003); Brian Kronvang, Jadran Faganeli, and Nives Ogrinc, eds., *Interactions Between Sediments and Water* (Springer-Verlag, 2006); Colin F. Moffat, ed., *Environmental Contaminants in Food* (CRC Press 1999); National Research Council, *Identifying Future Drinking Water Contaminants* (National Academies Press, 2000); n.a., *Nutrient Management in Agricultural Watersheds: A Wetlands Solution* (Wageningen Academic Publishers, 2005); Piotr Szefer, *Metals, Metalloids, and Radionuclides in the Baltic Sea Ecosystems* (Elsevier Science & Technology Books, 2002).

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Oasis

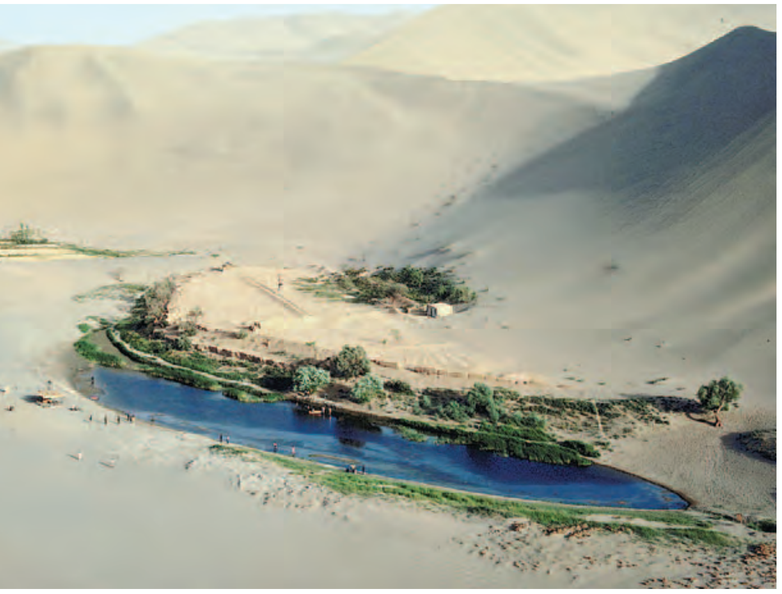
THE EARTH ITSELF is an oasis: An island of life in a vast and, as far as is known, mostly sterile solar system. Most envision the oasis as the classic, palm-filled area of land, an island in the desert. This is the type of oasis that will be described here, along with the unique environmental and social challenges faced by these fragile pockets of water and life.

What makes an oasis is not necessarily that it has life and a consistent source of water, but the fact that it is surrounded by a dry or largely lifeless expanse. Thus, what makes the oasis an oasis is not necessarily what grows within it but the desert surrounding it. An oasis must be disconnected from other regions with water to be considered a true oasis: A region of concentrated life and water standing alone. Like the earth, the oasis is dependent on water for its survival.

Most oases are small and uninhabitable watering holes where Bedouin or yearly migrants bring their livestock. Larger oases that have enough water to support life are rarer. These large oases have been exploited by social groups who use the desert as a shield and flee from central authority. Many simply wish to take advantage of the natural resources available in the oasis. Yet with such a small, contained ecosystem these societies face many environmental challenges; often the costs of isolation outweigh the benefits. While some oases are sustained by human ingenuity, many other oases and their water supplies are exploited beyond their capacity by human inhabitants, leading to the destruction of oasis habitants. Thus, in many ways, oases provide environmentalists, sociologists, and anthropologists an isolated microcosm of humanity's struggles with environmental scarcity.

Most oases are formed when land is low enough, or the ground porous enough, to allow a spring or pool to form from the aquifer: A region below the ground where water from far away, or from long ago, had reached the bedrock. The spring either naturally supports flora and fauna, or the water is exploited by humans; it is sent into channels and used for the irrigation of crops. Thus, by exploiting water humans can vastly expand the natural limits of an oasis, at least in the short to medium term.

There are three major, long-term human activities in oases, however, that can lead to the destabilization of oasis habitat and desertification, the advance of the desert into the oasis. These three activities are deforestation, overcultivation, and overgrazing. Deforestation, driven by a need for fuel and energy from wood, leads to erosion on the edge



Oases arise when low-lying land or porous ground allows a spring or pool to emerge from an aquifer below.

of the oasis. Overcultivation, the growing of food crops and cereals, also leads to the cutting of trees and the clearing of land. Often the land is rotated and allowed to lay fallow, but overpopulation can lead to overexploitation of the land. Without any cover, fertile soil can be blown away by the wind. Overgrazing by livestock, not only within the oasis community, but also by the large livestock brought into oases by migrating tribes, leads to the creation of permanent pasture out of once lush and fertile land. This also leads to conflict between settled agricultural and migratory tribes, a conflict that has come to a head today with the crisis in Darfur, Sudan. The Janjaweed, who have recently been driving villagers off oases are, for the most part, from migratory tribes. Indeed, as the current crisis of oasis communities in the Sudan suggests, it is in the best interests of the human population in general to come to an agreement over the sustainable use of the largest known oasis: the planet Earth.

SEE ALSO: Desert; Desertification; Sudan; Water; Water Demand.

BIBLIOGRAPHY. Madawi al-Rasheed, *Politics in an Arabian Oasis* (IB Tauris, 1991); H. Beadnell, *An Egyptian Oasis* (John Murray, 1909); Leif Manger, *The Sand Swallows Our Land* (University of Bergen, 1981); C. Nelson, ed., *The Desert and the Sown* (University of California at Berkeley, 1973).

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Obesity

OBESITY IS THE condition of being overweight. The specific definition of obesity may vary depending on source, but is frequently characterized by individuals who are at least 20 percent above their ideal body weight, based on age and height. Obesity has been linked with medical conditions such as diabetes, high blood pressure, strokes, and coronary heart disease. Worldwide, the number of obese people continues to rise.

Historically, obesity was an uncommon feature of social life. Through much of human history the primary dietary concern was the pursuit of adequate nutrition. In preindustrial environments obtaining and/or growing food was a difficult endeavor. In some societies in the past, being overweight or obese served as a marker of status; the ability of an individual to obtain high-caloric and excess food was affiliated with a higher socioeconomic position.

In the 20th century, the existence of obesity has emerged as a social issue in both developed and developing countries. The increased incidences of being overweight or obese vary in the developed world. The United States, in particular, appears to be facing a growing epidemic, with more than a third of Americans being overweight. In contrast, European nations tend to have lower incidence of obesity; however, the numbers of overweight individuals in many of these nations are also on the rise.

Traditionally, it was believed that obesity was only an issue in developed societies, but it is becoming apparent that obesity is affecting populations in developing societies. One correlation that appears to be associated with growing incidences of obesity in the developing world is the increasing likelihood of a Western diet, which is often more inclusive of meat and carbohydrates, as well as high calorie processed foods. Still, many underdeveloped nations continue to face famine and undernourishment, which are strongly influenced by economics. In these societies, obesity emerges primarily among higher socioeconomic groups.

Industrialization and increasing dependence on and use of technology are affiliated with this shift toward obesity. Technology first enabled the expansion and further development of agriculture, which improved the availability of crop foods for consumption. New means of transportation eased the distribution of food goods within a nation and between nations. Increased supply of diverse food sources, particularly within nations able to afford them, has expanded the choices and palates of many within the developed world. Technology has also fostered the transformation of food crops into high calorie processed foods. The consumption of calorie-dense foods, such as snack goods and soda, has been strongly tied to obesity.

Technology has also changed the types of work people do. In developed nations, many people no longer do much manual labor. This transformation of work has led to decreased calorie spending and has been complimented by increased calorie consumption, leading to obesity. Finally, technology, particularly media such as television, has led to more sedentary leisure activities (also often accompanied by increased calorie consumption) which may also lead to obesity.

SEE ALSO: Agriculture (including Agricultural Revolution); Fast Food; Food; Technology.

BIBLIOGRAPHY. Eric A. Finkelstein, Christopher J. Ruhm, and Katherine M. Kosa, "Economic Causes and Consequences of Obesity," *Annual Review of Public Health* (v.26, 2005); Carlos A. Monteiro et al., "Socioeconomic Status and Obesity in Adult Populations of Developing Countries: A Review," *Bulletin of the World Health Organization* (v.82, 2004); Rodolfo M. Nayga, Jr., "Sociodemographic Factors Associated with Obesity in the USA," *Journal of Consumer Studies & Home Economics* (v.23, 1999); E.M. Young, "Globalization and Food Scarcity: Novel Questions in a Novel Context?," *Progress in Development Studies* (v.4, 2004).

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Ob-Irtysh River

THE OB RIVER originates in the Altai Mountains in southern Russia and flows northwest across the Western Siberian Lowland, a vast expanse of flat land surrounded by mountains on three sides and the Arctic Ocean to the north. The Irtysh River begins in the highlands of China's Sinkiang Province, flows to the northwest, and joins the Ob near the town of Khanty-Mansiysk well within the Western Siberian Lowland. To the east of the Ob/Irtysh Basin and along the foothills of the Central Siberian Highlands the Yenisey River flows north to its mouth on the Arctic Ocean. Both of these river systems move considerable volumes of water across the flat expanse of the confined lowland.

Because the rivers flow north, they freeze in the fall of the year from their mouths southward precluding the free flow of water within its channel. When the spring thaws begin, water is first liberated along the southern extent of these mighty rivers. The physical outcome in both seasons is the accumulation of millions of gallons of water on the surface of the lowland. Some of the water is absorbed into the ground, but most of the accumulation stays on the surface creating a literal swamp comparable in size to approximately one-third the area of the contiguous United States. In winter the swamp turns into an enormous field of ice. In the warm season the standing water makes transit across the plain nearly impossible. In addition, much of the lowland is underlain with permafrost, a condition that limits the amount of water that can be absorbed and renders the surface impractical for the construction of road beds and rail lines. The Trans-Siberian Railroad, which runs from St. Petersburg to Vladivostok, crosses the Ural Mountains at Yekaterinburg and then proceeds south and east in order to avoid the swamp conditions on the lowland.

Both the Ob and Irtysh are navigable during the warm seasons. Since 1933 the Russian Northern Sea Route has operated large vessels on the ice-free waters of the Arctic Ocean near the Siberian coast and in the major rivers for four months a year. The city of Omsk is an important river port on the Irtysh, and Novosibirsk, home of the world famous Academ Gorodok (Science City), a cluster of national research institutions, is located on the

Ob. Both cities are key points on the Trans-Siberian Railroad. A number of hydroelectric generating plants have been built at points in the Ob-Irtysh river basin and a dam was constructed on the Ob at Novosibirsk, creating the Ob Sea, the largest artificial lake in Siberia.

The Ob River has been identified as a possible source of water to refill the decimated Aral Sea, which has dried to about 10 percent of its original size. The demise of the Aral Sea is one of the most serious environmental catastrophes in recent years. The Davidov Plan, conceived during the Soviet era, envisioned the construction of water diversion channels leading from the Ob River to the Aral Sea and other areas within the deserts of Kazakhstan. However, the plan was shelved following the introduction of glasnost in the 1980s and the Aral Sea continues to shrink.

SEE ALSO: Aral Sea; China; Rivers; Russia (and Soviet Union); Ural Mountains.

BIBLIOGRAPHY. Ruth Jenkins, *Russia* (Facts on File, 2005); Victor L. Mote, *Siberia: Worlds Apart* (Westview Press, 1998); Philip R. Pryde, *Environmental Management in the Soviet Union* (Cambridge University Press, 1991); Denis Shaw, *Russia in the Modern World* (Blackwell Publications, Inc., 1999).

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Oceanography

THE TERM *OCEANOGRAPHY* refers to a descriptive science of the marine environment. Within the study, there is a wide variety of separate fields of scientific study, such as geology (including studies of marine and coastal sediments and studies of submarine tectonic plates and processes that affect coastal land forms), biology (for example, marine zoology, ecology of marine species, and marine microbiology), geography and meteorology (particularly oceanic processes that affect weather and climate), astronomy (the effects of astronomical bodies on tidal forces), physics (including fluid dynamics, currents, the behavior of waves, the effect of temperature on marine waters, and the behavior of sound in water), and, finally, chemistry (for example, the density of marine water bodies and the study of dissolved substances in seawater and chemical pollution in marine waters).

Oceanography can entail studies in the open ocean environment (oceanic) or in the coastal environment (neritic), on the sea bed (benthic) or in open waters (pelagic). Studies of the estuarine environment (enclosed areas where freshwater meets the marine environment) are also covered by the term. As such, oceanography encompasses a very broad field of scientific research.

The physical area encompassed by the field is also substantial, i.e., 71 percent of the world's surface is covered by oceans, with the Pacific Ocean encompassing an area equal to that of all continents combined and covering half the planet's surface. The importance of the marine environment is also emphasized when one considers that marine areas actually make up 99 percent of the known biosphere. However, 80 percent of the world's oceans remain effectively unexplored.

The scholar Rupert Riedl divides the history of exploration of the marine environment into four principal eras. First was the time of seafarers, which began either circa 2500 B.C.E., with the Polynesian exploration of the Pacific, or circa 1200 B.C.E., with the journeys of the Phoenicians. These ancient mariners sailed the eastern Atlantic as far north as the British Isles and as far south as the tip of southern Africa. Later came the expeditions of the Norse explorers to Greenland and North America in the late 10th century, and later still those of famous European explorers such as Columbus and Magellan.

One individual who stands out in this era of exploration is Captain James Cook. Starting in 1768 he made three voyages to map the world's oceans and landmasses, discovering New Zealand, Tahiti, Australia, and South Georgia; exploring the Southern Ocean; and charting the Hawaiian Islands, the west coast of North America and the Bering Sea. He became the first person to sail in both polar seas. In addition, Cook also recorded important oceanographic information such as ocean depths, prevailing wind directions, surface currents, and water temperatures.

The second era was the era of major oceanographic expeditions. Probably the most famous of these was the British Challenger Expedition (1872–76). Six scientists undertook a four-year voyage on the HMS *Challenger* to study the chemical composition of seawater and the distribution of marine animals, to record coastal and ocean currents, and to map ocean basins. This expedition made 362 soundings in the Atlantic, Pacific, and Indian Oceans, mapped major currents, and collected 7,000 marine specimens. The researchers identified 4,417 species new to science. The data accumulated from the expedition took 20 years to analyze and was published in 50 volumes as the *Challenger Reports*.

Marine expeditions were followed by the era of marine laboratories and research stations. The oldest marine station in the world was established in Kristineberg, Sweden, in 1830, followed by stations in Concarneau, France (1859), Naples, Italy (1872), St. Andrews, Scotland (1884), and Plymouth, England (1888). These United Kingdom (UK) stations were preceded by the oldest British marine laboratory, the *Ark*, which was a floating barge converted into a laboratory that was first moored in Scotland at Granton near Edinburgh (1884), then moved to Millport near Glasgow in 1885.

In the United States, the U.S. Commission of Fish and Fisheries (now known as the National Marine Fisheries Service) began a station at Woods Hole, Massachusetts, which still exists as the Northeast Fisheries Science Center, and in 1888 Alpheus Hyatt established the Woods Hole Laboratory. The current Woods Hole Oceanographic Institution was established in 1930. In 1903 on the West Coast of the United States, a marine biological laboratory was established in San Diego, which in turn became part of the University of California in 1912 and was renamed the Scripps Institution of Oceanography.

The fourth era of marine discovery was the era of field studies. This was greatly aided by the invention of the self-contained underwater breathing apparatus (SCUBA) by Emile Gagan and Jacques Cousteau in 1943. SCUBA allowed researchers to directly observe marine species in their natural environment. However, only about two percent of the ocean's volume is accessible to scientists using SCUBA equipment; manned submersibles have increased the depths humans have been able to reach to study organisms and features in the field. Remotely operated vehicles (ROVs) have been used underwater since the 1950s and are also an important means by which researchers study oceanographic features and marine organisms. ROVs are unmanned submarine robots with umbilical cables transmitting data between the vehicle and researcher. They have the advantage of being able to operate for longer periods and at greater depths than human divers and do not involve risk to human operators. They are also considerably less expensive to operate than manned submersibles.

Satellites are increasingly being used as another means of gathering data in oceanographic studies. They can be used for mapping marine habitats such as coral reefs, tracking marine life tagged with sensors to determine migratory patterns, and gathering data such as sea surface temperature—which in turn can provide information on currents, cold water upwellings, and climate. Satellites can also observe the color of the ocean, giving information on chlorophyll abundance and, hence, oceanic productivity. It could be argued that we are entering the oceanographic era of remote observational studies.

The scholar Michael Stachowitsch has suggested that there is an additional (current) era of marine/oceanographic research, one in which scientists are studying deteriorated marine ecosystems. He writes that almost all marine ecosystems have been disturbed and damaged by human activities. Indeed, examining the global extent of marine pollution, assessing stocks of marine species depleted by overexploitation, and evaluating the current effects of global warming on oceanographic processes and marine life are all becoming major areas of marine research.

SEE ALSO: Biosphere; Ecology; Ecosystem; Global Warming; Marine Pollution; Marine Science; National Marine Fisheries Service (U.S.); Zoology.

BIBLIOGRAPHY. P. Castro and M.E. Huber, *Marine Biology*, 5th ed. (McGraw-Hill, 2005); R. Reidl, "Marine Ecology—A Century of Changes," *Marine Ecology* (v.1, 1980); M. Stachowitsch, "Research on Intact Marine Ecosystems: A Lost Era," *Marine Pollution Bulletin* (v.46, 2003); K.A. Sverdrup, A.C. Duxbury, and A.B. Duxbury, *An Introduction to the World's Oceans*, 7th ed. (McGraw-Hill, 2003); H.V. Thurman and A.P. Trujillo, *Introductory Oceanography*, 10th ed. (Prentice Hall, 2004).

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Oceans

OCEANS COVER 71 percent of the earth's surface and contain 97 percent of the planet's water. Over 20 percent of the world's petroleum is derived from offshore sources, and 95 percent of world trade by weight—or two-thirds by value—is carried by ship. Eighty percent of the world's fish catch comes from the ocean, supporting the livelihoods of 140 million people. Economists have calculated that the world's oceans provide services to humanity valued at 21 trillion dollars, as opposed to only 12 trillion dollars provided by land.

Yet the ocean has emerged as an area of environmental concern only recently. In the European tradition of marine management, it was long believed that the ocean's resources were inexhaustible and that its environment was invulnerable to damage from human activities. These beliefs contributed to 17th-century jurist Hugo Grotius's assertion that, beyond the coastal zone, the ocean should be immune to possession by states, a legal principle that continues to inform the law of the sea.

By the mid-20th century, however, it was becoming clear that the ocean demanded the attention of environmental scientists, activists, and policy makers. Economic competition was breeding technological innovations that were increasingly endangering the marine environment. For instance, competitive pressures were leading fishers to adopt new technologies. These new technologies not only enabled higher catch rates, but they also led to a situation wherein fishers *had* to catch more fish in order to pay for their expensive equipment. Similar dynamics were occurring in the emergent industry of offshore petroleum drilling. At the same time, an increase in the volume of shipborne trade—from 996 million tons in 1959 to 6,760 million tons in 2005—was increasing the potential for ship-generated pollution.

As the 20th century proceeded, more effluents from industrialization, urbanization, and chemical agriculture on land were finding their way to the sea, joining waste products that were being dumped there intentionally. As oceanographers gained a better understanding of ocean currents and marine geophysics, they realized the magnitude of the connections among the world's oceans: What seemed like a local environmental problem could have global implications. Indeed, environmental scientists today usually speak of one world-ocean rather than several smaller oceans.

In addition, as climatologists have learned more about periodic climactic events (e.g., the El Niño Southern Oscillation and the North Atlantic Oscillation) and global climate change, they have gained an appreciation of the ocean's role as both an indicator and regulator of trends in the world's climate. An increase in the atmospheric temperature, for instance, would raise the temperature of the ocean. This, in turn, could lead to disastrous impacts for fish stocks, human populations (because of increased storm activity), and ocean circulation systems. Alterations in the ocean circulation system, in turn, could further impact local climates, creating a vicious cycle of climate change in which the ocean would play a leading role.

Increased scientific understanding of (and concern for) the marine environment has been joined by a growth in public awareness. The adventures of celebrity-explorers like Jacques Cousteau, the writings of environmental travel writers like Carl Safina, the interventions of policy advocates like Sylvia Earle, and the warnings of environmental muckrakers like Rachel Carson have all alerted the public to the world's endangered marine environment. To raise environmental consciousness, environmentalists have used a number of images that highlight the ocean as a space deserving protection: The image of the globe from outer space, which illustrates the significance of water on the "blue planet"; the romantic ideal of the ocean as a pristine space of nature that is free from the institutions and influences of human society; and the exotic character of iconic marine fauna and flora, such as whales, manatees, and coral reefs.

MANAGEMENT PROBLEMS

Despite the upswell of support for protecting the environment, it has been difficult to achieve effective ocean governance. In part, this is because marine resources are common property resources. Individuals have little incentive to effectively manage a resource if they believe that others will benefit from their sacrifice. Proponents of this "tragedy of the commons" scenario contend that all fishers have an incentive to overexploit a fishery, because if they were to show restraint it would only aid their neighbor's catch. Compounding this problem is the fluid nature of the ocean as a physical space. Put simply, fish and pollutants move. If one individual (or one country) chooses not to fish a certain species in order to conserve it, that fish will likely move into another individual's (or country's) territory, where it can be caught. Most pollutants are similarly mobile in the ocean (as they are in the air). One has less of an incentive to curtail marine pollution if one believes that others will bear the bulk of the cost.

These problems are exacerbated by the fact that much of the ocean lies outside the territory of any state. To implement any restrictions in international waters, all states (or at least all sea-going states) would have to agree to curtail the behavior of their ships. This rarely happens, given the competitive nature of the global political-economic system in which states are central actors. But even if all states were to adopt a program for effectively managing the ocean, there still would be the problem of enforcement. Under international law, the High Seas (the area of the ocean beyond the borders of any state) are considered the territory of no one.

A ship on the High Seas is treated as an extension of the territory of the state whose flag it is flying (a ship not flying any national flag is legally designated as a pirate ship and can be seized by any other ship). This means that if the world's states were to agree to marine environmental regulations, they would have two options for enforcement: Either each state would be responsible for policing the environmental behavior of its own ships or all states (or at least all sea-going states) would have to cooperate together to patrol the High Seas. Either option would be tremendously expensive. Even in a state's territorial waters (or in its Exclusive Economic Zone [EEZ], the zone between 12 and 200 nautical miles from shore in which a state has exclusive rights to its resources), many states are unable to mount effective patrols. As a result, many countries lose substantial revenues due to resources that are "poached" from their EEZs or territorial waters. In international waters, policing is nonexistent. Thus, even if all of the world's sea-going states were to agree on a marine conservation strategy, they also would need to devote tremendous resources to patrolling the seas so as to prevent rogue states (or rogue ships) from "cheating."

Finally, efforts to develop a comprehensive regime for managing the world's marine environment have been hampered by the fact that the most important use of the sea, in terms of economic value, is associated with its function as a surface for shipping. Shippers (and the world's navies) depend on the sea being a relatively open space—with few boundaries, few rules, and few policing authorities—and they have long been wary of efforts to govern and patrol the ocean, for fear that these efforts might encroach on the "freedom of the seas" that they enjoy.

FISHERIES MANAGEMENT

Notwithstanding these obstacles, there have been many efforts to manage the marine environment at a number of scales. Historically, many fisheries have managed themselves. Common property resources have not always been constructed as open access. In some instances, new entrants have not been allowed to fish existing areas. In other cases, all fishers have agreed to limit their technology. Knowledge may be tightly guarded, effectively barring new entrants from an existing fishery. Seasonal restrictions and catch limits are common as well. In some communities, fishers obtain formal tenure rights over aquatic resources. In Japan, for instance, no conceptual distinction exists between land holdings and land tenure and sea holdings (or sea tenure) and fisheries enjoy a legal status equal to that of land ownership.

When these techniques have been adopted by state fishery management agencies, they typically have been aided by calculations regarding a fishery's Maximum Sustainable Yield (MSY). To determine a fishery's MSY, ecologists examine population dynamics in a fishery and model the changes that are likely to occur from increased or decreased fishing rates and from changes in the marine environment. Using these models, one can estimate the maximum rate of extraction that will allow the fishery's population to remain stable.

MSY is not without its critics. Some have noted that MSY calculations typically revolve around sustaining the viability of a specific species and not that of an ecosystem. Allowing one species to thrive through partial protection may lead other species' populations to expand or decline, which could precipitate a cascading series of unforeseen circumstances that may—in the end—endanger the survival of the very species that one was initially trying to protect.

Others have noted that MSY models are based on the principle of sustaining fish and not the communities of humans that depend on those fish. Still others note that MSY models are informed by the assumption that local environments are essentially stable and tend toward equilibrium, and they charge that this assumption may not represent the actual dynamism of local ecologies.

Once an MSY is established, governmental agencies (in some cases at the national scale and in other cases at more local scales) typically implement a number of strategies to reduce annual fish catch to this level. In some cases, governments attempt to reduce the size of regional fishing fleets through voluntary means, for instance by offering to buy back fishing equipment and to train fishers for new livelihoods. Sometimes governments will resort to more top-down measures, such as prohibiting the use of certain technologies, shortening the fishing season, banning the harvesting of juvenile fish who have not reproduced, or setting seasonal or daily catch limits.

There also have been efforts to give consumers the lead role in mandating sustainable fishing practices. This involves "green labeling" fish that have been harvested from sustainable fisheries. If consumers refuse to purchase fish or fish products that do not bear this label, then fisheries will have an incentive to modify their practices so as to obtain certification.

Another means for managing fisheries involves the institution of Individual Transferable Quotas (ITQs). ITQs effectively transform a fishery from a common property resource into individual property. In a typical ITQ system, each fishing vessel is given an ITQ, which essentially is a license to fish a percentage of the MSY. In theory, over time the less efficient fishers will sell their ITQs to more efficient fishers, creating a fishery that is both economically profitable and environmentally sustainable.

In practice, however, outside interests often end up buying and controlling large fleets of vessels, disrupting what previously may have been a self-governing fishing community. Because they can choose to sell their ITQs and take their investments elsewhere, these outside interests may be even less devoted to the sustainable management of the fishery than were the local fishers who had been fishing it as a common property resource.

MARINE PROTECTED AREAS

Perhaps the most sweeping technique for managing the oceans is the establishment of Marine Protected Areas (MPAs): bounded territories in the ocean in which certain marine activities are not allowed. These may be established as a temporary measure (for instance, to allow a species to rebound after years of overfishing) or as a permanent measure (for instance, as an underwater national park).

MPAs cause dramatic dislocations in existing fishing (and other ocean-going) communities, and some critics have also questioned whether MPAs are truly designed to support the ocean environment or whether they are simply a strategy used by one ocean-using industry to remove the presence of a competing ocean-using industry. For instance, in the waters of the coast of Florida much of the pressure for drawing boundaries around an area in which offshore drilling is prohibited has come not from environmentalists seeking to preserve the marine ecosystem but from the tourism industry, which is dependent on attracting beachgoers and sport-fishers and which would be devastated by a coastal oil spill. Likewise, several tropical islands in the Caribbean and the Indian Ocean have established MPAs where fishing is banned. Critics charge, however, that this is being done not so much to preserve local fish stocks as to create protected spaces for scuba-diving tourists.

The UN estimated that as of 2000, approximately 50 percent of the world's fish species were being harvested at their maximum sustainable yield and 25 percent were overfished.

INTERNATIONAL AGREEMENTS

As heavily-capitalized fleets began fishing distant waters, whether on the High Seas or near to another country's coast, fisheries regulation entered the arena of international treaty law. Some of the first international fishing regulations were bilateral treaties governing specific fish stocks that were known to swim between two adjacent countries' territorial waters, such as the 1830 English-French accord on fishing in the English Channel and the six-state North Sea convention of 1882.

These were followed by multilateral treaties that—although covering larger areas and extending into portions of the High Seas—were still regional, including United States–Canada accords on North Pacific halibut and salmon, signed in 1923 and 1930, respectively, and a 1943 eleven-state accord governing fishing of various species in the Atlantic and Arctic. While some treaties like these remain important, others have become obsolete as the standard breadth of a state's territorial waters has grown from 3 nautical miles (the norm until the 1960s) to 12 nautical miles (the norm since then), and as states have claimed EEZs out to 200 nautical miles. These expansions of state authority in the sea were legitimated by the 1982 United Nations (UN) Convention on the Law of the Sea (UNCLOS), and, in some cases, they have obviated the need for international accords and facilitated state efforts to manage fisheries.

Even with these extended territorial waters, however, there are still some species that defy unilateral or bilateral control because they are harvested in waters beyond the 200 nautical mile limit or because they migrate over several states' EEZs. International policy makers realized early on that conservation of these species posed a particularly difficult problem, and some of the early multilateral marine treaties—including a 1926 whaling convention and a 1949 tuna convention—were specifically directed at these highly migratory species that often are harvested beyond the continental shelf.

In 1995, just as UNCLOS was coming into force, the UN passed a side agreement "relating to the conservation and management of straddling fish stocks and highly migratory fish stocks" that encouraged the establishment of regional fishing associations among states whose vessels fished an area of the High Seas and adjacent EEZs.

The side agreement required that states belonging to a regional fishing association ensure that their vessels follow whatever rules might be agreed to by these associations as well as follow any rules that had been established by global treaties restricting the harvesting of a specific species. Membership in a regional association (or in a global treaty) is voluntary, however, and neither individual states nor the UN has the authority to remove a ship flying the flag of a nonmember state from a High Seas fishery.

Amidst this patchwork of regulatory frameworks, efforts to manage the world's fisheries have been only partially successful. The UN Food and Agricultural Organization (FAO) estimates that, as of 2000, approximately 50 percent of the world's fish species were being harvested at their MSY, 25 percent were being overfished, and 25 percent could be fished at higher rates.

The FAO also notes that the percentage of fish species being overfished has increased significantly since the early 1970s. Furthermore, declining populations of some species are leading fishers on a race, quite literally, to the bottom, as fishers redirect their efforts to the ocean's depths where they are harvesting cold-water species that previously had evaded their attention. These fish, which often are culinary delicacies, typically grow and reproduce at very slow rates and hence are extremely vulnerable to population collapse and even extinction.

SHIPPING

While global fishery regulations, for the most part, have been organized by states (operating on their own or through the UN), the shipping industry has largely regulated itself. Individuals and corporations that trade goods via ship require that ships carry insurance, and insurance companies require that ships are manufactured and operated according to certain standards, so as to maximize the likelihood that the ship will deliver its cargo safely. Industry-associated institutions include Lloyd's of London, which, since 1834, has been classifying ships according to their construction standards and operating conditions, and the Comité Maritime International (CMI), an association of national maritime-law associations created in 1897 to facilitate the creation of universal industry standards.

Historically, however, few of the self-regulations adopted by the shipping industry have concerned the marine environment through which ships sail. Instead, the industry has focused on such issues as: Ship owners' liability, duty to tender assistance, salvage rights, mortgages and liens on ships, safety of navigation, immunity of state-owned ships, treatment of stowaways, status of ships in foreign ports, and registry rules. Ship owners have largely ignored the marine environment for the simple reason that, unlike fishers, the degradation of the marine environment would have minimal impact on their business.

Nonetheless, shipping can impact the environment, both from wrecks (most notably of oil tankers) and from normal operations (e.g., discharge of bilge water). The National Ocean Industries Association, a U.S. industry group, estimates that 44 million gallons of petroleum are released into the ocean annually by tanker ships, and additional quantities of petroleum and other pollutants are released by ships transporting goods other than petroleum. Discharged ballast water also can endanger the marine environment by introducing invasive species that have been transported from a distant area of the world-ocean.

Ship owners (and their insurers) have begun to pay more attention to the environmental impacts of shipping, as they recognize that they risk liability if pollution generated by a ship causes environmental damage to a coastline or a state's territorial waters. There is no remedy, however, if a ship pollutes the High Seas, so long as it is not violating the laws of the state under whose flag it is flying or the conditions of an international convention to which that state is a party.

MINERAL EXTRACTION

A third major use of (and potential threat to) the marine environment is mineral extraction. Although salt has long been extracted from the ocean, the most economically significant mineral resource in the ocean today—petroleum—began to be extracted from offshore locations only in 1937. In a sense, mineral extraction is the simplest marine activity to regulate because it occurs at fixed points. Additionally, because miners must make investments in the sites where they mine, they require states to govern their activities (for instance, by setting up leasing systems whereby mining companies make royalty payments to governments in return for exclusive rights to mine an area).

This dependence on governmental regulation gives states a degree of leverage over miners' environmental impacts that they do not have over fishers or shippers. State regulation of marine mining activities also has been facilitated by the fact that, for now at least, all marine mineral extraction takes place on the continental shelf and thus falls within a state's territorial waters or EEZ.

In the 1960s, it appeared that this aspect of marine mining was about to change, as economists calculated that it would soon become profitable to mine the seabed outside of EEZs. Specifically, miners were attracted to the possibility of mining manganese nodules, potato-sized concentrations of manganese, nickel, cobalt, and copper that coat the surface of the seabed in certain areas of the ocean, beyond the continental shelf.

The potential for manganese nodule mining posed a number of environmental and legal dilemmas. Environmentally, it was not clear what impact the scraping of the seabed over a large swath of space would have on the surrounding marine ecosystem (most other marine mining is undertaken by digging downward, not by scraping the surface). Legally, miners were faced with the problem that they wished to mine in a zone that was the territory of no one. While in one sense this was ideal for miners (there would be no one to make royalty payments to) it was unsettling to potential investors who feared that there would be no political authority to guarantee a company's legal right to mine a surveyed area.

In the end, the UN established a regime under which, for these purposes only, it would behave much like a state, with the High Seas as its territory. The UN's International Seabed Authority claimed the right to manage extraction of resources from the seabed beneath the High Seas, because the seabed's resources were "the common heritage of mankind."

For various reasons, High Seas manganese nodule mining has never occurred at a commercial scale. Nonetheless, the establishment of a global regime for managing and extracting resources from this global space has led policy makers and environmental activists to look to the ocean as they consider new models for environmental management. Whether one focuses on "traditional" ocean tenure systems through which communities have managed their local fisheries or the international seabed regime established by the UN for managing production in a space outside state borders, the interconnectedness of the world-ocean forces one to consider how an environment can be managed both as a distinct space of social and natural relations and as one component of an interconnected, global ecosystem.

SEE ALSO: Fisheries; Law of the Sea; Marine Pollution; Marine Science; Maximum Sustained Yield; National Marine Fisheries Service (U.S.).

BIBLIOGRAPHY. Elizabeth Mann Borgese, *The Oceanic Circle: Governing the Seas as a Global Resource* (United Nations University Press, 1998); Rachel Carson, *The Sea Around Us* (Oxford University Press, 1951); John Cordell, *A Sea of Small Boats* (Cultural Survival, 1989); Sylvia Earle, *Sea Change: A Message of the Oceans* (Balentine, 1996); William Langewiesche, *The Outlaw Sea: Chaos and Crime on the World's Oceans* (Granta, 2005); Carl Safina, *Song for the Blue Ocean: Encounters Along the World's Coasts and Beneath the Seas* (Owl Books, 1999); Philip E. Steinberg, *The Social Construction of the Ocean* (Cambridge University Press, 2001); Jon M. Van Dyke, Durwood Zaelke, and Grant Hewison, *Freedom for the Seas in the 21st Century: Ocean Governance and Environmental Harmony* (Island Press, 1993).

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Odum, Eugene P. (1913–2002)

SOMETIMES CALLED THE father of modern ecosystems ecology, Eugene P. Odum helped to make *ecosystem* a household word in the United States in the late 20th century. Beginning in the 1950s, Odum developed radiation ecology, later ecosystems ecology, as a science of interconnections among interlocking human and natural systems. This helped make ecological perspectives, which focus on interrelations and interdependence among elements of the whole, nearly synonymous with holistic views of nature and environment among varied communities of scientists, environmental managers, and environmentalists. However, these groups often understood the implications of the new ecology differently.

Odum wrote *Fundamentals of Ecology*, the university textbook that introduced the ecosystems perspective to generations of ecology students over the run of five editions between 1953 and 2004. In 1960 he founded the University of Georgia's Institute of Ecology. In the same year, on the grounds of the U.S. Atomic Energy Commission's (AEC) Savannah River Plant, he also established the Savannah River Ecology Laboratory. Odum was more than just "the father of modern ecosystems ecology": his contributions to environmental science, thought, and values were significant and complex.

Gene Odum, as he was known, grew up in Chapel Hill, North Carolina; his father was the eminent sociologist Howard W. Odum. Eugene earned two degrees in zoology at the University of North Carolina before moving to the University of Illinois, where he was awarded a doctorate in zoology in 1939 for an innovative research thesis measuring the heart rates of birds in terms of a "physiological ecology." The following year, Odum joined the zoology faculty at the University of Georgia, where he would continue to work, later as an active emeritus, for more than six decades.

In collaboration with his younger brother, the ecologist Howard T. Odum, Eugene became increasingly interested in using the new language of cybernetics—developed during the 1940s as an interdisciplinary language of systems and feedback loops for creating electrical circuitry, control systems, computing, and artificial intelligence—to describe the relations among organisms, species, and environments.

The development of atomic sciences and technology in the United States following World War II provided resources for ecologists. The Odum brothers took advantage of the opportunities presented by government funding for large scale nuclear projects during the cold war era, along with the practical needs for environmental and waste management that these projects produced, to secure both funding and key experimental sites for what would become pathbreaking research on the modeling of ecosystems.

In 1954 the Odums studied the effects of radiation on a coral reef at the U.S. Pacific nuclear proving grounds in the Marshall Islands, seeking to better understand the interrelations, or metabolism, of the whole ecosystem by tracing its energy flows. The results of the study suggested the importance of symbiotic relations between organisms in the reef, a mutualism that reinforced long term tendencies toward ecological stability. For the Odums, nature thus had lessons to offer to society, which the ecosystems perspective helped to decipher. In 1955 they wrote:

> Since man is having great difficulty in establishing symbiotic relations with the plants and animals which he requires for his existence, we certainly have much to learn from the way nature has accomplished this on the coral reef.

Eugene Odum also worked in less exotic places. In 1951 he initiated a long-term ecological research program near the Savannah River in rural South Carolina, in what had become the 300-square-mile nuclear buffer zone surrounding the Savannah River Plant, an AEC industrial site for the production of tritium and plutonium for use in nuclear weapons. Observing nature coming back in the farmlands evacuated to create the buffer zone, Odum and a team of graduate students added to theories of ecological succession and contributed a wide range of population ecologies based on long-term observation in the new wilderness at the species level. In 1960, the Savannah River Ecology Laboratory was established on the site, administered by the University of Georgia but funded chiefly by the AEC (and through the present day by the U.S. Department of Energy).

Amid the explosion of federal scientific funding in the United States during the 1950s and 1960s, Eugene Odum built an ecosystems ecology, both conceptually and institutionally, around America's Cold War nuclear architecture. Throughout his career he would continue to stress the necessity of ecological research and education for solving practical environmental problems, including ecological applications both in the management of radioactive and industrial wastes and in conservation practices. Odum was among the influential scientists who brought the atomic age together with the age of ecology, and he remains an important figure in the history of both.

SEE ALSO: Biosphere; Coral Reefs; Disequilibrium; Ecology; Ecosystems; Equilibrium; Interdependence.

BIBLIOGRAPHY. Betty Jean Craige, *Eugene Odum: Ecosystem Ecologist and Environmentalist* (University of Georgia Press, 2001); Joel B. Hagen, *An Entangled Bank: The Origins of Ecosystem Ecology* (Rutgers University Press, 1992); Eugene P. Odum, *Fundamentals of Ecology*, 2nd ed., in collaboration with Howard T. Odum (W.B. Saunders Company, 1959); Eugene P. Odum, "The Strategy of Ecosystems Development," *Science* (v.164, 1969); Howard T. Odum and Eugene P. Odum, "Trophic Structure and Productivity of a Windward Coral Reef Community on Eniwetok Atoll," *Ecological Monographs* (v.25, 1955).

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Ogallala Aquifer

THE OGALLALA AQUIFER is one of the world's largest aquifers, which are layers of underground rock containing water that may be tapped for human use. Located under portions of eight U.S. states, it is centered under the Great Plains region, notably the high plains of Texas, New Mexico, Nebraska, Kansas, and Oklahoma, and covers around 174,000 square miles. Use of the aquifer began in earnest at the beginning of the 20th century; subsequently, depletion of the water resource has become considerable as the usage of aquifer water now exceeds the ability of natural sources of rainwater to replenish it. This leads to three significant negative outcomes: First, the water resource will in due course be exhausted; second, the ground above the aquifer will begin to sink, which causes many problems, especially in urban areas; and third, it is possible for seawater to seep into the spaces vacated by freshwater, exposing the aquifer to salination that would make the resource unusable for human purposes. Depletion of the water resource has unleashed various legal battles aimed at determining rights to exploit and own water resources that reside on or under publicly owned ground.

The Ogallala Aquifer, which was named by Nelson Horatio Darton in 1899, was formed in ancient times (possibly the Miocene period). It was a byproduct of the creation of the Rocky Mountains, which resulted in part in a band of porous, sedimentary rock being created to the eastern and southeastern sides and below the newly forming ridges. The band measures up to 558 feet (170 meters) at its deepest and still contains some water dating back to the last ice age, since the recharging water tends to occupy the space vacated by water already pumped from the aquifer. The shape and depth of the aquifer varies considerably across its extent as a result of different pressures exerted during its creation.

It is believed that the extent of depletion of aquifer water in the United States greatly exceeds its repletion rate, as is common throughout most of the developed and industrializing world, although it is difficult to calculate exactly the rate of this occurrence. Reasons for the increased depletion rate include the intensification of agriculture across the region and the greater use of water for both domestic and industrial use. In states such as Texas, residential development increases demand for water for sprinklers and other gardening purposes as residents set out to change the character and appearance of the land.

The U.S. government has been concerned about depletion of the aquifer since the 1970s and has legislated various measures to reduce the impact of too-rapid depletion. These measures include the return of agriculture to previously employed dry land methods, which is planned to be completed by 2020. Since current agricultural activities have proven to be unsustainable, they will in the future either have to be supported by water diverted from elsewhere (which is believed to be impractical in currently foreseeable conditions) or else be scaled back or ended completely. This will inevitably have an impact on the local economies that are currently supported by these activities. It may also lead to economic and social problems among existing communities, probably sparking migration to cities or other regions where water resources are more abundant. Falling land prices resulting from the declining attractiveness of agriculture will require the courts to try to identify who, if anyone, is responsible for this loss of value and whether compensation would be required.

SEE ALSO: Agriculture; United States, Great Plains; United States, Southwest; United States, Texas; Water Conservation; Water Demand.

BIBLIOGRAPHY. E. Brooks and J. Emel, *The Llano Estacado of the US Southern High Plains* (United Nations University Press, 2001); Kent W. Olson, "Economics of Transferring Water to the High Plains," *Quarterly Journal of Business and Economics* (v.22/4, 1983); Bonnie L. Terrell, Philip N. Johnson, and Eduardo Segarra, "Ogallala Aquifer Depletion: Economic Impact on the Texas High Pains," *Water Policy* (v.4/1, 2002); Allen L. Torell, James D. Libbin, and Michael D. Miller, "The Market Value of Water in the Ogallala Aquifer," *Land Economics* (v.66/2, 1990).

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Oil Spills

OIL SPILLS CAN hurt wildlife, the scenic beauty of coasts, and people's livelihoods. For these reasons, government, industry, and environmental groups have sought to find ways to prevent and respond to oil spills to avoid environmental damage while minimizing the costs of moving crude oil and refined products. Oil spills do not constitute the majority of oil pollution in the oceans. A report of the National Academy of Sciences found that "nearly 85 percent of the 29 million gallons of petroleum that enter North American ocean waters each year as a result of human activities comes from land-based runoff, polluted rivers, airplanes, and small watercraft." Nevertheless, these spills are generally dispersed—attention-grabbing oil spills are the ones that are large, near the shore, and do visible damage.

The damage done by oil spills is a function of at least three things: the nature of the oil spilled; the proximity of the spill to the shore where most marine life lives; and the nature of the weather, current, and tides. For example, when the *Argo Merchant* spilled seven million gallons of fuel oil (which is thicker than crude oil) in the waters near Nantucket in 1976, the damage was minor because currents took the oil out to sea. On the other hand, smaller oil spills from barges, pipelines, and small tankers can do significant environmental damage.

Thicker oil near shore does more damage than oil offshore, and refined petroleum products like gasoline or kerosene, while highly toxic, tend to evaporate when spilled into water. Large oil spills far out to sea tend not to do a great deal of environmental damage, because the oil "weathers" and breaks up before it reaches a shoreline. The worst sort of spills, and the ones that receive the most attention, are of crude or heavy fuel oil in bad weather near a shoreline.

RESPONDING TO OIL SPILLS

Oil spill responses are designed to contain or disperse oil before it does damage. Methods for containing oil include booms, which are floating barriers that keep oil from moving across the water; skimmers, which are boats with equipment designed to skim the oil out of the water; and chemical dispersants and detergents that break up the oil into smaller parts that will then disperse in the water column. This latter technique is very controversial: some argue that the dispersed oil still does damage while it is in the water, while others argue that it is best to disperse the oil before it can do worse damage on the shoreline. Other promising techniques include bioremediation, in which particular strains of bacteria are introduced into the water to eat the oil. In addition, some absorbent materials are showing promise in soaking up spilled oil. To reduce the impact on wildlife, responders may set off loud noises to scare animals away so they are not exposed to the oil.

Regardless of the response technique, large oil spills are complex environmental events that require expert management. Since the passage of the U.S. Oil Pollution Act in 1990, the Coast Guard and the Environmental Protection Agency (EPA) are in charge of oil spill cleanup in the United States; other federal agencies are asked for help as needed. Response costs can be recovered from the spiller. In the end, it is very rare to recover all or even most of the spilled oil, particularly in poor weather or when heavy oils are involved.

HISTORIC OIL SPILLS AND PUBLIC POLICY

Oil spills did not receive much attention until the late 1960s, when the environmental movement gained prominence. In World War II, many tankers were sunk along the East and Gulf coasts by German submarines, spilling their loads of crude oil and refined products on beaches. These spills were not viewed as problems because the nation was at war. Even contemporary wars that spill oil receive relatively little attention compared with the war itself: Actions taken by the Iraqi regime during the 1991 Gulf War spilled thousands of gallons of oil into the Persian Gulf, and the Israeli bombing of a power station in Lebanon in 2006 resulted in a significant spill of fuel oil in the Mediterranean Sea.

The first major oil spill to receive worldwide attention was the *Torrey Canyon* spill off the United Kingdom. The response to the spill—including the attempt to set fire to the oil, and the use of detergents to break it up—was widely seen as inept, although international liability regulations for oil tankers did change because of the spill. The first major oil spill to gain similar attention in the United States was the 1969 Santa Barbara, California, oil spill, in which 200,000 gallons of oil spilled from an offshore well, killing wildlife, and leading to a famous picture of President Nixon walking along the oily beach. This spill was small by historic standards—less than 20 percent the size of the *Exxon Valdez* spill—but the spill came just as the modern environmental movement was finding its voice, and it was used by environmental groups as evidence that oil spills could do substantial damage. The Santa Barbara Spill resulted in a drilling moratorium on state lands in Santa Barbara Channel, and has greatly affected public perceptions of offshore drilling worldwide.

The next major oil spill to occur in the United States was the *Argo Merchant* spill off Nantucket. This spill did not do as much environmental damage as its size—7.7 million gallons—would suggest. However, the spill did initiate a 14-year-long debate over how oil transport should be regulated, and how liability should be assigned. This debate was brought to a swift conclusion when the *Exxon Valdez* ran aground on a reef in Prince William Sound, Alaska, spilling 11 million gallons of oil in one of the richest marine environments in the world. The *Exxon Valdez* spill was only the 35th largest in world history; the sheer size of the spill was less important than the nature of the oil and the damage it caused.

Before 1970 there were no laws to make oil spillers liable for cleanup costs and damages. The only tool available to make claims against shipping was the Limitation of Liability Act of 1851. When applied by the courts, this statute often resulted in absurdly low liability limits. However, the law also provided that if the spill occurred intentionally or if the ship owner knew it could happen, the limits could be surpassed. Still, the complexity of this statute made this law unsuitable for forcing shippers to clean up oil, and did not cover offshore drilling at all.

The inadequacies of the Limitation of Liability Act led to the enactment of what is popularly known as the Clean Water Act of 1972. Section 311 established liability limits for owners of oil facilities and ship owners at $8 million for fixed facilities and the lesser of $100 per gross ton or $14 million for ships. Amendments in 1978 raised only ship owners' liability to $150 per gross ton for ships and $125 per ton for barges. This limit was still seen as low, and did not serve as an effective incentive for ship and facility owners to operate more safely.

Section 311 also required that a national oil spill contingency plan be established with a fund to cover costs incurred by the federal government in cleaning up oil spills. This fund never reached its authorized size of $35 million, reaching at most $24 million in 1985. In 1973, the Trans-Alaska Pipeline

Authorization Act created a similar fund for the Trans-Alaska Pipeline System (TAPS), funded by a five cent per barrel tax on oil, with a $100 million cap. This level was reached in 1981, but investments raised its balance to $250 million. This fund was not called upon to clean up the *Exxon Valdez* oil spill, as Exxon chose to rely on its resources, but it is important to note that the fund was far smaller than the costs of cleaning up the *Exxon Valdez* spill. Other liability regimes were created by the Deepwater Port Act of 1974 and by the Outer Continental Shelf Lands Act Amendments. Safety regulations were enacted in the Tanker Safety Act of 1978 (Public Law 95-474), which addressed technical aspects of tanker equipment and personnel and was inspired by the *Argo Merchant* spill.

For years Congress was unable to agree on a comprehensive solution to the problem of oil spills, in large part because of disagreement between the House and Senate over whether federal liability laws should "preempt" state laws. The Senate generally favored retaining the state laws to create a greater incentive to avoid oil spills. The House sought a uniform national standard in large part to reduce the potential costs of transporting oils. The *Exxon Valdez* spill was the event that tipped the balance in favor of more stringent oil spill legislation. The spill, and Exxon's response to it, caused so much public and congressional anger that the House ended up dropping its insistence of federal preemption of state law. With the preemption issue out of the way, oil spill legislation passed relatively easily, and President George H.W. Bush signed the Oil Pollution Act (OPA) into law on August 18, 1990.

The OPA provides for vastly tougher penalties and liability for spillers of oil, allocates more resources for dealing with spills, and places more responsibility on the executive branch to respond to oil spill incidents promptly. The creation of the spill cleanup fund in the OPA was also a major accomplishment. The fund consolidated three smaller funds to create a bigger fund than ever before. At $1 billion, such a fund may not be sufficient to clean up the largest spill, but it still comes closer to the costs of cleaning up a spill of the magnitude of the *Exxon Valdez* than did any of the other funds.

A final feature of the OPA was its requirement that oil companies phase in the use of double-hull tankers in U.S. waters. Such double hulls are said to be able to withstand collisions or groundings (the cause of both the *Torrey Canyon* and *Exxon Valdez* spills), although some experts have questioned their effectiveness. Since the OPA, the incidence of major oil spills in the United States and worldwide has dropped significantly. There has not been a major oil spill from a tanker or an offshore oil platform in U.S. coastal waters since 1990.

SEE ALSO: Alaska Pipeline; Bush Administration, George H.W.; Clean Water Act; *Exxon Valdez*; Petroleum; Pollution, Water.

BIBLIOGRAPHY. Ann Cooper, "Oil Spills: Tanker Safety Legislation Pushed," *Congressional Quarterly Weekly Report* (v.38, 1977); R.O. Easton, *Black Tide: The Santa Barbara Oil Spill and Its Consequences* (Delacorte Press, 1972); *Exxon Valdez Oil Spill: Final Report, State of Alaska Response* (Alaska Department of Environmental Conservation, 1993); T.D. Hopkins, "Oil Spill Reduction and Costs of Ship Design Regulation," *Contemporary Policy Issues* (v.10, 1992); International Tanker Owners Pollution Federation (ITOPF), www.itopf.com (cited August 2006); Harvey Molotch and Marilyn Lester, "Accidental News: The Great Oil Spill as Local Occurrence and National Event," *American Journal of Sociology* (v.81/2, 1975); R.T. Sylves, "How the Exxon Valdez Oil Spill Changed America's Oil Spill Emergency Management," *International Journal of Mass Emergencies and Disasters* (v.16/1, 1998); U.S. Environmental Protection Agency, www.epa.gov (cited August 2006); U.S. National Oceanic and Atmospheric Administration, www.noaa.gov (cited August 2006); J.A. Wiens, "Oil, Seabirds and Science," *BioScience* (v.46/8, 1996).

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Old Growth Forest

OLD GROWTH FORESTS, also referred to as ancient, late-seral, or late-successional forests, are found throughout the world and are extremely rich in biodiversity and natural resources. A universally accepted definition of old growth forests is diffi-

After years of legal and political disputes, the U.S. Northwest Forest Plan was signed in 1994.

cult to resolve, but most experts would agree that several key features characterize these ecosystems. These forests are not exclusively comprised of older, gigantic sized trees, nor are they always left unaffected by natural or human disturbances. They exhibit a multilayered canopy, which is created by tree species of varying sizes and ages. These forests typically need to be anywhere from 100 to 350 years old to be classified as old growth and will vary in composition depending on the area in which they are found. Fallen trees, woody debris, and dead standing trees (snags) are common attributes that contribute to high biomass. Canopy openings, pits, and mounds are other classic characteristics.

Old growth forests house diverse plant and animal species, some of which may be endemic or endangered and only thrive in these unique habitats. For example, some wildlife species may be dependent on old growth conditions for optimal nesting grounds because conditions might be more specialized than in younger stands. Small-scale, infrequent natural disturbances such as fire, disease, insect infestation, and storms are crucial in preserving genetic diversity, and old growth areas demonstrate resilience in maintaining ecosystem equilibriums. However, this resiliency has a limited capacity; if heavy degradation takes place and thresholds are crossed, unfavorable consequences are bound to arise.

Old growth forests help sustain healthy environments. Research has shown that old growth forests carry out important ecological functions such as climate regulation, soil and water conservation, maintenance of hydrological cycles, storage and cycling of nutrients, and breakdown of pollutants. Forestry products, fish and animal stocks, and recreational activities are some of the more tangible human benefits.

In spite of their ecological, economic, and social significance, these forests are vulnerable to increasing harmful anthropogenic disturbances; they have already suffered immensely on a global scale. Illegal logging practices, clear-cutting, and deforestation for agriculture, housing, and industry are major threats because they disrupt, if not completely destroy, forest equilibrium. These activities may also displace local or indigenous populations who rely on forest resources for everyday subsistence. Social and environmental implications have been severe as these forest tracts steadily decline. There has been great contention among politicians, scientists, industries, environmentalists, and citizens over the need to protect these forests and the desire to exploit them for short-term economic gains.

It takes a significant amount of time for old growth forests to reach their optimum state; it is likely that once biodiversity is lost it cannot be regained. Possible remediation efforts include restoration—a long-term process that can be implemented in order to encourage old growth features within a forest. Although mimicking natural features can accelerate this process, it is best achieved by leaving the forest alone for a substantial amount of time.

In recent years, public concern has resulted in calls for appropriate policy and management strategies to help prevent further devastation. Much attention has been focused on protecting these habitats so that rare species can survive and flourish. Perhaps the best known example in North America is the case of the northern spotted owl of the Pacific Northwest. This bird began to decline in numbers in the 1980s as a result of habitat destruction and was declared a threatened species.

Environmental organizations argued that extensive logging of the forest needed to be reduced, if not halted, while the timber industry stated that unemployment levels would rise, crippling the local economy. After years of legal and political dispute, the Northwest Forest Plan was signed in 1994 with the intent of executing more sustainable and environmentally friendly logging practices in old growth woodlands. The "jobs versus owls" controversy highlighted the complexity of finding a balance between human needs and those of the environment. Furthermore, it symbolized the wider social, cultural, and ecological implications of how to understand, manage, and protect forests. While there is now heightened appreciation for these forests, more pertinent scientific research must be conducted to truly understand how they function and respond to both short- and long-term changes.

SEE ALSO: Forest Management; Forests; Forest Service (U.S.); Forest Transition Thesis; Northern Spotted Owl.

BIBLIOGRAPHY. Claire Andre and Manuel Velasquez, "Ethics and the Spotted Owl Controversy," *Issues in Ethics* (v.4/1, 1991); Bill Freedman, *Environmental Science: A Canadian Perspective* (Prentice Hall, 2001); B.C. McCarthy, "Eastern Old-Growth Forests," *The Ohio Woodland Journal* (July 2006); A. Mosseler, I. Thompson, and B.A. Pendrel, *Environmental Reviews: Overview of Old-Growth Forests in Canada from a Science Perspective* (Natural Resources Canada, 2003); Ontario Ministry of Natural Resources, *Extension Notes: The Old Growth Forests of Southern Ontario* (LandOwner Resource Centre, 1999); T.A. Spies et al., "Conserving Old-Growth Forest Diversity in Disturbance Prone Landscapes," *Conservation Biology* (v.20/2, 2005).

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Olmsted, Frederick Law (1822–1903)

FREDERICK LAW OLMSTED was one of the principal architects and landscapers of the early modern United States. Combining his design work with research and writing, Olmsted became known as an influential force in forging the combination of aesthetic and technical issues that have become established as the dominant paradigm in urban and rural planning concerns. Popularly, he is more well-known for being the designer of such famed parks and open areas as the lands surrounding the Capitol Building in Washington D.C., Central Park in New York City, and the Niagara Reservation near Niagara Falls. Generations of Americans have benefited from the recreational and health-promotional opportunities provided by parks envisioned and planned by Olmsted.

Olmsted's career encompassed foreign travel and an investigation into the slave trade in the southern United States. His experiences in the South, in Britain, and in China helped him to understand the importance of egalitarianism in designing public parks.

In most hierarchical societies, the ability to gain access to public goods such as parks was limited to various degrees. European societies had tended to limit the access to these goods to wealthy elites, while overseas imperial possessions were restricted on the grounds of ethnicity. Colonial Shanghai, for example, was infamous for its (apocryphal but symbolic) signage "No Dogs or Chinese" in supposedly public spaces.

Olmsted was committed to identifying ways in which such discrimination would be impossible to sustain and the methods by which he worked have become guidelines for the industry he helped to create. Not just people but the physical environment too was to be integrated into the design scheme. He realized the importance of maintaining the quality and good health of the land on which parks were to be built in order to ensure they could be sustained for future generations.

He was able to come to this understanding due to, at least in part, his wide range of experiences and travel: among his accomplishments were commanding a unit in the American Civil War (1861–65) and managing a gold mine in California. Nevertheless, the apparent rationality of his ideas belies the fact that at the time his approach was considered not just unusual but extreme and slightly improper. Ultimately, rationality and systematization won out over romanticism.

The combination of skills that Olmsted helped bring together for the field of landscape design, together with noted colleagues such as Calvert Vaux, have helped him to become known as the father of American landscape architecture. It also brought to bear a systematic and scientific approach to the discipline that underlines the general American ideology of subjugating, or at least transforming, nature to fulfill the will and desires of the people, variously defined. This tradition is reflected in American political ideology as it has often been expressed toward the land and the environment.

SEE ALSO: Central Park; Landscape Architecture; Urban Parks Movement; Urban Planning.

BIBLIOGRAPHY. Troy A. Erdman, "Landscape Architecture: Design and Problem Solving," *Tech Directions* (v.61/2, 2001); Susan L. Klaus, "Efficiency, Economy, Beauty: The City Planning Reports of Frederick Law Olmsted, Jr., 1905–15," *Journal of the American Planning Association* (v.57/4, 1991); Frederick Law Olmsted, *Civilizing American Cities: Writings on City Landscapes*, S.B. Sutton, ed., (Da Capo Press, 1997); Witold Rybczynski, *A Clearing in the Distance: Frederick Law Olmsted and America in the Nineteenth Century* (Scribner, 2000).

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Oman

THE SULTANATE OF Oman has been involved in a modernization program since 1970 when Qaboos bin Said Al Said toppled his father's regime. The new Sultan began developing strong political and military ties to Britain and thereafter established Oman as a moderate among Middle Eastern nations. Oman's status as an oil-producing nation has raised the country to middle-income status with a per capita income of $13,400. The United Nations Development Programme Human Development Reports rank Oman 71st in the world in overall quality-of-life issues.

In addition to petroleum, other natural resources include copper, asbestos, marble, limestone, chromium, gypsum, and natural gas. Less than one percent of the land area is arable. Oman's population of 3,001,583 people includes approximately 577,293 nonnationals. In an effort to curb the 15 percent unemployment rate, the government has launched "Omanization," a program designed to replace foreign workers with locals who have been trained in information technology, business management, and the English language. Other economic goals are focused on developing and expanding gas resources, metal manufacturing, petrochemicals, and international transshipment ports.

In addition to land borders with Saudi Arabia, the United Arab Emirates, and Yemen, Oman has a coastline of 1,297 miles (2,092 kilometers) that borders the Arabian Sea, the Gulf of Oman, and the Persian Gulf. The climate of Oman ranges from dry desert to hot and humid along the coast. Although the interior tends to be dry, the far south experiences a distinct summer monsoon season from May to September.

The rugged mountains of the north and south give way to central plains in other areas. In the midst of periodic droughts, Oman's summer winds frequently produce large sand and dust storms. These winds carry desert sands into cultivated areas, resulting in extensive desertification.

Like many of its neighbors, Oman has almost no natural freshwater resources. Twenty-one percent of Omanis lack sustained access to safe drinking water, and 11 percent lack access to improved sanitation. Industries have polluted groundwater in many areas. The soil of Oman is becoming increasingly saline, particularly in the coastal plains of Batinah. The presence of large, oil-spilling tankers has also led to major beach pollution. In 2006 a study by scientists at Yale University ranked Oman 60th among 132 nations in environmental performance, slightly above its geographic group but well below the average for other middle-income nations.

Low-ranking categories included air quality and biodiversity and habitat.

Nearly 78 percent of the population have become urbanized, leading to a marked increase in air pollution. Between 1980 and 2002, carbon dioxide emissions in Oman rose from 5.0 per capita metric tons to 12.1. Efforts to improve biodiversity in Oman sometimes conflict with entrenched traditions, such as the practice of wearing rhinoceros horns as status symbols. Outsiders have also depleted Omani wildlife. For instance, the Arabian oryx, a large desert antelope, was hunted to the point of extinction. Over time, international efforts managed to reintroduce oryx bred in captivity into their natural habitats. Strict policies concerning the protection of wildlife are now enforced in Oman, and nature preserves have been established to protect animal life that includes 13 species of whales and dolphins and 400 species of birds.

The Ministry of Regional Municipalities and Environment and Water Resources is responsible for drafting and implementing laws and regulations concerning sustainable development and conservation of resources and for monitoring compliance with all laws. Responsible for specific aspects of Oman's environmental policies, the ministry is divided into the Departments of Inspection and Environment Control, National Conservation Strategy, Pollution Control Operation Center, Environmental Planning Permits, and Chemical Substances.

Oman participates in the following international agreements: Biodiversity, Climate Change, Desertification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Whaling.

SEE ALSO: Desertification; Drinking Water; Oil Spills; Petroleum; Pollution, Air; Urbanization.

BIBLIOGRAPHY. Central Intelligence Agency, "Oman," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Regional Municipalities and Environment and Water Resources, www.mrmewr.gov.om (cited April 2006); Alanna Mitchell, *"Dancing at the Dead Sea" Tracking the World's Environmental Hotspots* (University of Chicago Press, 2005); United Nations Development Programme, "Human Development Report: Oman," hdr.undp.org (cited April 2006); World Bank, "Oman," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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One Child Policy, China

CHINA HAS THE highest population of any country in the world. Mid-2006 estimates set China's population at just over 1.3 billion; its rate of natural increase (RNI) is 0.6 percent per year. This rate is one-half that of the world and only one-third of India's RNI (1.7 percent). There is every indication that India will pass China in total population some time between 2030 and 2040. Despite its relatively low RNI, China has chosen to continue its often criticized official policy of one child per family, which has been reauthorized through the current five-year plan (2006–10). The Chinese government justifies the extension of this policy by stating that it continues to be consistent with the country's basic plan for population growth, a plan that reflects an insistence on slow growth. Along with the statement reauthorizing the one child policy was a proclamation that it would stay in place permanently.

The one child policy was initiated in 1979, when the Chinese government identified it as a short-term measure. At the time of implementation there was great concern that the growth of China's population would get out of hand. The country's arable land was limited, and over 60 percent of the population was approaching childbearing age. The prospect of high population increase and the potential inability to produce enough food for growing numbers provided the impetus for the policy. The legislation included several requirements in addition to the one child provision. Included was the insistence on later marriage, a policy long in place in some Scandinavian countries, and on the spacing of children in situations where more than one child was allowed. Other exclusions covered families in which a child was disabled, both parents worked in high-risk industries, or the parents were only children. In addition, there were special provisions in place for rural families. Generally, a second child was allowed after number of years, especially if the first was a girl. In some severely underpopulated regions of China, a third child was allowed.

The one child policy includes provisions for the awarding of economic incentives for families in compliance, and penalties and fines for not adhering to the rules. Some of the more severe sanctions include the loss of personal property and dismissal from work.

Within the one child policy is the acceptance of various means of birth control through contraception and abortion. This approach is similar to conditions in Japan following the end of World War II, when the country was stripped of overseas territorial acquisitions and was back on its four-island homeland. Almost overnight, the rate of population increase in the country declined to low levels and overall population growth was curtailed.

The one child policy was implemented despite an already sharply declining total fertility rate (TFR), defined as the average number of children born per woman in the childbearing years. In the early 1970s, the TFR in China was nearly six, which would indicate a high rate of population increase if it persisted over many years. By 1979, the year in which the one child policy began, the TFR was down to approximately 2.7. The mid-2006 estimate for TFR in China is 1.6, well below the replacement rate of 2.1 and the world average of 2.7. Despite these reassuring figures, the Chinese government insists that the one child policy is within the long-term interests of the country.

Of great concern is the fact that without the policy in place, there could be a dramatic increase in population within a generation, even though the TFR is significantly below the replacement rate. This is because of the high percentage of the population still in the childbearing age group. In short, the Chinese government does not want to run the risk of bringing on a baby boom similar to the ones experienced in the 1950s and 1960s. The government insists that the Chinese population not exceed 1.4 billion by 2010 and that total numbers begin to decline before mid-century.

The ratio of males to females in China is 1.2, reflecting the traditional preference for male children.

On the plus side is the change in attitudes toward large families occurring as a population becomes more urbanized. Although China's urban population is only 37 percent of the total, the move to urban areas is occurring at a rapid pace. This transition is expected to continue well into the future as the country continues to build its manufacturing and industrial base, economic thrusts that are largely based in cities. Also, there is every indication that families in China are becoming more attuned to having small families without the need for enforcement of the government-imposed one child policy. There is evidence as well that the traditional preference for a male child is not as prevalent as in past years. Incidences of female infanticide or the aborting of female fetuses have dramatically declined. Nonetheless, the ratio of males to females in China is 1.2, a reflection of the long-held preference for male children. This current male/female ratio portends serious problems as a generation of boys grows to marriage age with a significant portion of them having limited prospects for finding wives. The impact of this demographic on the political and social conditions of China in the next few years remains unknown.

SEE ALSO: Birth Control; Birth Rate; China; Population.

BIBLIOGRAPHY. Isabelle Attane, "China's Family Planning Policy: An Overview of Its Past and Future," *Studies in Family Planning* (v.33/1, 2002); Nicholas Eberstadt, "Power and Population in Asia," *Policy Review* (v.123, 2004); Susan Greenhalgh, "Science, Modernity, and the Making of China's One-Child Policy," *Population and Development Review* (v.29/2, 2003); Dudley L. Poston, "Son Preference and Fertility in China," *Journal of Biosocial Science* (v.34/3, 2002); Feng Wang, "Can China Afford to Continue Its One-Child Policy?," *Asia Pacific Issues* (v.77, 2005).

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Opium (and Heroin)

IN THE PHARMACEUTICAL industry, opium is derived from a natural substance extracted from the poppy plant and serves as the raw element for painkillers such as morphine and codeine. The illegal drug heroin, also a derivative of opium, is possibly the most addictive drug in the opiates family.

Opium has been the subject of popular fascination for centuries. Two reasons might explain this phenomenon: First, opium and heroin create a fast and strong addiction in their users, and second, images of opium have been much used by European artists and writers in the last two centuries in their representations of an exotic Far East. Literary representations include Thomas De Quincey's *Confessions of an English Opium Eater* (1821), Jean Cocteau's *Opium* (1928), and even an illustrated book for children, *The Blue Lotus* (1936), by Belgian author Hergé, features some scenes set in an opium house in Shanghai. Nowadays, the word *opium* has become a part of everyday life, even though it still represents a real danger. For example, Opium is the name of a long-standing, luxury Yves Saint Laurent perfume. In 1967, the U.S. rock group Velvet Underground released a song titled *Heroin*; in 1969, the Rolling Stones recorded a song cowritten with Marianne Faithfull called *Sister Morphine*.

In the 19th century, England traded opium in China against the Chinese state's will, and that conflict was a contributing factor in the Anglo-Chinese War (1839–42), also known as the Opium War. The Second Opium War (1856–60) was also known as the Arrow War or, in China, the Anglo-French War.

Presently, Afghanistan is the largest world producer and exporter of illicit opium, while India—and to a lesser degree Turkey—produces most of the "legal" opium used for medical and pharmaceutical purposes through a licensing system.

According to the United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA), and other sources, thousands of Afghan farmers grow and harvest opium poppies in rural zones. The International Monetary Fund has found that opium accounts for up to 50 percent of the Afghan economy.

Although sometimes part of an underground economy, farmers involved in poppy cultivation may run a family business or a small enterprise, and reinvest the annual profits into equipment, machines, and buying new fields, as in any mainstream business. They do not worry much about ethical issues, citing the fact that they live in a poor region without many resources. However, the risks are high because these farmers can easily become addicted to their product in a country where solutions to drug-related problems (like detoxification clinics) do not exist.

According to UNOCHA, the harvest of an average of just six kilograms of opium poppies provides the equivalent of about $3,000 to an Afghan farmer for a year of work, making it much more profitable than any other crop in the country. Apart from profitability, poppy cultivation also has social meanings

Khun Sa

A Burmese (Myanmar) warlord, Khun Sa has long been a prominent opium trader in the "Golden Triangle"—the area of land where the Thai, Burmese, and Laotian borders meet. He was born into a Chinese family in 1933 and named Chan Shi-fu; when his mother married a prince from the Shan States in Burma, he adopted the name Khun Sa ("Prince Prosperous").

Khun Sa initially served with the Chinese Nationalist soldiers in Burma who had escaped the Communists at the end of the Chinese civil war in 1949. Gradually he formed his own militia group known as the Ka We Ye, which fought the Shan rebels for a period. After Burma became independent in 1948, a large number of diverse ethnic groups, including the Shan, were seeking independence or autonomy.

By the mid-1960s Khun Sa had stopped working with the Burmese government and was in control of large parts of remote Burma. There he moved into opium cultivation and production. At the height of his power he had 15,000 men under arms—known as the Mong Tai Army (or Shan United Army)—with weapons brought in from Thailand.

His headquarters were at Homong near the Thai border; there he had his own opium factories, residences for chemists, a power station, street lights, telephones, and brothels. Although Khun Sa did try to develop political dimensions to his operations, inviting tourists to visit and interview him, most saw him as a drug dealer. Khun Sa even once offered to sell his entire opium crop to the United States rather than let drug couriers smuggle it into other countries.

At the end of 1995 Khun Sa surrendered to the Burmese SLORC government after striking a deal with them. He moved to Yangon, then the Burmese capital, and still the major city in the country. The Burmese government has refused to extradite him to face charges of drug trafficking into the United States.

and cultural roles. In Afghanistan, owning a poppy field is a symbol of wealth and can even serve as a gift in marriages.

Introduced in the 1960s in various Asian countries, so-called "opium replacement programs" tried to shift farmers involved in poppy cultivation toward other products, vegetables, and grains. In the current combat against illegal opium production, plans have been created to reimburse Afghan farmers for destroying their lucrative harvests of poppy plant. This is a rare case when the targeted destruction of natural plants on a large scale can have positive effects on mankind.

However, the fight against narcotics faces extensive corruption and poverty in Afghanistan. A 2006 World Bank and United Nations Office on Drugs and Crime (UNODC) report states, "Efforts to combat opium production in Afghanistan have…failed to prevent the consolidation of the drugs trade in the hands of fewer powerful players with strong political connections."

There are also strong links between the illegal drug trade and terrorism in Afghanistan, as opium has become a way for terrorist organizations to access large amounts of money. In other words, it is the drug users and heroin addicts in Western countries who, albeit indirectly, finance some terrorist actions. According to the U.S. Office of National Drug Control Policy, other countries producing illicit heroin include Colombia, Burma (Myanmar), and Mexico.

SEE ALSO: Afghanistan; Drugs; International Monetary Fund; United Nations.

BIBLIOGRAPHY. Kim Barker, "Very Bad News on Opium War," *Chicago Tribune* (September 3, 2006), www.mapinc.org (cited November 2006); Jean Cocteau, *Opium: Journal d'une Désintoxication*, (Delamain & Boutelleau, 1928); Common Sense for Drug Policy, "Heroin Production on the Rise Again in Afghanistan," www .csdp.org (cited November 2006); Thomas De Quincey, *Confessions of an English Opium Eater* (1821); Hergé (Georges Rémi), *Le Lotus Bleu* (The blue lotus) (Casterman, 1936); International Monetary Fund (IMF), "IMF Executive Board Approves US$119.1 Million PRGF Arrangement for the Islamic Republic of Afghanistan," News Release (n.6/144, June 26, 2006), www.imf.org (cited November 2006); Carl Robichaud, *Afghanistan Watch*, www.tcf.org (cited November 2006); United Nations Integrated Regional Information Networks, "Afghanistan: Interview with Female Opium Farmer," www.irinnews.org (cited November 2006); United States Office of National Drug Control Policy, "Drug Facts," www.whitehousedrugpolicy.gov (cited November 2006); World Bank and the United Nations Office on Drugs and Crime, "Afghanistan's Drug Industry: Structure, Functioning, Dynamics, and Implications for Counter-Narcotics Policy," www.unodc.org (cited November 2006).

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Organic Agriculture

ORGANIC AGRICULTURE IS a method of producing crops without synthetically derived chemical pesticides and fertilizers. Indeed, soil fertility is the central goal of organic farming, as healthy soil produces abundant crops and diminishes the occurrence of pests. Preemptive measures focusing on soil quality are the main way that organic farmers reduce the need for chemical inputs.

Organic farmers use techniques such as crop rotation (changing the crops grown in a field each season) to build healthy fertile soil that has fewer pest problems. Organic farming techniques may also include the use of beneficial insects such as ladybugs to destroy crop-eating aphids. Likewise, companion cropping of certain plants together helps ward off pests.

Organic farming is also based on diversity: Growing a large number of crops both for ecological diversity and for sales diversity. Organic farming is unique in terms of crop choice, planning, harvesting, and marketing. Marketing is accomplished through specific channels as farmers seek out independent sales outlets, often selling to numerous wholesalers, brokers, or directly to consumers. Such direct marketing activities are exemplified in organic farmer participation in farmers' markets and Community Supported Agriculture (CSA), both of which have increased rapidly in the past decade.

Organic farming is distinct from "conventional agriculture," which is based on chemical applications and large-scale specialized production of one or two crops. Indeed the geographic distribution of organic cropland varies substantially from the patterns of conventional production. For example, 80 percent of U.S. conventional cropland is in just four crops: Corn, wheat, hay, and soybeans, but these crops represent less than half of certified organic cropland. On the other hand, organic vegetables comprise 12 percent of certified organic cropland, compared to only 1 percent of total U.S. cropland.

These cropping variations are seen in regional variation as well, with the Pacific and mountain regions comprising two-thirds of organic cropland, but only one-third of total U.S. cropland. The opposite is seen in the Corn Belt, which comprises only 11 percent of certified organic cropland, but represents 25 percent of total U.S. cropland. Overall, organic farmers grow more types of crops and more diverse crops that are not common among conventional farmers in the same region. It is a challenge for organic farmers to identify reliable, distinct organic marketing avenues that will provide the necessary price premiums on the numerous crops they grow.

Estimates place the growth of U.S. organic markets at 20 percent annually since 1990. The year 2000 marked the first year that more organic foods were sold in mainstream supermarkets than in any other venue. In fact, three-fourths of conventional grocery stores now carry some organic food. Natural food stores and direct marketing continue to play a role in the distribution of organic products. Organic food sales are led by fresh produce, non-dairy beverages, breads and grains, packaged foods, and dairy products. Organic dairy items increased by 500 percent in the 1990s as a result of consumers seeking to avoid rBGH, a genetically engineered hormone injected to increase milk production in convention dairy cows. Sales of organic snacks, candy, and frozen foods have increased by 70 percent in recent years.

Consumer demand for all organic products is likely linked to concerns about pesticide residues and genetically modified organisms (GMOs) in food. Indeed, a study by the Consumers Union shows significantly lower pesticide residues on organic compared to conventional food. Parental concern about food safety often motivates parents to buy organic food for their children. A recent study shows that children who eat organic food have significantly lower levels of pesticides in their urine.

ORGANIC CERTIFICATION

Certified organic is an important term because it signifies a specific process of certification, which varies by country but typically indicates that farmers omit synthetic agrochemicals for at least three consecutive years. Detailed farm histories must be written and every input to the organic fields must be documented. An annual inspection by an independent inspector is required and farms must show soil building through rotation and use of green manure (crops planted and plowed under to fertilize the soil).

According to a United States Department of Agriculture (USDA) report, in 2001 certified organic cropland totaled 2.34 million acres. There are wide variations by crop types, with approximately 2 percent of the major fruit and vegetable crops, apples, carrots, lettuce, and grapes, and 2 percent of all tomatoes, grown by certified organic methods. For grains, these figures are much lower: only 0.1 percent of corn, soybeans, and wheat are organically grown. But significant amounts of specialty grains are certified organic, such as spelt (37 percent) and buckwheat (30 percent).

Geographic variation is seen among the states, as California, North Dakota, Minnesota, Wisconsin, Iowa, and Montana have the largest certified organic acreage (influenced by large areas of pasture and rangeland), and California, Washington, Wisconsin, Minnesota, Iowa, Pennsylvania, Ohio, New York, Vermont, and Maine have the largest numbers of certified organic farmers.

RESEARCH AND STANDARDS

Although consumer demand is high, research and information on organic agriculture is sorely lacking. Even by 2003, when land-grant universities had 885,863 acres of field plots and research lands in the United States, only 0.02 percent (151 acres) were certified organic. This is 100 times less than the 0.2 percent of total U.S. cropland that is certified organic and hundreds of times less than the percentage of some crops; for example, 2 percent of tomatoes grown in the United States are certified organic.

The lack of research attention indicates the general disregard for organic farming within the conventional agricultural research system. Because of this indifference, organic farmers have experimented and developed their own pest management and soil fertility techniques, which they often share with other organic farmers. Current research information is a particularly acute need for organic farmers, as information needs intensify with the adoption of reduced-chemical methods. Even programs in sustainable agriculture have been irrelevant for organic farmers, as exemplified by the most important national initiative for sustainable agriculture (the USDA's Sustainable Agriculture Research and Education Program) of which only 19 percent of the funds are for organic production and marketing projects.

Organic farmers are highly diverse; some have moved from conventional methods to organic methods, others started farming more recently and have only employed organic farming techniques. Demographic characteristics also vary greatly, but in general these farmers have strong convictions that have compelled them to undertake something different. They are independent and innovative, as they try new crop rotations, seek out sources of information, solve pest concerns on their farms, and market their numerous crops to meet growing consumer demand for organic food.

Implementation of organic agricultural policy in the United States has been fairly recent. The 1990 Farm Bill initiated the establishment of a USDA organic farming office to draft standards with the assistance of an advisory board. Finally, in 2002, the National Organic Certification Standards were put into effect. Labeling now indicates three designated levels, with products labeled "100 percent organic" containing only organically produced ingredients. The "organic" label indicates products that are at least 95 percent certified organic and "made with organic ingredients" are for items with at least 70 percent of organic components. Any product containing less than 70 percent of organic ingredients may not be marketed as an organic food. Foods that fall into these organic categories qualify to display the "USDA Organic" seal.

The natural foods retail industry strongly supports the national certification standards. The Grocery Manufacturers of America represents major food producers and they note that national organic standards increase consumer confidence through uniformity of organic products. This highlights the conflict between the market-driven success of organic products and the grassroots ethical concerns of organic farming, as national standards will not necessarily support a locally-based organic food network. It is not clear how these divergent ideas will be balanced within the framework of the national certification standards, but it seems that market growth is currently driving the process.

CORPORATE INVOLVEMENT

In addition to policy issues, business concerns also influence the future of organic farming. As organic farming sees rapid growth in demand, it is pulled into the conventional mode of production. Agri-business corporations realize the large market growth in organic products and are well aware of the trends. For example, several multinational corporations have controlling interests in many organic food labels. In addition, in mid-2006, Wal-Mart made a public statement indicating that they seek to vastly expand the organic products they sell. Wal-Mart is already one of the world's largest retailers of organic foods, so this recent move could further increase their influence on the organic food marketplace.

Such corporate involvement exemplifies the growing pains associated with organic agricultural production and consumption: local versus international; and farmer versus multinational. The organic farming system of producing food based on soil health, innovation, and earlier "hippie" movements, is now becoming big business. The potential negative aspects of this evolution are that it may become dominated by the large scale agri-business corporations seen in conventional agriculture.

On the other hand, the positive aspects of the success of organic agriculture are that more diverse consumers can afford to buy organic products and there are environmental benefits to reduced agrichemical use. In the future, organic agriculture will likely struggle to keep its roots in local farming and sales.

Estimates place the growth of U.S. organic markets at 20 percent annually since 1990.

SEE ALSO: Farmers' Markets; Farming Systems; Food; Green Consumerism; Pesticides.

BIBLIOGRAPHY. Cynthia L. Curl, Richard A. Fenske, and Kai Elgethun, "Organophosphorus Pesticide Exposure of Urban and Suburban Preschool Children with Organic and Conventional Diets," *Environmental Health Perspectives* (v.111, 2003); Carolyn Dimitri and Catherine Greene, "Recent Growth Patterns in the U.S. Organic Foods Market," *Agriculture Information Bulletin* (U.S. Department of Agriculture [USDA] Economic Research Service, no. 777, 2002); L.A. Duram, *Good Growing: Why Organic Farming Works* (University of Nebraska Press, 2005); Catherine Greene, "U.S. Organic Farming Emerges in the 1990s: Adoption of Certified Systems," *Agriculture Information Bulletin* (USDA Economic Research Service, no. 770, 2001); Catherine Greene and Amy Kremen, "U.S. Organic Farming in 2000-2002: Adoption of Certified Systems," *Agriculture Information Bulletin* (USDA Economic Research Service, no. 780, 2003); P. Howard, "Consolidation in Food and Agriculture: Implications for Farmers and Consumers," *California Certified Organic Farmers Magazine* (v.21, 2003); Nicolas Lampkin, *Organic Farming* (Farming Press, 1990); Jane Sooby, *State of the States: Organic Farming Systems Research at Land Grant Institutions, 2000–2001* (Organic Farming Research Foundation, 2003).

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Organization of the Petroleum Exporting Countries (OPEC)

CREATED AT THE Baghdad Conference on September 10–14, 1960, the Organization of Petroleum Exporting Countries (OPEC) is a multinational consortium whose purpose is to coordinate and regulate petroleum pricing and policies among its member countries. OPEC was created to assure stable prices for member petroleum producers, securing cost-effective and regular supplies of petroleum and distillates to consuming nations with reasonable profits to its members and investors.

The original founding members were Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela, which were later joined by Qatar in 1961, Indonesia in 1962, the Socialist People's Libyan Arab Republic in 1962, the United Arab Emirates in 1967, Algeria in 1969, Nigeria in 1971, Ecuador from 1973 to 1992, and Gabon from 1975 to 1994. The organization located its first headquarters in Geneva, Switzerland, for five years, then moved to Vienna, Austria, on September 1, 1965. Nigeria joined OPEC in 1971 and represents the final member nation.

OPEC rose to international prominence during the 1970s when it dominated its own domestic oil production while increasing its direct influence on global crude oil markets. Prompted by the Arab oil embargo of 1973 and the Iranian Revolution in 1979, the world's crude oil prices skyrocketed (nominal value at $38/barrel), and OPEC's role in the world market became obvious. The organization's first Sovereigns and Heads of State Summit was held in March 1975 in Algiers.

Crude oil prices peaked in the early 1980s, only to plummet, causing a worldwide crude oil collapse in 1986. Prices revived in the following years but never approached the earlier high prices until 2000, when crude oil per barrel prices soared to $36/barrel. Nothing however, prepared OPEC for current price escalation to more than $70/barrel due to recent production problems and conflicts across the Middle East.

With increasing Middle East conflicts, market panic instigated a sudden increase in crude oil prices that was reduced by increased production and output dictated by the OPEC members. Prices remained stable until a collapse in 1998 due to economic recessions in Southeast Asia; cooperative action by OPEC and some non-OPEC producers brought about a relative price recovery. A wave of corporate mergers among the major international oil companies followed, which aggravated price fluctuations until the disastrous attack on the United States on September 11, 2001.

With the consequent Iraq war, crude oil production in Iraq, a major global supplier, halted from warfare-related disruption and sabotage, pushing prices in 2006 to more than $70/barrel. These high petroleum values were then exacerbated with the landfall of Hurricanes Katrina and Rita along the U.S. Gulf Coast in 2005—which kept prices high due to importance of that region in North American oil production and distribution services. Increasing Asian demands on oil consumption also contributed to the price rise.

The foremost aims of OPEC, according to its statute, are:

> the coordination and unification of the oil policies of its member countries and the determination of the best means for safeguarding their interests, individually and collectively; [devising] ways and means of ensuring the stabilization of prices in international oil markets with a view to eliminating harmful and unnecessary fluctuations; [giving due regard] at all times to the interests of the producing nations and to the necessity of

securing a steady income to the producing countries; an efficient, economic and regular supply of petroleum to consuming nations, and a fair return on their capital to those investing in the petroleum industry.

OPEC is administered by a board of governors overseen by the secretary general, who is appointed for a term of three years. The secretary general is the legally authorized representative of OPEC and chief executive of the secretariat and administers the affairs of the organization in accordance with the directions of the board of governors. The secretary general is assisted by the Research Division, the Administration and Human Resources Department, and the Public Relations and Information Department.

SEE ALSO: Automobiles; Energy Crisis; Gasoline; Markets; Petroleum.

BIBLIOGRAPHY. Jahangir Amuzegar, *Managing the Oil Wealth: OPEC's Windfalls and Pitfalls* (I. B. Tauris, 2001); Albert L. Danielsen, *The Evolution of OPEC* (Harcourt College Publishing, 1982); Arabinda Ghosh, *OPEC, The Petroleum Industry, and United States Energy Policy* (Quorum Books, 1983).

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Organophosphates

ORGANOPHOSPHATES ARE A class of chemicals (specifically esters of phosphoric acid), many of which act as neurotoxins. Organophosphates are created primarily through reactions between phosphoric acid and alcohol, a process that has been used since the middle of the 19th century. Used as pesticides and chemical weapons, they are among the most toxic substances to humans and other vertebrates. They have been used on an industrial scale as pesticides and on a smaller scale for therapeutic purposes. Organophosphates have also been used as a weapon by some military forces and one form, sarin, was used in a terrorist attack on the subways of Tokyo in 1995, which led to numerous deaths and thousands of injuries. Contact with organophosphates at a low level may have negative health impacts, although the evidence is not fully established. There is considerable research concerning the possible use of organophosphates in treating dementia, including Alzheimer's disease. Other medical and industrial applications are under active consideration.

The use of organophosphates as pesticides is generally controlled by governmental agencies owing to the persistence and severity of the toxicity of the substance. In the United States, the Environmental Protection Agency (EPA) monitors and regulates the use of the chemicals in industrial and domestic terms. Their use has been permitted when fears about the spread of infectious disease have been raised. A well-known example is that of the outbreak of West Nile virus, which led to chemical spraying in New York's Central Park, as well as other parts of the country.

Such decisions are often controversial because of evidence of health concerns from proximate exposure. There is always a measure of conflict between those who wish to use organophosphates or any other form of chemical as effective agents in industrial processes for economic gain, and those who believe that potential long-term risks make this an unwise proposition.

In developing countries, the poorest and most vulnerable rural workers are most likely to be exposed to pesticides, and they are the least likely to receive effective medical intervention. In the developed world, acute exposure to organophosphates among farm workers represents a serious environmental justice issue, as does long-term exposure at lower dosages in urban settings.

SEE ALSO: Mosquitoes; Pesticides; Wars; West Nile Virus.

BIBLIOGRAPHY. Lucio G. Costa, "Current Issues in Organophosphate Toxicology," *Clinica Chimica Acta* (v.366/1–2, 2006); Ramesh C. Gupta, *Toxicology of Organophosphate and Carbamate Compounds* (Academic Press, 2005).

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Orientalism

ORIENTALISM REFERS IN general to the interest by Western Europeans and Americans in Near Eastern and Far Eastern societies, cultures, art, and architecture, which reached a peak in the 18th and 19th centuries but has long been a facet of European culture. The term also refers to a pejorative, romantic, and colonial habit of thinking, embodied in such academic study and ongoing into the present, which holds that the East is in some way essentially different from the West. This latter meaning of the term is rooted in Edward Said's book of the same name, *Orientalism*, published in 1978.

During the period of the Crusades, many designs and ideas from the Near East, as Turkey and the Holy Land were then known, were taken to Western Europe. Some of these concerned philosophical views, medical science, and geometry. Others concerned art, architecture, and military sciences. With the rise of the Seljuk Turks from the 11th century, and the Ottoman Empire from the 15th century, few people from Western Europe were able to get to China, Marco Polo (1254–1324) being a major exception. His account was, for much of the early modern period, the only one readily available that described Imperial China. It excited the culturally adventurous in Europe, but some recent detractors have argued that he may not have gone to China.

In 1510 the Portuguese had not only sailed to India but captured the city of Goa, making it the center of their power on the Indian subcontinent until 1962. They seized Malacca (in modern-day Malaysia) in 1511 and started trading with China in 1513. They established their base at Macau in China in 1557, and also traded with Japan.

These Portuguese voyages fostered Western European interest in Indian, Chinese, and Japanese foods and artifacts. The Dutch, French, and British soon tried to take control of as much of the trade as they could. In 1671 Louis le Vau built the Trianon de porcelaine at Versailles, France, where Chinese art and locally-made items in the style of Chinese art, were used to decorate a room. The idea quickly spread and the term *chinoiserie* came to represent this European and North American fondness for Chinese-style furniture, pottery, textiles, and interior decoration. Few large houses in Germany were without their "Chinese room."

During the War of Austrian Succession (1740–48) and the Seven Years War (1756–63), Britain emerged as the preeminent military power in India, with great riches flowing back to the country. The fortunes made by Lord Clive and Warren Hastings inspired many British (and other) young men to seek their fortunes in India. Many died there, but others returned, often with a taste for Indian food and art. Among the many places with Indian architectural styles were the facade of the Guildhall, London (1788–89); Sezincote House, Gloucestershire, England (around 1805); and Sanssouci, Potsdam. When the British Lord Macartney went to China to try to open an embassy in Beijing in 1792, it was hoped that this would facilitate trade between Britain and China. The Chinese declined the British offer, but drawings of the meetings, and other similar encounters in India and elsewhere, showed the clothing, furniture, and decorations of the Orient to a public that had sufficient disposable income to purchase oriental items.

By the 18th century, the Orient came to represent anything from the Balkans eastward, including Egypt—not just India, China, Japan, and Southeast Asia. This interest in Eastern art and culture received a boost when Napoleon embarked on his invasion of Egypt in 1798–1801. He took with him many scholars and essentially led to the creation of the discipline known as Egyptology, which involves the study of pharaonic Egypt from 4500 B.C.E. until 641 C.E. Subsequent French interest in North Africa, leading to the invasion of northern Algeria in 1830, led to the formation of a painting school known as the Orientalists, often including painters who had only been to Morocco and Algeria, as well as Egypt and Arabia. Some even saw the Moorish style of Spain as being Oriental.

In 1811, the British sent a massive expedition to the Dutch East Indies (modern-day Indonesia), with the commander, Lord Minto, bringing with him antiquarians and archivists. In the early 19th century, trade between China, India, and Western Europe was vast. Tea clippers brought large amounts of tea to Europe, with tea houses opening in many cities. Some of these were decorated with Chinese artifacts, and it was not long before local copies of Chinese art started to appear on the market, and some buildings inspired by Chinese architecture were built. The Royal Pavilion at Brighton, England, was constructed in 1815–22, and represents the interest in Mogul Indian architecture in Regency Britain. Chinese-style pagodas were built in botanical gardens, including in Kew Gardens in London and the English Gardens in Munich. Large numbers of houses in England and France, and also later in the United States, now had a Chinese room, where items from China, or in the style of these, were displayed. Chinese or Chinese-style furniture was also used to decorate these rooms and other parts of the house.

The 19th century also saw a large number of books written about the Orient. Novels such as Gustave Flaubert's *Salammbo* (1862), set in Carthage (modern-day Tunisia) captured the essence of Orientalism of that period. The opening up of Japan in the 1860s saw an interest in Japanese woodblock prints and Japonaiserie. By the early 20th century books and stories set in the Orient often had a more dangerous edge to them. Agatha Christie's *Murder on the Orient Express* (1934), P.C. Wren's *Beau Geste* (1924), and Sax Rohmer's character, Fu Manchu, set among the Chinese in London, focused on this exotic but dangerous Oriental theme. Nowadays the all-encompassing term *orient* has been replaced with more specific interest in Arab, Chinese, Egyptian, Indian, Japanese, Korean, Mongolian, Persian, Tibetan, or Turkish styles.

The persistence of certain ways of thinking rooted in the colonial era, however, are arguably still present in contemporary "oriental" regional scholarship. This persistence of essentialist ideas, holding the orient to be distant, alien, irrational, and the mirror "other" to the West's rationality, has been pointed to by a large number of postcolonial scholars. Most prominent among them is Edward Said, whose book *Orientalism* points out that domination of colonial nations and peoples around the world was historically not simply a matter of brute force, but also one of ideology. The necessary logic of domination, he suggests, is one where the East is mystical, unknowable, irrational, feminine, and in need of control. The long scholarly tradition noted above, he further insists, deeply reflects and constitutes an academic tradition that cements this vision of the world and justifies foreign rule. Orientalism refers therefore to an academic field as well as a dangerous state of mind.

In terms of environmental issues and ecological history, Orientalism has been arguably influential in the development of modern environmental science. The notion of "tropicality," for example, a discourse that holds that temperate environments are more suited to civilization, is a long-standing tradition in historiography, closely tied to essentialist ideas of the "primitive" or mystical East. Quaint as such ideas may seem, their tacit persistence suggests that Orientalism remains a pertinent issue in human/environment studies.

SEE ALSO: Algeria; China; Colonialism; Egypt; India; Japan; Morocco; Postcolonialism; Turkey.

BIBLIOGRAPHY. Alexander MacFie, *Orientalism: A Reader* (Edinburgh University Press, 2000); Donald Rosenthal, *Orientalism: The Near East in French Painting* (Memorial Art Gallery of the University of Rochester, 1982); Edward Said, *Orientalism* (Random House, 1978).

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Orographic Effect

THE OROGRAPHIC EFFECT is also known as the Foehn effect and orographic precipitation or relief rainfall, although these two terms only comprise a part of the process. The orographic effect is the series of changes at a synoptic scale in temperature and humidity as a result of the flow of air masses over mountain ranges or oceanic islands. It may engender orographic precipitation when moisture is captured, cloudiness, and differences in air temperature and humidity between the windward and leeward sides of the range. A large local gradient, or spatial variation, of precipitation and temperature results.

When a moving mass of stratified air containing abundant moisture hits a topographic barrier, the air is forced up. In the upward movement, the air cools adiabatically and becomes increasingly saturated. When temperature falls below the dew or condensation point, orographic clouds develop, water vapor condenses, and precipitation occurs as rain or snow, so that some moisture is removed. Rainfall increases as air raises the barrier. The air keeps rising until it reaches the same temperature as the surrounding air. In the condensation process latent heat is released to the air and this is warmed.

During the descent down the lee side of the barrier, the drier air mass warms adiabatically by increasing its pressure. Precipitation drops radically and cloud coverage dissipates. The heat gained in condensation adds to compressional heating. This dry air mass increases its temperature—about 6 degrees per kilometer—more quickly than leeward moist air decreases when ascending—about 10 degrees per kilometer—so that it reaches a higher temperature at an equal elevation. The warmer dry area to the lee side conforms to a precipitation or rain shadow, although sometimes—depending on wind speed—precipitation is projected leeward, a phenomenon called spillover.

Different types of vegetation respond to the contrasting environmental conditions; while the windward side of mid-latitudes mountain ranges are covered by forests, the leeward side frequently exhibits arid, stepparian vegetation—the grassland in the lee of the Rocky Mountains—or, in certain cases, deserts. Death Valley in California and the Great Basin both illustrate the latter.

Examples of significant descending winds produced by a steady manifestation of the orographic effect over a short time are commonly designated by local names, such as Foehn in the European Alps, Chinook in the Front Range of the Rocky Mountains, or Zonda in Western Argentina. Eventually, surface winds flow very strongly and reach disruptive speeds that are considered to have some effects on human behavior. The Santa Ana wind in Southern California reveals some differences. The dry air mass originating from the north and east high deserts over the Great Basin, or northernmost areas, advances over the San Gabriel Range, where no cloud formation occurs, and descends to the coast. The lower altitude of the Los Angeles area allows the increase of temperature combined with a lower relative humidity. Chinook winds are originated by oceanic air moving over the Cascade Mountains and Sierra Nevada Range, where moisture is drained; then the air mass descends to the lee side, creating the dry Great Basin, and the hot and dry wind progresses to the Rocky Mountains, where it may melt the snow cover.

Other less common types of orographic effects include the feeder-feeder effect and the Puget Sound Convergence Zone. The feeder-feeder effect starts with precipitation from an upper-level cloud over a lower-level orographic cloud that feeds precipitation of the lower, increasing the total precipitation. In the second case, moist air masses from the Pacific Ocean, instead of rising, are blocked, split into two air streams, and deflected by the Olympic Mountains. The two branches converge over Puget Sound (on the leeward side of the mountains), and are forced to uplift—leading to convection—and causing precipitation in the Puget Sound Convergence Zone. Although an orographic process, katabatic wind or mountain breeze originates from differential cooling of high elevation and valley air masses. As soon as solar radiation ceases, top mountain air cools faster than in lower areas, becomes denser, and flows downslope, creating a local high pressure.

SEE ALSO: Andes Mountains; Climate; Mountains; Rocky Mountains.

BIBLIOGRAPHY. W. Brinkmann, "What Is a Foehn?" *Weather* (v.26, 1971); Kerry A. Emanuel, *Atmospheric Convection* (Oxford University Press, 1994); Lawrence C. Nkemdirim, "Canada's Chinook Belt," *National Journal of Climatology* (v.16, 1996); Marilyn N. Raphael, "The Santa Ana Winds of California," *Earth Interactions* (v.7, 2003); Gerard H. Roe, "Orographic Precipitation," *Annual Review of Earth and Planetary Sciences* (v.33, 2005).

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Overfishing

OVERFISHING IS, IN the simplest terms, the harvest of more fish from a population than it can bear. Yet, the word takes on multiple meanings in practice and the causes and consequences of, and alternatives to, overfishing are even more complicated.

At a first level of approximation, two kinds of overfishing are possible. Recruitment overfishing refers to the harvest of a species such that its ability to reproduce itself back to its preharvest condition is compromised. This can take the form of destroying broodstock directly or harvesting organisms before they have a chance to reproduce at all. Recruitment overfishing can result in less catches over time and, if sufficiently serious, to crashes in abundance, but this can be temporarily masked by the delay of several years between the culling of one year's breeding population and the resulting hole in the population from the loss of recruitment.

Growth overfishing refers to the taking of fish before they have achieved a size or value determined to be optimal. As a primarily economic issue, it does not bear the same seriousness to the ecology of fisheries, but intense growth overfishing can easily shade into recruitment by harvesting juvenile individuals before they have spawned. The calculation of growth overfishing is contingent on the relationship between natural and fishery mortality, such that the maximum size possible for a given species is seldom achieved in the wild, making harvest of a considerably smaller size perhaps the most remunerative option for fishers.

The consequences of overfishing can be quite severe. Overfished populations can take much longer to rebuild to a healthy condition than it took to degrade them, even if fishing pressure on them is relieved. This can be due to the small number of surviving spawning adults, but can also be because opportunistic species have taken over the habitat. Fishing capacity going unused reduces employ-

The decline of a fishery stock may lead to intensified effort to harvest remaining individuals from it, exacerbating overfishing; or it may lead to the abandonment of fishing for other livelihoods.

ment, creates a crisis of fixed capital investment, contributes to local and regional economic decline, and can—for fisheries crucial to regional food security—contribute to malnutrition. Overfishing in West Africa is believed to contribute to the intensification of the bushmeat trade, which threatens many kinds of wildlife in the region. The decline of a fishery stock may lead to intensified effort to harvest remaining individuals from it, exacerbating overfishing; or it may lead to diversification of effort onto other fisheries (with benign or harmful effects), or the abandonment of fishing for other livelihoods. The specific social, economic, and ecological contexts of a given fishery are important in understanding what a fishery will do when faced with overfishing.

Theories to explain overfishing often converge around the Tragedy of the Commons, which argues common property resources inevitably lead to overexploitation and conflict requiring coercive enforcement and enclosure. This general perspective translated into fisheries implies that with open access situations, where there are no restrictions to harvesting, more fishers will add their effort to the collective effort because their individual gain is larger than the collective loss of that share of the resource, until expenses equal benefits and no profits are gained by anyone.

The generally employed rubric for managing fisheries to avoid commons tragedies is known as bioeconomics, which seeks to establish and regulate the amounts and types of harvest acceptable to sustain fish populations and the profitability of fisheries. Managers use statistical models drawing on data from research vessels or surveys of commercial landings to model the population dynamics of individual species or multiple species interactions. Surplus production models are utilized to understand how much fishing mortality can be sustained by a population and what biomass will generate the highest rate of increase to augment production. These models are used for establishing Maximum Sustainable Yield (MSY), the largest harvest possible that should leave enough individuals to reproduce an equivalent harvest. Yield per recruit models are used to calculate the best harvest size to maximize catches so as to avoid growth or recruitment overfishing.

Managers make use of the conclusions of these statistical tools through a variety of regulations. Basic management measures include setting Total Allowable Catches, limiting entry to fisheries, mandating size and number limitations on catches, controlling fishers' access to certain territories or at certain times, or regulating the use of certain types of fishing gears. Drawing on the ideas of Hardin and others, advocates for fishery rationalization support the implementation of Individual Fishing Quotas (IFQs) to simulate private property rights on the premise that marketizing access will lead to better stewardship and allocation of fisheries, reducing overcapitalization.

Pioneered in New Zealand and now used in some Alaskan fisheries, IFQs can reduce wasteful fishing practices caused by "derby fishing," where a fleet quota is established and fishers compete to bring in the most fish before the quota is filled. They have, however, a tendency to encourage high grading, where fishers throw back suboptimal fish (many of which may die) in order to get the most valuable fish under their IFQ.

Common property theorists pose a counter-narrative to this perspective that stresses that institutions for governing common property, if well-suited to the needs of fish and fishers, can overcome tendencies toward overfishing. Community-based marine resource management is expanding in places like the South Pacific, employing means like conservation education and comanagement by harvesters and the state over defined community territories at sea.

The decline of the groundfish fisheries of Atlantic Canada in the early 1990s is a well-known recent example of overfishing. Many factors contributed to this disaster. More efficient but less selective dragging gear was adopted by a sector of Canadian fishers, which made for more discards. Overcapitalization was encouraged by state support to industrialize the fisheries after the withdrawal of foreign fleets in the late 1970s. A lack of enforcement of fisheries regulations caused more fishers to break rules so as to not lose out on the higher catches that cheating could generate. Overly optimistic projections of fishery populations created false confidence and prevented effective corrective action, and high levels of debt on some vessels mandated that fishers keep fishing or go bankrupt, imposing political economic costs on controlling effort on the fishery.

By contrast, the nearby Maine lobster fishery is considered among the most sustainable fisheries in the world. An informal system of territorial management by fishers gives them incentives for protecting the resource in their areas and disincentives from acting destructively. The gears used are highly selective and allow undersized or egg-bearing lobsters to be returned to the water unharmed. The regulations of the state have evolved over decades to be supported by most fishers because they were seen as beneficial and fair, making compliance rates relatively high. Fisheries like Maine lobster, which have a history of management success, appear to build upon that success, but there is no simple checklist of measures to make the fishery commons less tragic. Careful attention must be paid to the history and contemporary social structure of the fishery as well as its ecology and modifications to it by human action to understand how and why overfishing happens (or does not). One emergent truth is that rules that fishermen feel are counterproductive and unjust do not engender the kind of cooperation that makes management effective, if possible at all.

SEE ALSO: Common Property Theory; Fisheries; Maximum Sustained Yield (MSY); Oceans; Tragedy of the Commons.

BIBLIOGRAPHY. J. Acheson, *Capturing the Commons: Devising Institutions to Manage the Maine Lobster Industry* (University Press of New England, 2003); S. Jennings et al., *Marine Fisheries Ecology* (Blackwell Science, 2001); C. Palmer and P. Sinclair, *When the Fish Are Gone: Ecological Disaster and Fishers in Northwest Newfoundland* (Fernwood Publishing, 1997).

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Overgrazing

OVERGRAZING IS A term without a precise scientific meaning. Yet, it is widely used and its use has enormous implications for the management of livestock and wildlife and for the livelihoods of individuals and societies throughout the world. It is called one of the most destructive human practices on earth. It is said to be harmful to vegetation and wildlife and to cause soil erosion and desertification. But without a precise definition, these claims have no real meaning, nor can they be proved or disproved.

Range management is a profession that uses range science and practical experience to maintain and improve grazing system components (plants, animals, soil, water) and the production of goods and services from rangelands in combinations needed by society. Range management defines grazing as the consumption of standing forage (edible grasses and forbs) by livestock or wildlife, and browsing as the consumption of edible leaves and twigs from woody plants (trees and shrubs) by large-hoofed animals. Forage plants coevolved with grazers and have developed the capacity to recover from grazing. But this capacity depends on how much tissue is lost, when it is lost in the life cycle, and how frequently it is lost. From the individual plant's point of view, *overgrazing* could be defined as exceeding its capacity in any of these ways. However, this is not a definition that can be easily generalized.

Range management does not offer a scientifically validated and agreed upon definition of *overgrazing*. This is because there are many different grazing systems, different ways to measure the effects of grazing that are difficult to measure and calculate in practice (examples are carrying capacity, utilization, and range condition and trend), and different temporal and spatial scales over which the effects could be measured. In addition, since the 1980s, nonequilibrium models of ecology have been replacing the equilibrium models on which the range succession model, which has guided range science since the 1950s, is based. The range succession model posited a predictable, linear relationship between grazing and vegetation change and the existence of an optimal level of grazing that could balance desired outcomes. Nonequilibrium models, on the other hand, emphasize variability and unpredictability, making it even more difficult to define *overgrazing*.

As it is commonly used, the term *overgrazing* indicates damage or harm to vegetation caused by grazing or browsing. For example, wildlife biologists debate whether the decline of willow and aspen in

Yellowstone National Park is due to overgrazing by elk. Most often the term refers to harm to vegetation caused by domestic livestock grazing. It is also frequently used to explain environmental change in regions where ranching or "pastoralism" is practiced. Because the term *overgrazing* does not have a precise definition, its common usage is problematic for several reasons. First, harm is often in the eye of the beholder. For example, rangelands in arid regions can appear to be overgrazed from the perspective of an observer from a wetter climate. Thus, eastern visitors to the western United States might see western rangelands as overgrazed. Or European visitors to Africa might enthuse over herds of nondomestic ungulates grazing the African savannah, but deplore the depredations of native livestock. Second, perceived harm is often attributed to livestock grazing without actual evidence of a causal relationship.

FALSE CAUSE

This is a mistake in reasoning called false cause: It assumes that two events juxtaposed in time or space have a cause and effect relationship. The tendency to make this mistake can be aggravated when there is an awareness of events in the not-too-distant past where overgrazing could be said to have occurred on a vast scale, as in the late 19th century in the American West. Grazing is not harmful, by definition, so overgrazing should require evidence of harm. The third reason that common usage of the term *overgrazing* is problematic is that, when livestock are seen as the cause of overgrazing, the livestock owners are usually blamed. This attribution of blame does not take into consideration the wider social, political, and economic conditions in which livestock owners operate in the present. It may also be informed by colonial and racist pasts. When these types of assumptions underlie the use of the term *overgrazing*, it becomes an example of "received wisdom": A powerful orthodoxy that is taken for granted and rarely questioned. Usage of the term may convey more information about its user's social, geographical, and ideological position than about actual conditions on the ground. To understand why the term *overgrazing* carries this ideological baggage, it is helpful to examine the early development of range management.

Although "pastoralism," a human adaptation to marginal environments that emphasizes the herding of livestock, originated approximately 7,000 years ago, the scientific discipline of range management only began to develop toward the end of the 19th century. Both European colonialism, particularly in Africa, and Euro-American western expansion in North America were central to this development. As a result, the term *overgrazing* carries along with it traces of Eurocentric histories and environments. In Africa, European colonial administrators were charged with managing and making productive vast territories whose climate, landscape, and societies were very different from their countries of origin. They were accompanied by an array of scientists whose job it was to inventory and develop scientific management regimes for their colony's natural resources. Europeans either did not recognize indigenous resource management systems, although these systems may have developed and been sustainable over many centuries, or they considered them unproductive because they were not designed to produce the surplus colonists needed for export.

In southern Africa, a science-based approach to range management began to develop toward the end of the 19th century when colonial scientists tailored climatic theories prevalent at the time, which linked deforestation to climate change, to the arid environment of southern Africa. Their "dessication theory" predicted that grazing could reduce vegetation cover and lead to decreased rainfall, increased frequency of drought, soil erosion, and eventually desertification. Scientific range management was intended to prevent desertification and, at the same time, increase livestock production. When scientific range management failed to live up these expectations, instead of questioning science, colonial administrators blamed African graziers who failed to adopt the new methods. Although it has been brought into question, the belief that there is a cause-and-effect relationship between grazing and desertification is still strong today.

In North America at about the same time, a rapid expansion of livestock herding west of the 100th meridian—into a region where average annual precipitation is significantly less than to the east and farming is not possible without irrigation—was taking place. Fueled by a rapid rise in beef prices, the building of railroads, and an influx of foreign capital after the end of the Civil War in 1865, the western rangelands soon became a "cattle kingdom" where cattle and sheep "barons" built up huge herds and competed for forage on the unregulated public domain lands. Overgrazing serves as the classic example of the Tragedy of the Commons and this tragedy played out in the late 18th century on the American rangelands as a series of droughts denuded the range and were followed by severe winters that killed off a larger part of the weakened livestock population.

The disaster shocked ranchers, the American public, and government officials and contributed to a change in attitudes toward ranchers and toward open range grazing. The damage done to the western range during this period is probably irreversible. Range management became an imperative in the United States in the wake of this disaster. Because of its implication with colonial histories, the term *overgrazing* may carry unavoidable ideological implications.

Modern range management has moved away from the use of the term *overgrazing*, and the retroactive consideration of damage done that it implies, to a more proactive consideration of the ecological processes that sustain range productivity.

SEE ALSO: Common Property Theory; Livestock; Pastoralism; Tragedy of the Commons.

BIBLIOGRAPHY. Richard Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600–1860* (Cambridge University Press, 1995); Jerry L. Holechek, Rex D. Pieper, and Carlton H. Herbel, *Range Management: Principles and Practices* (Prentice Hall, 2004); Terry G. Jordan, *North American Cattle—Ranching Frontiers: Origins, Diffusion, and Differentiation* (University of New Mexico Press, 1993); Melissa Leach and Robin Mearns, eds., *Lie of the Land: Challenging Received Wisdom on the African Environment* (James Currey, 1996); Nathan Sayre, *The New Ranch Handbook: A Guide for Restoring Western Rangelands* (The Quivira Coalition, 2001); Martin Vavra, William A. Laycock, and Rex D. Pieper, eds., *Ecological Implications of Livestock Herbivory in the West* (Society for Range Management, 1994).

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Overkill Hypothesis

THE OVERKILL HYPOTHESIS concerns the extinction of megafauna, particularly in the Americas and Australia. Archaeological excavations reveal that a number of species, perhaps more than 100, disappeared within a comparatively short period of time, less than 1,000 years.

Excavations also demonstrate that at least some of those animals were hunted and eaten by newly arriving humans. The hypothesis follows that the migrating humans were responsible for the extinctions because the animals were not frightened of them and so were easily hunted. A contrast is drawn with the megafauna of Africa and Eurasia, where a long period of cohabitation with humans taught the animals to be wary of humans. This hypothesis is controversial because the evidence does not convince all observers, and alternative explanations have been suggested, including the impact of climate change or the introduction of unfamiliar diseases.

The arrival of humans in North America and Australia is closely correlated with the disappearance of many large animal species. However, such correlation does not imply causation; further, reliance upon fossilization for evidence is suboptimal, principally because it is such a random method of preservation that it cannot be certain that those that have been preserved are representative of the population. Extinctions happened so rapidly that they have been conceptualized as a form of blitzkrieg, or lightning war resulting in mass extinctions. Some researchers object to this hypothesis for philosophical reasons, because it suggests that humanity cannot live in harmony with the natural environment.

Others maintain that it is impossible to rule out additional factors that would accompany such extinctions, as for example other creatures that would migrate alongside humans, or some other interaction between people and the environment. This has been observed in more recent examples of mammal extinctions, such as when old-world rats and other aggressive creatures have been introduced into island environments and native life has had insufficient time to adapt. Other problems with the hypothesis result from dating two possibly separate incidents with precision, when that precision is notoriously difficult to obtain.

Nevertheless, the evidence that has been gathered does lend support to the overkill hypothesis. One important finding is that it was not necessary for humans to have hunted down every single representative of a species, merely to kill more than were born, and this is quite possible in a 1,000-year period. In addition, the related Keystone Herbivore Hypothesis suggests that the large species, such as elephants and rhinoceroses, are significant environmental engineers and that their rapid disappearance would have a negative effect on the environment inhabited by large numbers of other creatures, some of whom would follow them into extinction.

New forms of scientific research are helping scientists to distinguish between overkill, disease, and climate change theories. Extraction of DNA and other organic material from frozen mammoths, for example, provides the opportunity to identify the presence of viruses or other disease-bearing organisms. Ice core analysis is able to provide more accurate information concerning climate change.

SEE ALSO: Animals; Extinction of Species; Keystone Species.

BIBLIOGRAPHY. C.E. Kaye, "Aboriginal Overkill: The Role of Native Americans in Structuring Western Ecosystems," *Human Nature* (v.5/4, 1994); Paul S. Martin, *Twilight of the Mammoths: Ice Age Extinctions and the Rewilding of America* (University of California Press, 2005); Paul S. Martin and Richard G. Klein, eds., *Quaternary Extinctions: A Prehistoric Revolution* (University of Arizona Press, 1989); Stephen Wroe et al., "Megafaunal Exinction in the Late Quaternary and the Global Overkill Hypothesis," *Alcheringa* (v.28, 2004).

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Overpopulation

OVERPOPULATION IS A situation in which the resource demands of a population exceed the resources available in a given area. The concept of overpopulation may be used in conjunction with the concept of carrying capacity, which originated in the field of ecology and refers to the number of individuals and species that a particular habitat may support. When used in reference to humans, overpopulation is often identified as a causal factor of poverty and a driver of environmental degradation, particularly in the developing world. However, since Thomas Malthus professed his views on the grim consequences of unchecked population growth more than two centuries ago, the concept of overpopulation has not only eluded refinement, it has also proven deeply controversial.

In his 1798 *Essay on the Principle of Population,* Malthus maintained that population, due to people's natural desire to reproduce, will expand at a geometric rate, while the means of subsistence (i.e., food production) will increase at an arithmetic rate. The product of this fundamental tension between population and resources was poverty and misery for much of humanity. According to Malthus, humans had not yet multiplied to fill the earth because of what he termed "preventative" checks (e.g., abortion and postponing marriage) and "positive" checks (e.g., war, disease, and, most importantly, hunger). Positive checks tended to fall most heavily upon the poor, whom Malthus held in particularly low esteem owing to their supposed sexual profligacy.

Malthus's principle of population has been critiqued from a number of angles, including for its obvious conflation of moralist and scientific approaches. An early critic of Malthus was Marx, who argued that capitalism, not overpopulation, was the cause of poverty and that capitalistic laws of accumulation, rather than universal laws of population growth, pushed society to the limits of its natural resource base. Marx further contended that under capitalism, "surplus" population performed a vital function as a readily exploitable industrial reserve army of laborers.

Nonetheless, theories of overpopulation and physical resource scarcity crises remained influential. In the context of the rise of environmentalism and concern about rapid population growth in developing countries, the 1960s and 1970s witnessed a reemergence of Malthusian thought in the North that extended Malthus's underlying premise to include environmental degradation as a consequence of overpopulation.

Influential neo-Malthusians included biologist Garrett Hardin (renowned for his Tragedy of the Commons thesis) and fellow biologist Paul Ehrlich, who in *The Population Bomb* (1968) predicted that the earth would soon experience dire famines due to population outstripping food supply. Also, in 1972 the Club of Rome issued its report *The Limits to Growth,* which concluded that exponential population growth and resource development would eventually lead to resource exhaustion and worldwide economic collapse.

Response to neo-Malthusian models came from several camps. Free-market proponents such as Julian Simon argued that rather than inescapably leading to misery and hunger, growth in human population—considered by Simon the "ultimate resource"—actually stimulated innovation and economic development. Also influential was the work of Danish economic historian Esther Boserup, who concluded that population pressure in agrarian societies promoted agricultural intensification through the mobilization of labor and the application of other inputs. Countering Malthus, Boserup thus argued against the inelasticity of food production, a position buttressed by the substantial per-acre yield increases achieved after World War II with the aid of Green Revolution technologies.

In addition, contemporary Marxist critiques maintain that poverty does not result from Malthusian global resource scarcity crises, but rather from the highly unequal distribution of resources and power inherent to capitalism. Critics from developing countries have, in a similar vein, attempted to shift the debate away from population patterns in the south to consumption patterns in the north. Identifying "overpopulation" in developing countries as a driver of environmental degradation amounts to blaming the poor, these critics argue, while residents of developed countries, in fact, consume the vast majority of the world's resources.

Thus, given the multitude of cultural, political-economic, and technological variables that influence the population-resources dynamic as well as highly uneven geographic patterns of resource production and consumption globally, the concept of overpopulation has proven exceedingly difficult to define. Commentators, notably David Harvey, have nevertheless highlighted the political implications of theories of overpopulation themselves—in particular, the degree to which they may be used as ideological levers to justify class or ethnic oppression domestically or neo-imperialist policies abroad.

SEE ALSO: Boserup, Ester; Capitalism; Carrying Capacity; Club of Rome; Green Revolution; Hardin, Garrett; Malthus, Thomas; Malthusianism; Marx, Karl; Poverty; Tragedy of the Commons; Underdeveloped ("Third") World.

BIBLIOGRAPHY. David Harvey, "Population, Resources, and the Ideology of Science," *Economic Geography* (v.50/3, 1974); Robert W. Kates, "Population and Consumption: What We Know, What We Need to Know," *Environment* (v.42/3, 2000); Thomas R. Malthus, *An Essay on the Principle of Population,* Donald Winch, ed. (Cambridge University Press, 1992); Mario Petrucci, "Population: Time-Bomb or Smoke-Screen?" *Environmental Values* (v.9, 2000); John R. Weeks, *Population: An Introduction to Concepts and Issues,* 8th ed. (Wadsworth Thomson Learning, 2002).

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Owens Valley

LOCATED IN INYO County in southeastern California, the Owens Valley stretches for approximately 75 miles (121 kilometers) between the Sierra Nevada Mountains to the west and the White and Inyo Mountains to the east. Owens Valley is most notable for an intense battle persisting throughout the 20th and early 21st century between the city of Los Angeles and local residents over land rights and the diversion of the valley's surface and groundwater. Owens Valley provides a significant portion of Los Angeles's water despite being located over 200 miles (322 kilometers) to the northeast.

Prior to the diversions, the region was site to Owens Lake, an important stopover for migratory birds and a navigable water body for recreation. The valley was also home to the Owens River, which supported rare high desert riparian habitat and provided water to local farmers. The Owens Valley "water wars" began when the city of Los Angeles Department of Water and Power (LADWP), under the orchestration of Superintendent William Mulholland, drew up plans to divert water from the Owens River to an aqueduct serving the city of Los Angeles. The LADWP acquired water rights from valley farmers and ranch owners despite their protests. By 1913 the 223-mile (359-kilometer) Los Angeles Aqueduct was complete and began diverting water from the Owens River.

In the years following the initial diversions, 50 miles (81 kilometers) of the Owens River as well as Owens Lake dried up. Farmers in the region gave up their dying crops and orchards and were forced to relocate as the region lost its vegetation cover and productive capabilities. A second aqueduct built in 1970, which was heavily dependent on pumping groundwater from Owens Valley, only exacerbated the desertification process.

By 1970, early environmental regulations began affecting the future of both the Los Angeles Aqueduct and Owens Valley. The California Environmental Quality Act (CEQA) of 1970 required the LADWP to describe the environmental consequences of their diversion projects in an environmental impact report (EIR). In 1972, Inyo County used these stipulations to take LADWP to court over their plans to increase groundwater pumping in Owens Valley. The LADWP submitted two EIRs in 1976 and 1979 that were both rejected by the courts.

Numerous scientific studies and court cases occurred over the next 20 years, and several EIRs were unsuccessfully negotiated. Meanwhile, the city of Los Angeles continued to pump groundwater out of Owens Valley. By 1997, the Owens Valley Committee, the Sierra Club, and others signed a Memorandum of Understanding to outline the rewatering of lower portions of the Owens River. Although the majority of this rewatering has yet to occur, the Owens Lake basin is now occasionally shallow flooded by the city of Los Angeles in order to control air pollution from alkali dust storms. Enough water is present in the Owens Lake vicinity to still be designated a Nationally Significant Important Bird Area by the National Audubon Society.

In 2004, Los Angeles Mayor James Hahn proposed a Conservation Easement for all LADWP land in the Owens Valley. Advocates for this plan argue that it would protect the region from economic growth in neighboring areas, while critics argue that the city of Los Angeles will continue to control a landscape they took from local residents nearly 100 years ago.

SEE ALSO: Desertification; Groundwater; Habitat Protection; Irrigation; Los Angeles River; Mulholland, William; Property Rights; Water.

BIBLIOGRAPHY. Rebecca Fish Ewan, *A Land Between: Owens Valley, California* (Johns Hopkins University Press, 2000); Norris Hundley, Jr., *The Great Thirst: Californians and Water: A History* (University of California Press, 2001); Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (Penguin Books, 1993).

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Oxygen

OXYGEN IS A normally gaseous, nonmetallic chemical element with the symbol O and the atomic number 8. It is widely prevalent in the earth's atmosphere, in which it is essential for the respiration of humans and other living creatures. It is also widely prevalent across 70 percent of the earth's surface in the form of water (H_2O), of which the most important compound is oxygen.

Oxygen was discovered in the 18th century by Joseph Priestley in England, Carl Wilhelm Scheele in Sweden, and Antoine Lavoisier in France, working independently. Lavoisier was responsible for identifying oxygen as an element and determining its role in combustion, which had previously been attributed to the phenomenon of phlogiston.

Oxygen constitutes approximately 0.03 percent of all atoms in the universe, which makes it the fourth most common element. However, it is the most abundant element on the earth, representing nearly half the mass of the earth's crust, 90 percent of the mass of the earth's water, and 20 percent of the mass of the air. In small quantities, particularly in the upper atmosphere, oxygen exists in the form of O_3 rather than the normal O_2 molecule, when it is known as ozone.

Oxygen first appeared on the earth in free form approximately two billion years ago when it was produced as a by-product of the living process of early anaerobic creatures. This enabled the evolution of modern, aerobic life forms and these subsequently developed photosynthetic processes that have greatly increased the amount of oxygen present. A significant amount of the oxygen reacted with hydrogen to create water, making organic life possible. Without the release of oxygen, therefore, the earth would have remained wholly inhospitable to modern life forms.

While plants absorb carbon dioxide and release oxygen as part of photosynthesis, animals including humans inhale oxygen and exhale carbon dioxide. This means that there is an approximate balance for total amounts of the different gases, although this balance is subject to many other intervening variables. Evidence suggests, albeit inconclusively, that it is the presence of free radicals (atoms or groups of atoms that have one missing electron and are usually oxygen atoms) that results in the aging process.

Oxygen has numerous scientific and technological purposes. Its role in combustion, in which it combines with another substance generally at high temperatures, means it has many uses in equipment for melting, soldering, and burning materials. The role of oxygen in respiration means that it is of great importance in medical science.

Oxygen is also important in regulating the environment in which fish and other aquatic creatures live, since these also need oxygen, and environmental degradation can reduce the oxygen level in water. Oxygen regulation is of great importance in fish farming and related industries. Intensive agricultural activities may have contributed to the lack of oxygen (hypoxia) in some important waterways.

Since oxygen will react chemically with many other substances, it is necessary to find methods to prevent the two coming into contact under some circumstances. This has helped to stimulate the creation of rust proofing and vacuum packing technologies. The opposite use of such technologies has been used in providing pressurized cabins that have enabled flight and space flight at high altitudes. As air pollution has intensified in the modern world, particularly in urban environments, increasing numbers of people have been suffering from asthma and similar conditions and have sought relief from inhaling oxygen. Pure oxygen for sale has become a feature in supposedly chic urban cafes.

SEE ALSO: Ozone and Ozone Depletion; Water; Water Quality.

BIBLIOGRAPHY. C.E. Cross et al., "Oxygen Radicals and Human Disease," *Annals of Internal Medicine* (v.107/4, 1987); Nick Lane, *Oxygen: The Molecule that Made the World* (Oxford University Press, 2004); Marc Ribaudo, "Hypoxia in the Gulf: Addressing Agriculture's Contribution," *Amber Waves* (v.4, 2006).

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Ozone and Ozone Depletion

OZONE (O_3) IS a form of oxygen that forms naturally in the atmosphere and also as a result of some electrical activity. It has a characteristic odor and is an irritating and toxic gas at even low concentrations. Ozone plays a vital role in shielding the surface of the earth from damaging ultraviolet radiation. In recent years, ozone has become increasingly depleted as a result of the emission of man-made chemicals into the air. Fears of widespread damage to the ozone layer—which some believe have led to such diseases as skin cancer—have prompted concerted action to repair the problem.

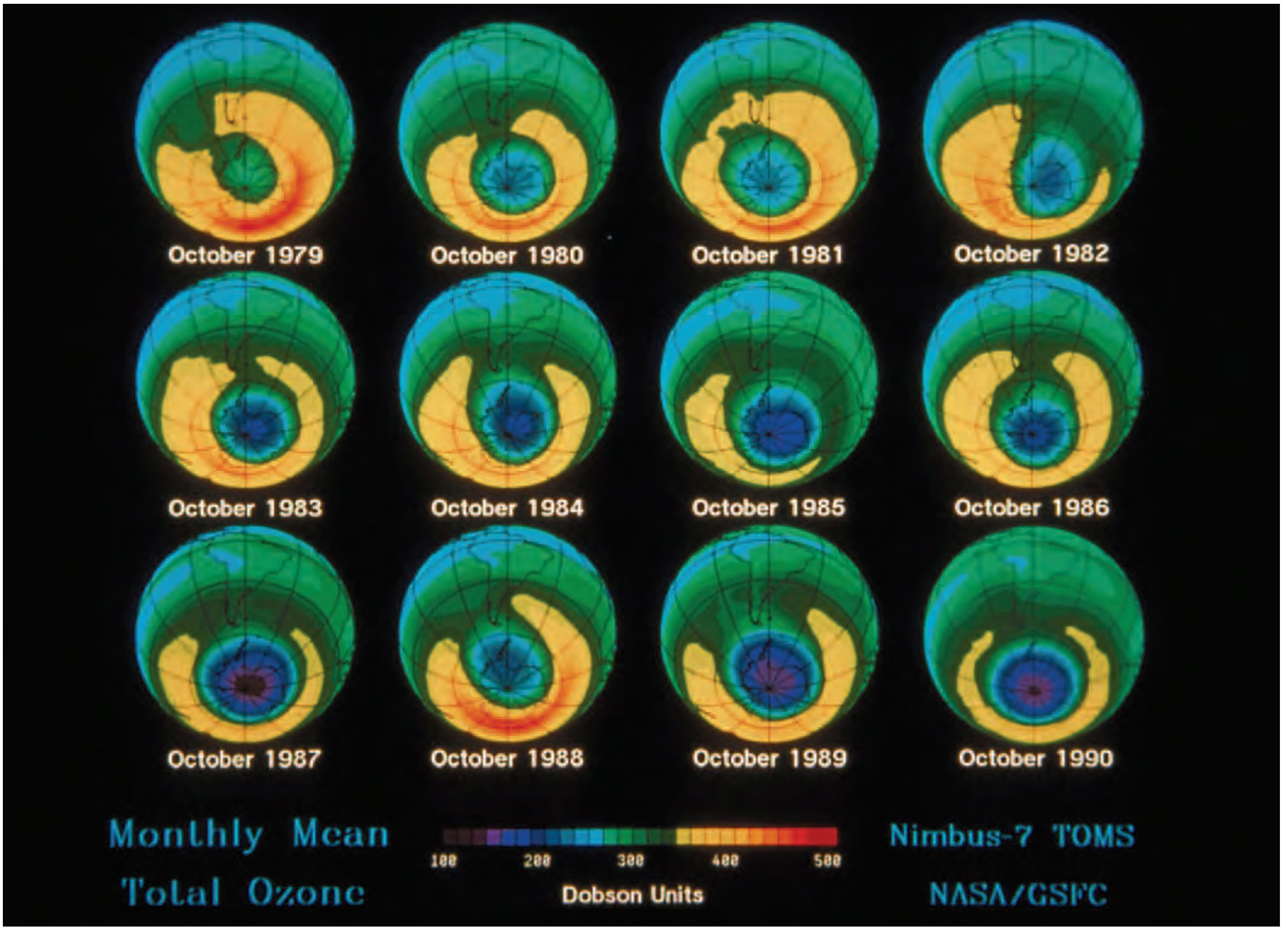
Ozone is present in the stratosphere, which is a layer in the atmosphere from 10 to 50 kilometers above the surface of the earth. This is the height at which airplanes are flown. Ozone in the stratosphere acts as the primary shield against ultraviolet (UV) radiation. Without ozone, severe cellular damage to nearly all forms of life on earth would result. In humans, UV radiation darkens the skin and destroys cells depending on the position within the UV spectrum it occupies. UV radiation is defined as being between 40 and 400 nm, which occupies the space between X-rays and visible light. Excessive UV radiation can lead to the formation of skin cancers and cataracts, in addition to sunburn (erythema).

By passing an electrical discharge through a stream of normal, diatomic oxygen (O_2), ozone may be manufactured. It has a number of industrial applications, including chemical oxidation, organic syntheses, and water disinfection. It can decolorize and deodorize a number of substances, which is useful for consumer goods. Depending on the presence of certain other catalysts, ozone may rapidly decompose at everyday temperatures or at the boiling point of water and above. This and the toxicity of the gas mean that it must be handled with some care.

The amount of ozone in the stratosphere has historically been constant, although processes of formation and destruction of individual ozone molecules is continuous. The total amount has varied within predictable and fairly well-established levels, depending on changes in seasonality and latitude and on the changing prevalence of sunspots. However, it has become increasingly obvious in recent years that the depletion of atmospheric levels of ozone has exceeded all known precedent and may have reached a level beyond which natural restorative processes will replenish it. The reason for this is due to the release of chlorofluorocarbon gases (CFCs) into the atmosphere. CFCs have been used in consumer goods and industrial applications since their development some 50 years ago. They are customarily low in toxicity, nonflammable, and stable and of great value as refrigerants, solvents, and fire retardation agents, among other uses.

Unfortunately, it is the stability of these compounds that causes the problem as it permits the

Despite measures to ban CFCs, the amount of ozone loss is still reaching record levels. According to the most recent data, the ozone layer hole will reach an unprecedented size each year until 2018.



chlorine-bearing compounds to be released into the atmosphere when the substances begin to deteriorate. Although chlorine has been extensively used in human society in such applications as hygiene in swimming pools, this chlorine does not reach the upper atmosphere because it quickly reacts with water in the atmosphere and falls in the form of rain. CFCs are instead driven through the atmosphere by wind action and may pass into the stratosphere. Intense UV radiation can cause the CFC molecules to break down and release chlorine into the upper atmosphere. The chlorine acts as an extremely effective destroyer of ozone; as many as 100,000 molecules of ozone can be destroyed by a single chlorine molecule.

Prevailing winds and usage patterns determine that the flow of CFCs are concentrated more in some areas rather than in others. In 1985, a group of scientists led by Joe Farman, Brian Gardiner, and Jonathan Shanklin published research showing that a hole in the ozone layer had been detected over Antarctica. Subsequent research has shown that the hole appears on an annual basis and has been growing. At its greatest extent, the hole over Antarctica grew to a size that was the equivalent of more than three times the land area of the United States. Clearly, if the hole were to reach heavily populated areas, its impact would be disastrous.

The discovery of the hole led to the creation of one of the first global environmental treaties, the Montreal Protocol of 1987, which bans the production of CFCs. Gradually, the use of these chemicals has been phased out with old kitchen appliances such as refrigerators. Determined efforts have led scientists to predict that the hole is in the process of being repaired and could be fully restored by as early as 2050, assuming current trends continue. Despite measures to ban CFCs, the amount of ozone loss is still reaching record levels. Some 40m tons of ozone have been lost in 2005–06, showing that the ozone layer hole will reach an unprecedented size each year until 2018, according to the most recent data.

At that point, its overall size can be expected to decrease in size and significance. As the Montreal Protocol demonstrates, it is possible for determined human activity—cooperating together and coordinated at the state level—to tackle important, large-scale environmental problems. This may be seen as symbolic of the possibilities of the fight to restore the earth from the dangers of global climate change.

SEE ALSO: Chlorofluorocarbons; Global Warming; Montreal Protocol.

BIBLIOGRAPHY. F. Dentener et al., "The Global Atmospheric Environment for the Next Generation," *Environmental Science and Technology* (v.40/11, 2006); Environmental Protection Agency, www.epa.gov (cited November 2006); J.C. Farman et al., "Large Losses of Total Ozone in Antarctica Reveal Seasonal ClO*x*/NO*x* Interaction," *Nature* (May 16, 1985); Tim Flannery, *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth* (Atlantic Monthly Press, 2006); Elizabeth Kolbert, *Field Notes from a Catastrophe* (Bloomsbury, 2006); Montreal Protocol, ozone .unep.org (cited November 2006); Hilary Osborne, "Low Temperatures Increase Ozone Loss," *The Guardian*, www.environment.guardian.co.uk (cited October 2006).

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Pacific Ocean

THE PACIFIC OCEAN is one of the largest regions of the world. It spans from roughly 120 degrees east longitude eastward to 90 degrees west longitude for a total span of 150 degrees of longitude, covering almost half the globe. The Pacific Ocean also comprises nearly half the surface area of the earth's oceans. As a geographic region, it spans the Pacific Islands from New Guinea (including both the independent state of Papua New Guinea and Indonesia's Irian Jaya) eastward to Easter Island and Hawaii. Midway Island marks the northernmost island in the region. New Zealand is sometimes considered to be part of the Pacific Region due to its cultural affiliation with Polynesia, but is normally grouped with the Austral Region. The rest of Indonesia and the Philippines are typically considered to be part of Southeast Asia.

With the exception of the continental island of New Guinea, the region is dominated by volcanic high islands and atolls. Despite its vast spatial expanse, the region only hosts a population of roughly 8.5 million people (about 0.1 percent of the world's population) by 2005 estimates. Nevertheless, the region comprises roughly one-fifth of the world's 200-mile coastal exclusive economic zones. The island nations of this region thus have strong claims to fisheries and mineral rights in the region. However, most of these island nations are less-developed nations with little means of enforcing their fishing laws and illegal fishing is common. The fisheries of the region are at risk from overfishing, largely in conjunction with tuna fisheries.

The vast expanse of oceans and predominance of islands has exerted a strong influence on the biodiversity of the realm. The oceans act as filters limiting the numbers of species that are able to disperse between islands, and the relative isolation of the islands gives rise to the evolution of unique biota. Prior to human colonization, the terrestrial species in the Pacific dispersed eastward across the region. In terms of flora, the Pacific's plants show greater similarity to those of Southeast Asia, and hence the region is considered to be part of the Paleotropical Realm.

There is only one genus of mammal native to the region, fruit bats (*Pteropus*), and the fauna of the region is dominated by birds deriving from the area around Papua New Guinea. The Pacific is therefore classed as part of the Austral Realm in terms of its fauna. Given that these are island ecosystems, many of which lacked predators, many bird species evolved out of their ability to fly, leaving them vulnerable to extinction once humans and associated introduced species arrived.

The Pacific region was among the last areas of the globe to be colonized by humans. Although humans had settled into New Guinea and Australia by 40,000 years ago, and had settled into the nearby Solomon Islands by 28,000 years ago, eastern Melanesia (Vanuatu to Fiji), western Polynesia (Tonga and Samoa), and Micronesia were not colonized until roughly 3,500–3,000 years ago. Eastern Polynesia (Society Islands and the Marquesas) was settled roughly 2,200 years ago, and the outermost extremes of Polynesia (Hawaii, Easter Island and New Zealand) between 1,700 and 1,200 years ago.

The immediate impact of ancient human colonization was to transform landscapes and alter species composition of the islands. Polynesians introduced many terrestrial mammals to the Pacific Islands. Pigs and dogs were the primary economic mammal species introduced from outside the region, and rats the primary accidental introduction. Rats especially have been implicated in the extinction of many native and endemic bird species through predation, although human consumption and habitat conversion played a role as well.

The ancient Polynesians introduced many cultivars into the islands, such as taro (*Alocasia esculenta*), and also transported island tree species that were native to one portion of the region to other islands, such as *Pometia pinnata*, which had value as a famine crop. The total collection of all cultivar and forest species that the Polynesians dispersed among the islands is referred to as "transported landscapes." Although the conversion of habitat and introduction of species between islands has been detrimental to endemic species of these islands, many of these introduced species have become naturalized into the native flora.

There are examples, especially from Eastern Polynesia, where the extensive removal of forest cover has resulted in ecosystem collapse followed by collapse of the human societies that depended upon them (Easter Island being the most extreme example). Other Polynesian societies, such as Hawaii, recovered through implementing more intensified agricultural techniques, such as terracing, which helped stabilize soil erosion, among other benefits.

European contact and colonization saw the introduction of many new animal and plant species, accompanied with expansion of habitat loss in conjunction with market linkages. As a result, the South Pacific is considered to be among the most at-risk biodiversity hot spots in the world. Other environmental concerns involve global warming, especially as related to sea level rise (atolls, the predominant island type in Micronesia, with their highest elevations only a few meters above sea level, are especially vulnerable), and loss of coral reefs due to warming ocean waters (both in terms of biodiversity and subsistence for village economies). Conflicts arise over land use practice resulting in habitat loss, detrimental impacts of extractive activities by foreign companies, and perceived insensitivities to the needs of island states on the part of the cosmopolitan core countries in regard to climate change.

SEE ALSO: Atlantic Ocean; Biodiversity; Coral Reefs; Currents, Ocean; Easter Island; Indian Ocean; New Zealand; Oceanography; Oceans; Papua New Guinea; New Zealand.

BIBLIOGRAPHY: Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); H. J. de Blij and Peter O. Muller, *Geography: Realms, Regions and Concepts* (John Wiley & Sons, 2000); Patrick Vinton Kirch, *The Evolution of Polynesian Chiefdoms* (Cambridge University Press, 1984); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Population Reference Bureau, *2005 World Population Data Sheet* (Population Reference Bureau, 2005); Max Quanchi and Ron Adams, eds., *Culture Contact in the Pacific* (Cambridge, 1993).

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Packaging

PACKAGING IS ANY form of material or process used to prepare goods for distribution and sale in the market. It includes tin cans, paper and plastic bags, polystyrene balls, and high-tech covering for human organs transported from one hospital to another for transplanting. From a business perspective, there are many reasons for using packaging. The first and in many cases most important of these is to protect perishable items, such as eggs, from being damaged. A second reason for packaging is to provide needed information for consumers and retailers. This includes guidelines for use in the case of pharmaceuticals, ingredient lists and nutritional information for food items, and advertising for point-of-purchase sales promotion. Increasingly, consumer groups and others are putting pressure on governments to improve the amount and quality of such information on packaging.

The use of tin in the United States on a large-scale basis dates to the American Civil War (1861–65), when the mobilization of large numbers of soldiers required industrialized catering and stimulated the mining of tin in British Malaya and elsewhere. However, packaging has been used since the very earliest days of trade, as items were transported from community to community in clay amphorae or wrapped in banana leaves or other natural items. Ethnic minority groups prior to industrialization have shown considerable resourcefulness in using leaves, bamboo, and other plant or animal parts to create containers and other forms of packaging. These materials have the advantage of being mostly reusable, and rarely have negative environmental impacts when discarded. Even so, excessive use of particular items can lead to unsustainable practices.

The Industrial Revolution and subsequent internationalization of production and distribution massively increased the amount of packaging produced and used around the world and sparked the search for solutions that were lower cost and provided regularity of supply. This led to the exploitation of polymer—long molecular chains with properties suitable for creating moldable products—that were produced as plastics of various types from hydrocarbon by-products. Industrial processes soon found ways to mass produce plastic items in great numbers and at very low cost, and these were attractive to manufacturers and retailers, especially when methods of introducing lettering and graphics on plastic bags were developed. Advertising opportunities on such bags have encouraged redundancy of packaging.

The nature and extent of forms of packaging depend on cultural and geographical considerations. In urban environments such as Australia and the United States, people customarily have spacious housing and travel by car to supermarkets. In these cases, shoppers will buy large amounts of products in large containers or multiple unit packs. By contrast, people living in Hong Kong or Japan, where living space is at a premium, purchase items in much smaller unit sizes and numbers. Manufacturers and retailers must retain flexible packaging systems that can cater to these different requirements. The use of different languages, as mandated by governments importing manufactured items, also causes firms additional expense.

The amount and type of packaging has provoked considerable controversy because of concerns about the waste of resources and the impact that packaging has upon the environment. Some forms of packaging may be biodegradable, but many plastic shrink wrappings and bags remain in a similar form for extended periods. If the packaging is not dealt with effectively, it then contributes to pollution and negative health outcomes. In Bangkok, the propensity for people to throw plastic bags away in the street means they are caught in the canal and drainage system and contribute to flooding during the monsoon season, and the spread of waterborne diseases in the floods. Plastics have negative effects on waterways, rivers, and oceans, damaging and poisoning marine life. Even organic packaging material can contribute to problems.

The main methods taken to tackle the overuse of packaging or the use of unsustainable forms of packaging have included consumer education, recycling campaigns, and regulation and taxation of undesirable products. In developed countries, particularly in Europe and East Asia, most people have become aware of these issues and increasingly participate in systems in which shoppers provide their own reusable shopping bags and shops do not routinely give away plastic bags but will offer them for sale if requested. Using this system has helped in improving the quality and beauty of public spaces in cities such as Taipei. Meanwhile, recycling campaigns in the United Kingdom require most residents to sort their rubbish into one of several categories, including the kinds of plastic bags most commonly associated with packaging. Different categories have color-coded or day-coded means of collection and local councils are responsible for enforcing compliance.

No matter how intense or well-focused government or community support is for the reduction of packaging problems, there are still strong motivations for business to continue to use it extensively. As long as production and ultimate consumption remain separated by wide distances, goods will need to be protected to retain freshness and quality. In modern business, most consumer goods companies also rely on intangible assets such as brands and reputation for the bulk of their profits, and these are sustained by reminders of corporate identity, for which packaging is the most suitable medium.

SEE ALSO: Consumers, Economic; Consumption; Plastics; Recycling; Waste, Solid.

BIBLIOGRAPHY. Olga Ampuero and Natalia Vila, “Consumer Perceptions of Product Packaging,” *The Journal of Consumer Marketing* (v.23/2, 2006); D. Hitchens, “Environmental Policy and the Implications for Competitiveness in the Regions of the EU,” *Regional Studies* (v.31/8, 1997); Diane Mollenkopf et al., “Assessing the Viability of Reusable Packaging: A Relative Cost Approach,” *Journal of Business Logistics* (v.26/1, 2005).

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Pakistan

PAKISTAN IS A low income country in the northwest of the economically poor region of South Asia. For about 200 years prior to 1947 all of South Asia was either directly or indirectly under British colonial rule. When the colonial rule ended in 1947, the British partitioned their possessions in the subcontinent into the two sovereign states of India and Pakistan along religious lines. The modern state of India was predominantly Hindu, while Pakistan was predominantly Muslim. Pakistan has four federating units, Sindh, Punjab, North Western Frontier Province (NWFP) and Balochistan. Pakistan also holds a third of the disputed mountainous region of Kashmir. From the very outset, Pakistan has faced a range of environmental and resource based challenges including, water resources management, environmental hazards (primarily floods, droughts and earthquakes), land degradation, deforestation, rural poverty, and rapid urbanization.

The most important physiographic feature of Pakistan is the Indus basin and its five eastern and one western tributary river. More than 90 percent of Pakistan’s population resides in the Indus Basin, which has almost all the arable land of the country. Also, being a predominantly agricultural country, close to 70 percent of the population of the country directly or indirectly depends upon agriculture. Irrigated agriculture is the backbone of Pakistan’s agricultural economy. The Indus Basin is home to the largest contiguous surface irrigation system in the world covering approximately 16 million hectares. The irrigation system has enabled the largely semiarid country to have significant increases in agricultural productivity. Most of the agricultural productivity has, however, been achieved by increasing the total irrigated area and not by increase in per unit area yield of crops. Nevertheless, green revolution, high-yielding seed varieties coupled with surface irrigated area expansion have allowed the country to be a major producer of cotton, rice, and to a lesser extent wheat and other food crops.

The contribution of irrigated agriculture to total agricultural production is undeniable. However, the Pakistani irrigation system has been characterized by chronic issues of conveyance inefficiencies, inequity in water distribution, water pollution, and irrigation related water logging and salinity. Pakistan’s irrigation system is gravity based where water, diverted from the main stem rivers, flows by gravity to main canals, then to tributary canals, then to individual village water courses. Most of the canals and water courses are unlined, resulting in high seepage losses. The seepage losses in fresh groundwater zones are generally retrieved by farmers by tubewells and water pumps. In brackish groundwater zones, the water becomes unusable once it mixes with the brackish groundwater.

The pervasive water seepage from irrigation channels also leads to raising of the water table

Constantinos Doxiades and Islamabad

The city of Islamabad, the capital of Pakistan since 1967, was designed by the Greek architect and urban planner Constantinos A. Doxiadis (1913–75). His father was a pediatrician who later served as Greece's minister of refugees. Doxiadis graduated from Athens Technical University in 1935 with a degree in architectural engineering, then went to Berlin, where he earned his doctorate from Charlottenburg University.

In 1937 Doxiadis was appointed as the Chief Town Planning Officer for the Greater Athens area, and also headed the Department of Regional and Town Planning in the Ministry of Public Works. As a corporal in the Greek Army, Doxiadis worked in the resistance to the Axis powers, and was a member of the Greek delegation to the San Francisco Peace Conference in 1945. He was subsequently Greece's representative in its dealings with Britain, France, and the United States on matters of Greek postwar reconstruction. Doxiadis then held a number of minor government and diplomatic posts, founding Doxiadis Associates in 1951.

Constantinos Doxiadis was one of the most prominent of the urban planners involved in the ecumenopolis concept, or the movement known as Ekistics. Also known as "high modernism," it led to his plan for building Islamabad in sectors, each containing subsectors separated by parks forming a "green belt." With a strong emphasis on open space and greenery, Islamabad contrasted with Pakistan's previous capital, Karachi. Constantinos Doxiadis died on June 28, 1975, and the Doxiadis Foundation was established in his memory.

which at times can reach the surface, causing waterlogging of the soil. The groundwater on the surface can subsequently evaporate, but as it evaporates it deposits the salts it leeches from the ground by capillary action on the surface. The deposition of a salt layer on the surface through this process is called salinity. Both waterlogging and salinity render the land unusable for agricultural purposes. Every year Pakistan loses thousands of acres of land to waterlogging and salinity, necessitating either abandonment of the land, or expensive groundwater drainage projects.

Strong inequities in water distribution have also been documented in Pakistan. The gravity-based system along the water course is the arbiter of how much water is available. Those at the tail end of the course are typically at a disadvantage in such a system. Recent research on the system demonstrates that it is typically the small and poor farmers, located at the tail end of water courses, who do not get access to water not just because of their location but also because of stronger and richer farmers stealing water through illegal outlets or out-of-turn irrigation.

Groundwater has been significantly developed in Pakistan. In the Indus Basin much of the surface irrigation scarcity has been compensated for by the sinking of electric tubewells and diesel pumps. But the cost of such pumps is very high and only prosperous farmers can afford them. Out of the Indus Basin, primarily in the highlands of Balochistan, groundwater is the only source of water for agriculture and domestic use.

Historically in Balochistan, the ancient karez irrigation system was the main means of groundwater exploitation. *Karez* is an underground water channel starting from a mother well dug directly into the water table. The underground channel is connected by a series of wells, and the water flows by gravity until it reaches the surface, and from there it can be used for irrigation. *Karez* requires a high degree of labor for maintenance and the society had developed well-articulated modes of social organization around the *karez* system. Since the introduction of the tubewell in the arid highlands of Balochistan, the *karez* system is increasingly being replaced by tubewells. Only the richer farmers can afford the them and subsidized electricity for tubewells is inducing those farmers to overexploit the use of groundwater, leading to increasing extinction of *karezes* and abandonment of farms by small farmers who depended on *karez* water.

Back in the Indus Basin, in addition to issues of equity and efficiency, surface irrigation water is increasingly polluted by runoff from farms using of chemical fertilizers and pesticides to maintain yields. Water pollution from agricultural runoff is being compounded by industrial runoff from the growing urban areas of Pakistan. Some of the tributaries of the Indus, for example the upper reaches of the Ravi River by the city of Lahore, are biologically dead because of industrial pollution.

Poor water quality in the Indus basin is accentuated by excessive withdrawal of water for irrigation. Almost 75 percent of the inflow of water into the Indus Basin is withdrawn for agricultural and industrial use, with the result of the Indus delta being under serious threat from salt water intrusion, as are the fisheries and the communities that depend on those fisheries for livelihood. Construction of additional storage structures, in addition to the existing two dams on the Indus Basin rivers, is highly controversial. Furthermore, by the Indus Water Treaty, Pakistan signed away the flow of the three eastern tributary rivers of the Indus to India, accentuating the need for compensatory water infrastructure on the western rivers.

Many of Pakistan's environmental concerns are the outcome of slow development by government and society.

Environmental hazards are another challenge for Pakistan. Powerful earthquakes in northwestern Pakistan have caused significant loss of life and property in recent years. Much of the losses are the outcome of culturally and environmentally inappropriate construction, corruption in the construction of public buildings, and human habitation in vulnerable areas. Flood hazard is another chronic hazard in the Indus basin. Almost every year varying degrees of loss of crops, property and lives are experienced due to flooding. Because of excessive withdrawal of water from the river channels, many channels have lost their original capacity levels, leading to increased flood peaks from even moderate precipitation.

Overall, many of Pakistan's environmental concerns are the outcome of slow development by government and society. Development, narrowly defined as a replication of the West's development trajectory, is leading the country to make excessive demands on its fragile resource base. Also, the complete reliance on modern technology to the neglect of social and environmental considerations is likely to accentuate environmental challenges in the short- to medium-term, unless there is a paradigm shift toward more democratic, socially-responsible and environmentally-friendly conceptions of development.

SEE ALSO: Afghanistan; India; Rivers.

BIBLIOGRAPHY. Daanish Mustafa and James L. Wescoat, Jr., "Development of Flood Hazard Policy in the Indus River Basin of Pakistan, 1947–1995," *Water International,* (v.22/4); F. van Steenbergen, F. and W. Oliemans, "A Review of Policies in Groundwater Management in Pakistan 1950–2000," *Water Policy* (v.4/4); James L. Wescoat, Jr., Sarah Halvorson and Daanish

Mustafa, "Water Management in the Indus Basin of Pakistan: A Half-Century Perspective," *International Journal of Water Resources Development* (v.16/3).

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Paleoclimatology

PALEOCLIMATOLOGY INVOLVES THE reconstruction of past climates prior to the instrumental period. Paleoclimatology focuses on: (1) describing past climates, (2) understanding the natural and anthropogenic processes responsible for these patterns, and (3) using this knowledge of past climates and climate dynamics to identify and understand potential responses to climatic forcing. Detailed views of the modern climate can be obtained using available instrumental records and documentary or historical sources of information, but their short temporal resolution and/or sparse spatial coverage limits their ability to capture the variability that is inherent in the climate system. Paleoclimatology, therefore, extends instrumental and historical records further back in time, enabling the capture of a greater range of variability. This enhances not only our understanding of climate variability in terms of mean conditions, extremes, and states, but also improves insight into the dynamic forces controlling the operation of the climate system.

Examples of research areas that interest paleoclimatologists include: abrupt climate change, hydrological variability, land-cover change, sea-level rise, and modeling the potential response of the climate system to natural and anthropogenic forcing. Paleoclimate research methods involve the testing of specific hypotheses such as how to identify the forcing mechanism(s) or drivers responsible for specific climate events that occurred in the past (for example, the Dust Bowl, Little Ice Age, mid-Holocene aridity in central North America, and the Younger Dryas). One important field of paleoclimate research centers on identifying potential surprise behavior in the climate system, the mechanisms responsible for these nonlinear responses, and ultimately the impacts that may result.

Paleoclimatologists extract paleoclimatological data from a plethora of natural archives, or proxies, such as corals, ice cores, marine and lake sediment, tree rings, and spleothems. For example, ice cores recovered from alpine glaciers located in South America, Africa, and Central Asia and high latitude ice sheets located in Greenland and Antarctica have provided detailed records of atmospheric trace gas concentrations (CO_2, CH_4), temperature (O_{18}, δD), storminess (dust), and volcanic eruptions (SO_x) extending back over hundreds of thousands of years. The European Project for Ice Coring in Antarctica (EPICA) recently completed an ice-drilling project at Dome C, Antarctica that provided a climate record spanning the last 740,000 years. The data from Dome C suggests that a tight coupling between trace greenhouse gases and Antarctic temperature variations has existed for the last four glacial cycles (420,000 years).

Paleoclimate research is increasingly utilizing global and regional climate models to generate simulations of past climates and evaluate the role feedbacks play in the different climate subsystems (atmosphere, ocean, land surface, sea ice, and land ice) at various spatial and temporal scales. A recently completed study, the Paleoclimate Modeling Intercomparison Project (PMIP), systematically assessed the ability of the current generation of general circulation models (GCMs) to simulate past climates that differed significantly from present climate conditions. The output from these models was directly compared to biophysical and geochemical proxy records to evaluate how well models can simulate past conditions. Studies such as PMIP demonstrate that the current generation of general circulation models (GCMs) can simulate known past climatic conditions and events with skill, strengthening their ability to predict future climate change.

With respect to temporal scales, the paleoclimate record reveals that earth's climate varies on a number of different timescales: long-term (106 years), medium-term (104–105 years) and short-term (101–102 years). Long-term changes are generally associated with changes in the distribution of landmasses on the earth's surface, often referred to as continental drift, but more aptly described as plate tectonics. For example, the movement of landmasses from the equatorial region approximately 300 million years ago (Gondwana) to the poles facilitated the development of high latitude ice sheets and led to the last Great Ice Age. Changes in ocean circulation and orogenesis also operate on a similar timescale and impact climate globally. For example, the uplift of the Himalayan and Tibetan Plateau resulted in the development of the Asian monsoon, which affects global atmospheric circulation patterns.

Medium-term changes are associated with the periodic global expansion and contraction of glaciers during the last 2.8 million years (Pleistocene). The cyclical expansion and contraction of alpine glaciers and large continental ice sheets, with an overall periodicity of approximately 100,000 years, has been linked to astronomical forcing. The CLIMAP (Climate: Long-range Investigation, Mapping, and Prediction) Project and SPECMAP (Spectral Mapping Project) helped identify that variations in the earth's orbital parameters (orbital eccentricity, precession of the equinoxes and obliquity) were responsible for the dramatic glacial-interglacial cycles evidenced globally in marine and ice core records. Short-term alterations in climate are associated with changes in the concentration of atmospheric trace-gases, such as CO_2 and CH_4, changes in solar output, and variations in volcanic and anthropogenic aerosol forcing. It appears that slight changes in solar output may explain much of the variability evidenced in the climate system during the past 1,000 years, but the rate and magnitude of warming experienced during the 20th century strongly suggests that this variation has been amplified by human activity.

With nine of the warmest years on record (global land temperatures) having occurred since 1995, global climate change has become part of the lexicon. Changes are occurring in many of the climate subsystems, and many of these changes can be attributed, in part, to anthropogenic forcing. From variations in storm frequency and intensity, to the future of coastal communities and settlements, to changes in local and regional ecosystems, paleoclimatic records provide context and evidence regarding the potentially deleterious effects of climate change.

Questions still remain, however, regarding the degree to which human activity can be implicated as a forcing factor responsible for the modification of the behavior of the climate system. The value of the paleoclimate record lies in its ability to provide a broader context, that is, sufficiently long records to circumscribe baseline conditions and facilitate separating human-induced climate change from natural cycles. It is only with this longer-term perspective that the full range of variability that exists within the climate system can be captured; this will improve the understanding of the dynamic forces controlling the operation of the climate system.

SEE ALSO: Climate Modeling; Climatology; Global Environmental Change; Global Warming; Ice Core; Paleoecology.

BIBLIOGRAPHY. Raymond S. Bradley, *Paleoclimatology: Reconstructing Climates of the Quaternary* (Harcourt Academic Press, 1999); CLIMAP Project Members, "The Surface of the Ice-Age Earth," *Science* (v.191, 1976); EPICA Community Members, "Eight Glacial Cycles from an Antarctic Ice Core," *Nature* (v.429, 2004); John Imbrie et al., "On the Structure and Origin of Major Glaciation Cycles: The 100,000 Year Cycle," *Paleoceanography* (v.8, 1993); M.E. Mann, R.S. Bradley, and M.K. Hughes, "Northern Hemisphere Temperatures during the Past Millennium: Inferences, Uncertainties, and Limitations," *Geophysical Research Letters* (v.26, 1999); Jonathan T. Overpeck, "Paleoclimatology and Climate System Dynamics: U.S. National Report to International Union of Geodesy and Geophysics 1991–1994," *Reviews of Geophysics* (v.33/Supplement, 1995).

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Paleoecology

PALEOECOLOGY IS THE study of extinct organisms or groups of organisms in relation to their environments by means of their fossil records. Through these records we can discover how ancient plants and animals lived, fed, bred, and died. By studying them, we can relate their environments to ours, and try to understand how the world changes with time. Modern paleoecology is a branch of paleontology, the study of fossils. The study of fossils begins with asking four basic questions about fossils: What are fossils? In what time frame did this fossil live? From what organisms did this fossil descend from, and what organisms did it give rise to? Who originally discovered this fossil? Paleoecology begins by asking all of the above questions plus two more: How did the animal originate, and where did it originate? Paleoecology seeks answers to these two most important questions. Thus, paleoecology is the study of the habits and habitats of living organisms from the time they first appeared on earth.

Uniformitarianism is one of the main methods and basis of geological reasoning used by paleoecology. The basis of uniformitarianism is a simple one: study the present environment and its organisms, establish a relationship between them, and then deduce the environment of the past by studying organisms living at that time. We can make educated guesses about ancient environments by studying environments of similar present-day organisms. For example, we know that modern day tropical waters support reef corals within a very restricted range of tolerances, so we can safely assume that ancient reef corals lived under similar conditions in the past, also taking into account the change in lifestyle of reef corals with the passage of time. We can also apply uniformitarianism to the fossil's organic associates. Organic associates can provide a great deal of information about an organism like its eating habits and the type of weather it thrived in.

While uniformitarianism is a powerful tool in paleoecology, it does not apply when no comparisons are available between ancient organisms and modern-day life forms. This is when we make deductions based upon morphology (shape) of the fossil. In other words, when we come across fossils of extinct organisms like trilobites, we have to examine their shapes to make deductions of their lifestyles and their environments.

Another simple but useful tool to study ancient environments is to observe the orientation of fossils as they are found in rock or soil. We are immediately faced with three questions: Is this the natural position of the organism as it walked in life? Is this the natural position of the organism as it lay on the ground or sea floor upon dying? Is it the position in which the dead body of the organism fell? By studying such orientations, we can find out whether the animal lived under water or on land.

SEE ALSO: Ecology; History, Environmental; Research Methods.

BIBLIOGRAPHY. D.V. Ager, *Principles of Paleoecology: An Introduction to the Study of How and Where Animals and Plants Lived in the Past* (McGraw-Hill, 1963).

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Palestine

ORIGINALLY, PALESTINE WAS a geographical term describing an ever-shifting area between the Mediterranean Sea and Jordan River Valley. First controlled by the Romans, it was then ruled by successive empires. By the time of Ottoman control, Palestine was no longer a distinct territory. Palestine reemerged during World War I, denoting an area similar to historic Palestine that was seized from the Ottoman Empire and occupied by Britain in 1917. In 1920, Britain was given the Mandate for Palestine, which incorporated the Balfour Declaration promising the area to both the Jewish people and Palestinians. In the void left by the 1948 British withdrawal, the state of Israel was declared, and subsequent political and military events effectively ended Palestine's existence as a geographically defined entity. Although various wars and partition plans failed to establish a Palestinian state, some still use the term to refer to the Gaza Strip and West Bank, which are administered by Palestinians.

Palestine has many diverse climates: semiarid, temperate, subtropical, and mountainous. Gaza and northward, the Jordan Valley, and the Negev highlands each have their own distinct crops, creating year-round growing seasons and high biodiversity. However, a natural lack of nutrients and high salinity has limited marine life on the shores. Historically, Palestine was among the more prosperous and fertile areas. Crops, such as cotton, cereals, olives, and grapes, were produced in mass quantity and shipped to other areas. With the creation of the British Mandate, population increases put new strains on local resources causing escalated violence. Needing to feed and settle immigrants, Jewish groups primarily created agricultural settlements. The influx brought northern European flora and fauna to Palestine. Some survived, others died, and the rest became hybrid species. New residents also led to the displacement of Palestinian peasants from the land, often causing violent outbursts against the British, Jewish settlers, and Arab nobility.

Political problems and social conflicts influence access to resources and the quality of the environment. The Gaza Strip, only four to five miles wide, is among the most densely populated areas of the world, causing rapid urbanization and placing great strain on the environment. Further, there are few natural resources, most of the agricultural land has been confiscated, and other countries sometimes limit access to resources. For example, international treaties, such as the Camp David Accord, reduced Palestinian fishing rights. The Israeli army has uprooted thousands of olive and orange trees because they obstruct visibility, although the Israeli government spent millions to plant trees. Nonpolitical problems have also caused environmental damage. Overhunting and climate change have led to extinctions and a reduction in biodiversity. Attempts have been made by some Israeli and Palestinian conservation and aid groups to improve environmental conditions. Despite these efforts, with the construction of a security wall and the political unrest in the area, the future for Palestine is uncertain.

SEE ALSO: Israel; Jordan; Mediterranean Sea.

BIBLIOGRAPHY. William Cleveland, *A History of the Modern Middle East* (Westview Press, 2000); Samih Farsoun, *Palestine and the Palestinians* (Westview Press, 1997); Mariam Shahin, *Palestine: A Guide* (Interlink Books, 2006)

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Panama

THE REPUBLIC OF Panama is an irregular 30,193-square-mile (78,200-square-kilometer) strip of land connecting Costa Rica and Columbia. Early in the 20th century, the United States backed Panama in seceding from Colombia, paving the way for the construction of the Panama Canal, which provides a gateway between the Atlantic and Pacific Oceans by way of the Caribbean Sea. By the end of the century, the United States had relinquished the canal area to the Panamanians in compliance with the original treaty.

Panama's natural resources include copper, mahogany forests, shrimp, and hydropower. With a per capita income of $7,300, Panama is ranked 109th in world incomes. Some 37 percent of the 3,039,150 people live in poverty. Even though the unemployment rate is 8.7 percent, Panama has a serious shortage of skilled labor. Approximately 21 percent of the workforce are involved in agriculture. Nine percent of the population lack access to safe drinking water, and 28 percent have no access to improved sanitation. The United Nations Development Programme Human Development Reports rank Panama 56th on general quality-of-life issues.

Bordering on the North Pacific Ocean and the Caribbean Sea, Panama has 2,490 square miles (6,449 square kilometers) of coast. The tropical maritime climate is hot, humid, and cloudy. The rainy season lasts from May to January and is followed by a five-month dry season. The interior terrain of Panama is made up of steep mountains interspersed with upland plains. Land along the coast varies from plains to rolling hills. Panama occasionally experiences severe storms, and forests fires are a constant threat in the Darien area in the dry season.

Panama suffers from water pollution caused by agricultural runoff that is also threatening fishing. The depletion of the tropical rain forest is of major environmental concern, as are land degradation and soil erosion. Some 57.2 percent of the population live in urban areas where air pollution is a serious issue. Mining industries have proved to be the biggest polluters in the country. Currently, 38.6 percent of the land area of Panama is forested, and the government has protected 21.7 percent of the land. Panama's forests contain more species of wildlife than any other country in the Americas. Of 218 endemic mammal species, 20 are endangered, and 16 of 301 endemic bird species are threatened. In 2006, scientists at Yale University ranked Panama

37th out of 132 countries on environmental performance, placing the country above both relevant income and geographic groups.

The Institute for Renewable Natural Resources, the Ministry of Agricultural Development, and the Ministry of Health share responsibility for regulating and protecting the environment. The autonomous National Environmental Authority assists in developing strategies that promote sustainable development. Under the General Environment Law, these agencies work with the National Council of the Environment to implement and monitor all environmental laws. These laws are based on the principle that prevention should be the goal in protecting the environment. Consequently, environmental audits of all companies are made every three years. Through the National Environmental Council, relevant government ministries develop environmental polices according to the Constitutional Ecological Regime based on the constitution of 1972. Panama participates in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling. The agreement on Marine Life Conservation has been signed but not ratified.

SEE ALSO: Deforestation; Mining; Panama Canal; Pollution, Water; Rain Forests; Runoff.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apffel-Marglin, eds., *Rethinking Freire: Globalization and the Environmental Crisis* (Lawrence Erlbaum, 2005); Central Intelligence Agency, "Panama," *The World Factbook,* www.cia.gov (cited April 2006); Virviescas Hernandez and Marco Tulio, *The General Environment Law of the Republic of Panama* (Republic of Panama, 1998); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental Issues* (ABC-CLIO, 2004); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); Pavol Peter, *Canal and River Levees* (Elsevier Scientific, 1982); United Nations Development Programme, "Human Development Reports: Panama," hdr.undp.org (cited April 2006); World Bank, "Panama," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Panama Canal

IN 1534 THE King of Spain first studied feasibility for a canal in what would eventually become the center of Panama. While the Spanish never constructed this canal, they paved a road with stones to transport gold and other riches on mules. A New York–based company completed a Panamanian rail line in 1855. It carried tens of thousands of gold seekers until a U.S. transcontinental railroad was completed in 1869. In 1880, French companies began construction of a Panamanian canal, but the project was halted in 1887 due to hardship and disease.

In 1903 the province of Panama declared independence from Colombia. An agreement was quickly signed with the United States to begin construction of a trans-isthmus canal. This shipping canal opened in 1914 to connect the Atlantic and Pacific Oceans. An advanced engineering accomplishment, the United States spent $352 million on construction. Fifty thousand unskilled workers, from as many as 50 different countries, and 6,000 engineers and skilled workers, largely from the United States, were employed during construction. Workers routinely worked 10-hour workdays, six days a week. There were dual tiers of pay for gold workers (skilled) and silver workers (unskilled). Although medical records are incomplete, it is believed that 20,000 workers died during the U.S. and French canal-building initiatives combined. In addition to mosquito-borne illness, injuries from dynamite blasts, railroad accidents, and drowning claimed lives.

The canal required significant ecological change, including flooding to form reservoirs that store water for operation during the dry season. An average ship takes between eight and 10 hours to cross the canal, which is approximately 50 miles (81 kilometers) in length. The canal's complex geography includes two artificial lakes. Lake Gatún is one of the largest artificial lakes in the world. Most of the 52 million gallons (197 million liters) of freshwater needed in the canal's three locks originates from Lake Gatún, which is located at 85 feet (26 meters) above sea level. The water moves by gravity, but electricity is needed to open the gates of each lock.

The Canal Zone is 10 miles (16 kilometers) wide. It slices Panama in the middle, separating the east of the country from the west. The Panama Canal, and the entire Canal Zone, was under U.S. administration until December 1999. In 1977 President Jimmy Carter signed a treaty with President Omar Torrijos that began a highly structured and regulated governance transfer process. Although troop numbers have been reduced, the United States maintains a military presence in the Canal Zone, although now in coordination with other countries of the Americas.

Under Panamanian administration there have been technological improvements to the canal and the introduction of a new fee system based on the size and weight of vessels. It is likely that Panama will expand the waterway before it reaches its maximum capacity in upcoming years. Since 1999 more than 100 different studies have been undertaken to improve canal administration, as Panamanian officials restructure operations. It is possible that a third shipping canal will be added next to the two already existing. There have been other upgrades to canal equipment and investment in complementary transportation infrastructure to better link Panama with rest of Central America, such as the recent Centennial Bridge passing over the canal.

Other shipping locations have been considered for "post-Panamax" vessels, modern ships that surpass the size limits of the Panama Canal locks. Each lock chamber is about 110 feet (34 meters) wide and can accommodate boats less than 1,000 feet (305 meters) long. Other Central American locations have been evaluated for either dry or wet canals, including Mexico and Nicaragua, but construction plans have not been solidified. The Suez Canal, connecting the Mediterranean and Red Seas, is considered to be Panama's major competitor. Although it can accommodate larger boats, the Suez Canal does not serve as many routes. With increases in global trade, many smaller world ports are overburdened. Transportation routes utilizing railroads or roads are not as viable as the Suez and Panama Canals, at least in the short term, due to bottlenecks.

Conservation is important in the Panama Canal watershed to maintain water levels needed to transport ships. A central aspect of assuring the necessary water is forest protection in the Chagres National Park, which has received significant funding from international aid agencies. Deforestation in this area would lead to the quick flow of water down slopes and into the ocean. Forests serve to absorb the heavy rains and release water more slowly throughout the year. Deforestation also in-

George Goethals

George Goethals was the U.S. engineer who oversaw the construction and the opening of the Panama Canal. George Washington Goethals was born in 1858 in Brooklyn, New York, and graduated from West Point in 1880. He then joined the U.S. Army Corps of Engineers, teaching civil and military engineering at West Point until 1888. He served in the Spanish-American War as lieutenant-colonel and chief of engineers of the U.S. volunteers.

In 1907 President Theodore Roosevelt appointed Goethals chief engineer of the Panama Canal. A previous attempt by Ferdinand de Lesseps, backed by French funds, had failed, and Roosevelt believed that Goethals had the determination to see the project through. After changing the original plan several times, Goethals used vast quantities of dynamite to blast his way through mountains and finish the canal.

The Panama Canal opened in 1914, a year ahead of June 1, 1915, the scheduled completion date. For his efforts in the project Congress gave him thanks for "distinguished services in constructing Panama Canal." In recognition of his work he was appointed first civil governor of the Canal Zone from 1914–16. Goethals died in 1928; the Goethals Bridge, linking New York City to Elizabeth, New Jersey, is named for him.

creases siltation, which could lead to build up in Lake Gatún, reducing its water storage capacity.

SEE ALSO: Deforestation; Malaria; Panama; Suez Canal; Watershed Maintenance.

BIBLIOGRAPHY. Stanley Heckadon-Moreno, *Naturalists on the Isthmus of Panama: A Hundred Years of Natural History on the Biological Bridge of the Americas* (Smithsonian Tropical Research Institute, 2004); David Howarth, *Panama: 400 Years of Dreams and Cruelty* (McGraw-Hill, 1966); David McCullough, *The Path between the Seas: The Creation of the Panama Canal, 1870–1914* (Simon and Schuster, 1978); Panama Canal Authority, www.pancanal.com (cited July 2006).

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Papua New Guinea

THE INDEPENDENT STATE of Papua New Guinea is located on the eastern half of the island of New Guinea, with Indonesia comprising the western half of the island. The British took responsibility for Papua New Guinea in 1885 but transferred administration to Australia in 1902. Independence was granted in 1975. In 1990, the island of Bougainville revolted, leading to a nine-year conflict and the loss of 20,000 lives. Bordering on the South Pacific Ocean and the Coral Sea, Papua New Guinea has a 5,152-mile (8,295-kilometer) coastline. The climate is tropical with only slight seasonal variation. The staggered monsoon season lasts much of the year, occurring from December to March in the northwest and from May to October in the southeast. The terrain is generally mountainous interspersed with coastal lowlands and rolling foothills. One of the largest swamps in the world is located along the southwestern coast.

The rich store of natural resources includes gold, copper, silver, natural gas, timber, oil, and fisheries. Two-thirds of all export earnings come from mineral deposits, but the cost of developing these resources has prevented serious exploitation. Crime and government corruption also hamper development. Only a small portion (0.46 percent) of the land is arable. Some 85 percent of the workforce are engaged in the agricultural sector, but agriculture generates only 35.2 percent of the Gross Domestic Product (GDP). Only 13 percent of the 5,545,268 people live in urban areas. With a per capita income of $2,400, Papua New Guinea is ranked 171th out of 232 countries in world incomes. Around 37 percent of the population live in poverty even though Australia contributes to the nation's budget. The United Nations Development Programme Human Development Reports rank Papua New Guinea 137th of 232 on overall quality-of-life issues.

As New Guinea and much of Melanesia sits adjacent to the tectonically active Pacific "Ring of Fire," earthquakes are common and often severe. Droughts, mudslides, and tsunamis pose additional threats to the environment and to human lives and property. Due to the high commercial demand for tropical timber, the forests that cover 75 percent of the land area have been depleted, threatening 60 percent of the rain forest.

Heavy pollution is present wherever mining projects occurred because of open cast mining operations and the practice of directly discharging mining waste into water sources. Corals and sea coasts have proved to be especially vulnerable to this deterioration. Other contaminants, such as Polychlorinated Biphenyls (PCBs), pollute water and soil. DDT, used to control mosquitoes, shows up in samples of mother's milk and marine food.

Environmental threats to human health are very high in Papua New Guinea. Food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, and typhoid fever are common. In some locations, vectorborne diseases such as dengue fever and malaria pose additional risks. HIV/AIDS has also become a problem (0.6 percent). Over 60 percent of the population lack access to safe drinking water, and 55 percent have no access to improved sanitation. Infant and childhood mortality are both unacceptably high, contributing to the 4.1 children per woman fertility rate. Because literacy rate are low (71.1 percent), particularly among females (57.7 percent), the dissemination of environmental and health information is made more difficult. A 2006 study by Yale University ranked Papua New Guinea 96th out of 132 countries on environmental performance,

The Ok Tedi Mine

The Ok Tedi mine is located near a river of the same name in the central part of Papua New Guinea. It was built on a site believed to have the largest copper deposit in the world when it was opened in 1984. The result was a massive economic benefit to the local economy with the town of Tabubil being established—it now has a population of 10,000. Ok Tedi Mining Ltd. was majority owned by BHP Billiton, the world's largest mining company formed from a merger between BHP (formerly Broken Hill Proprietary Company of Australia) and Billiton, a South African mining giant. Since 2002, Ok Tedi Mining Ltd has been majority owned by PNG Sustainable Development Program Limited.

The economic benefits of the mine to both the highlands of Papua New Guinea and the country in general are obvious. However, there has been much criticism over the environmental damage it has wrought. The approximately 2,000 people on whose land the mine was built were well-rewarded for their support with jobs, money, and major infrastructure development, but others nearby who were badly affected were not compensated.

Some 90 million tons of contaminated mine tailings and mine-induced soil erosion pour into the Ok Tedi River each year. With 50,000 people living in about 120 villages downstream of the mine, there have been many complaints over chemicals from the mine killing or contaminating fish and harming all the wildlife associated with the river. Severe flooding has raised the level of the river bed and contaminated plantations of bananas, sago palm, and taro. Copper concentrations in the Ok Tedi River are 30 times the level before the mine was built.

slightly below the relevant income group and considerably below the relevant income group average. Scores were particularly low in the categories of environmental health and biodiversity and habitat. Clan ownership of lands has made it difficult to protect land, and there is no national park system in Papua New Guinea. The country is rich in animal and plant life, including more than 6,000 species of butterflies. Of 214 endemic mammal species endemic to Papua New Guinea, 58 species are threatened with extinction. Likewise, 32 of 414 endemic bird species are endangered.

In 1976, the National Parliament created the Office of Environment and Conservation (OEC) under the Department of Lands, Surveys, and Environment. In 1985, OEC became the Department of Environment and Conservation, charged with promoting sustainable development while advancing environmental responsibility and educating the public. The focus of environmental policy is based on the notion that polluters pay for the damage they do. Local, regional, and international groups are also heavily involved in environmental protection in the country, and projects such as the World Bank's Forestry and Conservation Project offer both funding and expert advice.

Papua New Guinea's commitment to the global environment is demonstrated through participation in the following international agreements: Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: DDT; Deforestation; Earthquakes; Endangered Species; Infant Mortality Rate; Malaria; Polluter Pays Concept; Pollution, Water; Polychlorinated Biphenyls (PCBs); Poverty; Rain Forests; Tsunamis; Typhus.

BIBLIOGRAPHY. Central Intelligence Agency, "Papua New Guinea," *The World Factbook*, www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Australia, Oceania, and Antarctica: A Continental Overview* (ABC-CLIO, 2003); Michael C. Howard, *Asia's Environmental Crisis* (Westview, 1993); K.R. Howe, *Nature, Culture, and History: The "Knowing" of Oceania* (University of Hawai'i Press, 2000); United Nations Development Programme, "Human Development Reports: Papua New Guinea," hdr.undp.org (cited April 2006); UNEP, *Pacific Island Regional Report:*

Chemicals (Global Environment Facility, 2002); World Bank, "Papua New Guinea Country Profile," devdata .worldbank.org (cited April 2006); World Bank, "Papua New Guinea," *Little Green Data Book,* lnweb18.world-bank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi/ (cited April 2006).

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Paraguay

THE REPUBLIC OF Paraguay has a long history of political strife. From 1865 to 1870, the country fought in the War of the Triple Alliance, which resulted in the loss of two-thirds of the male population. After decades of economic stagnation, the Chaco War of 1932–35 stripped Paraguay of important land areas previously acquired from Bolivia. At the end of the 20th century, Paraguay threw off 35 years of military dictatorship and held free elections.

With a per capita income of $4,900, Paraguay is ranked 137th in world incomes. Some 32 percent of the 6,347,884 population live below the poverty line. Unemployment is currently 16 percent, and there is a large informal sector that is engaged in the re-export business and various microenterprises such as street vending. Approximately 45 percent of the workforce are involved in the agricultural sector. The United Nations Development Programme Human Development Reports rank Paraguay 88th among 232 nations in overall quality-of-life issues.

The landlocked country has 3,649 square miles (9,450 square kilometers) of inland water resources. Roughly the size of California, Paraguay's climate varies from subtropical to temperate. The eastern section of the country experiences substantial rainfall, but the western section is semiarid. The terrain is also varied, with grassy plains and wooded hills to the east and low marshy plains to the west of the Paraguay River. Elsewhere, the land is dry forest and thorny scrub. From September to June, the southeast is subject to flooding. Because they are poorly drained, the plains are likely to become boggy between October and June. Paraguay's natural resources include hydropower, timber, iron ore, manganese, and limestone.

Environmental problems include massive deforestation, loss of wetlands, and water pollution. Around 17 percent of the population have no sustained access to safe drinking water. Over one-fifth of the people lack access to improved sanitation, and the lack of adequate waste disposal is creating

Migrants to Paraguay

Following the War of the Triple Alliance (1864–70), in which Paraguay fought Argentina, Brazil, and Uruguay, the country was briefly occupied by Brazil. The population and economy had been devastated. The newly discovered 1870 Paraguayan census revealed that as many as two-thirds of the country's population perished in the war. Some books claim that there were only 29,000 men out of a population of 221,000.

To try to rebuild the country, the Paraguayan government encouraged migrants to settle in the country. Francisco Solano Lopez had managed to get some French migrants to come in the late 1850s, but that had been a dismal failure. The new government was keen to attract farmers, and in 1872 a contingent of 888 "Lincolnshire farmers" came out from England. Unfortunately, few of them were actually farmers, and their settlement was a disaster.

In 1887 Bernhard Forster and his wife, Elisabeth (sister of Friedrich Nietzsche, the famous philosopher), organized a more successful German settlement. They established Nueva Germania (new Germany), which continued for a number of years—indeed, some descendants still live on the original farms. Over many years large numbers of other migrants have established "colonies" in Paraguay. These include Australians, Japanese in the 1930s, Russian Mennonites from 1930–32 at "Colonia Fernheim," Poles, Czechs, and many others. Many have prospered and moved to Asunción, Paraguay's capital, or to other countries.

health problems in population-dense urban areas of the south. Around 58.8 percent of land in Paraguay is forested, but the government has protected only 3.5 percent of land area.

The most ecologically significant areas in the country are the Pantanal wetlands, the interior Atlantic rain forest, and the Chaco dry forest. These areas are rich in biological diversity, but the destruction of forests and wetlands has taken a toll. Since the mid-1980s, 19.8 million acres (8 million hectares) of forest have been lost. Ten of 305 endemic mammal species are threatened with extinction, and six of 233 endemic bird species are endangered. In 2006, a study by Yale University ranked Paraguay 62nd of 132 countries on environmental performance, in line with the relevant income group but below the relevant geographic group. The lowest scores were received in the categories of air quality and biodiversity and habit.

The Ministry of the Environment, the Ministry of Agriculture and Livestock, and the National Forestry Service share responsibility for implementing environmental laws and monitoring compliance. Based on an environmental mandate in the National Constitution, Paraguay has a large body of laws designed to protect wetlands and wild areas, implement environmental assessments, and punish those who destroy the environment. However, such laws are not uniformly enforced. In 1999, for instance, the Comptroller General reported that 26,333 hectares of the reserve of the Rio Negro National Park had been illegally allotted to private individuals. Illegal logging continues in defiance of specific guidelines, often with the assistance of government officials.

The United States works with the Foundation for the Sustainable Development of the Chaco Region to provide Paraguay with funding and technical assistance for several areas, including the Biosphere Reserve of the Chaco, the Upper Parana Atlantic Forest (UPAF), and the Northern Block sub-ecoregion of the UPAF. Panama has signed the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Biodiversity; Deforestation; Endangered Species; Pollution, Water; Poverty; Wetlands.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apffel-Marglin, eds., *Rethinking Freire: Globalization and the Environmental Crisis* (Lawrence Erlbaum, 2005); Juan Maria Carron, "The Pantanal of Brazil, Bolivia, and Paraguay," www.pantanal.org (cited April 2006); Central Intelligence Agency, "Paraguay," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental* (ABC-CLIO, 2004); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); United Nations Development Programme, "Human Development Reports: Paraguay," hdr.undp.org (cited April 2006); World Bank, "Paraguay" *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Parasites

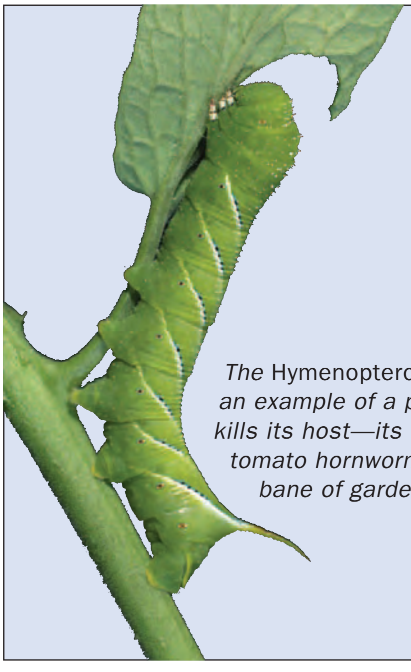
PARASITES OCCUR AMONG virtually all life forms on earth. Almost every plant or animal is subject to parasitism by one or more parasites. Parasitism occurs when the parasite plant or animal lives on or inside of the host plant or animal in order to feed on it. Heterotrophic nutrition is one form of parasitic nutrition. Autotrophic (self-nourishing) organisms synthesize their food either through photosynthesis, or in the case of some bacteria, by chemosynthesis. All animals and fungi and most bacteria feed themselves by some means of nutritional heterotrophy. In the case of animals, they are holozoic heterotrophs, that is, they eat solid particles. In the case of yeasts, molds, or most bacteria, the nutritional form is the saprophytic "eating" of decaying plant or animal matter. Parasites are beneficiaries of the parasitical relationship, usually at the expense of the host upon which it lives or feeds. Some parasites cause little or no harm to their hosts. However, most parasites damage their host. In some cases the parasite may also kill the host. If death occurs from the parasite, the parasitic relationship is called parasitoidism. Parasitoids that kill their hosts include some species of ants, wasps, bees, flies, butterflies, and moths.

Parasites cause a great deal of morbidity among plants and animals. Among humans, parasites cause enormous losses in productive energy. There are millions of human beings, especially in the tropics, who are infected with parasites that prevent them from working at their full capacity. Some parasites such as the *Trypanosoma brucei* cause sleeping sickness in humans. *Trypanosoma brucei* is a parasite of cattle, mostly found in Africa, which is passed to humans by the tsetse fly (*Glossina palpalis*).

There are several other forms of parasitism. Social parasitism is practiced by ants, which herd aphids and exploit them for a secretion that is a food for the ants. Cowbirds and cuckoos practice brood parasitism. They lay their eggs in the nests of other birds that then raise the parasite chick. The chick of the cowbird or cuckoo will usually kill the hatchling(s) of the host bird parents by pushing them from the nest. If a parasite is itself parasitized, the relationship is called hyperparasitism. For example, a hyperparasitic virus may be living on bacteria that are living on a protozoan, which is living in the digestive track of a flea, which is living on a cat.

Parasites can be directly harmful to humans. The parasites that infect human beings begin with the tiniest of viruses. Other parasites in humans include bacteria, single-celled parasites, and multicelled parasites. Common human parasites include pin worms, hook worms, round worms, lice, fleas, ticks, chiggers, yeast infections, and the fungus that causes “athlete’s foot.” In addition, parasites such as fleas may spread diseases like the Black Death (bubonic, pneumonic, and septicemic). Many parasites are spread by fouled water or by animal wastes. Millions of people in the world drink and bathe in streams, rivers, and wells that are sources of parasitic infection. Moreover, many animal and plant foods carry parasites. Usually these can be killed with proper cooking. The U.S. government’s Center for Disease Control estimates that 80 percent of the pathogenic outbreaks in the United States are due to improper food preparation.

An example is trichinosis (or trichinellosis), a painful condition caused by eating meat from animals infected with larvae of the trichina worm (*Trichinella spiralis*). The infection occurs among certain carnivorous and omnivorous animals such as pigs and bears. When the flesh of the infected host is eaten, it infects the new hosts. The larvae mature into males and females in the life cycle of the worm after they are eaten. The adults then breed in the new host and infect its muscles. The larvae cause soreness in the muscles and in humans can be very



The Hymenopterous *wasp is an example of a parasitoid that kills its host—its larvae will eat tomato hornworms, a common bane of gardeners.*

Garden Parasites

While parasites cause misery to millions of people around the world, some forms of parasitism are actually beneficial to humans. For example, the tomato hornworm is a common garden pest that eats the leaves of the tomato plant; however, if a small parasitoid *Hymenopterous* wasp of the Braconid family should lay its eggs on the tomato hornworm, its larva will feed on the hornworm, killing it.

Knowledgeable gardeners allow insect forms of parasitism to benefit their gardens. They make use of predator bugs like praying mantises, spiders, lady bug beetles, lacewings, some kinds of stink bugs, brown damsel bugs (nabid bugs), and pirate bugs.

painful. Infection in humans is rarely fatal, but it causes extreme discomfort.

Parasites can cause significant reduction in food supplies by damaging links in the food chain. Recent studies of food chains have extended the concept to the idea of a food web to express the interlinking of parasites with food chains. Until recently, parasites have not been rigorously included in food chain studies. These new studies have found many more links between parasites and hosts than between predators and prey.

SEE ALSO: Black Death; Disease; Mold; Symbiosis; Viruses.

BIBLIOGRAPHY. William J. Foreyt, *Veterinary Parasitology Reference Manual* (Blackwell Publishing Professional, 2001); Larry S. Roberts et al. *Foundations of Parasitology* (McGraw-Hill, 2004); Jennifer Viegas, *Parasites* (Rosen Publishing Group, 2004); Carl Zimmer, *Parasite Rex: Inside the Bizarre World of Nature's Most Dangerous Creatures* (Free Press, 2000).

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Participation

PARTICIPATION IS AN approach to environmental management and problem solving that solicits groups with locally specific knowledge and skills to contribute to sustainable environmental policies and projects. Sometimes called community-based natural resource management, participation seeks to actively include populations at the grassroots level in access, control, and management of natural resources.

Public participation frequently appears as a framework for facilitating sustainability and actor investment among populations that are (to be) affected by environmental policies. By involving indigenous groups in the creation of management institutions and guidelines, participation is expected to lead to empowerment. Cost and time efficiency are additional benefits to be achieved by facilitating local involvement in projects.

Participation as a precept was codified during the 1992 United Nations Conference on the Environment and Development (UNCED) in Rio de Janeiro, Brazil, as Principle 10, which states: Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 10 indicates that participation should be solicited from a variety of actors at many scales (e.g., the state, formal councils, private industry, activists, municipal administrators, consumers, and nongovernmental organizations [NGOs]). It also includes in its definition of participation access to environmental information and citizens' rights to know about potential hazards. Once citizens have this information they are to be included in decision-making processes. The state is also given responsibility for disseminating information to citizens and providing for their access to judicial and administrative processes in relation to environmental issues and citizens' rights.

Compared to "top-down" approaches to environmental planning, participation is expected to increase project success rates and lead to sustainable management practices. Top-down approaches involve allowing powerful groups (e.g., the state or donor institutions) to make decisions without accessing local environmental knowledge or consulting with users' groups. The failure of environmental policies and projects is blamed on lack of community participation and local people's indifference to their success.

Whether participatory approaches are more successful than "top-down" approaches to environmental decision making is debatable, and criticism of participation has grown with its popularity as an approach. Critics argue that participatory approaches are in name only, i.e., there may be much talk about the benefits of participation, but actual public participation is much less widespread. Others suggest that the cost and time efficiencies achieved by participatory approaches are mechanisms that shift state responsibilities onto citizens or lead citizens to self-regulate and monitor.

Another difficulty with participatory approaches is the variety of meanings and practices associated with the term. Participation has been used to validate a range of activities, e.g., justify expenditures, cut operation costs, improve public image, and create new markets. Decision makers and environmental planners may intend stable meanings for *participation*, but these meanings may change throughout planning and implementing phases of environmental management. The opposite problem arises when planners settle on a fixed set of participatory techniques or interventions, which limit flexibility when searching for potential solutions.

TYPES OF PARTICIPATORY APPROACHES

Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA; central to this approach is learning "just enough" from a community to enable decision making and planning), and Participatory Learning and Action (PLA) are names given to participatory approaches in general, and more specifically to techniques and methods of information gathering from local people. Although the term *rural* is in the definition of each approach, its methods are not limited to rural settings.

PRA is founded on the idea that individuals are aware of themselves, their situation, and their problems and, given a chance, they will actively seek appropriate solutions. In contrast to approaches where so-called experts arrive in a community, gather information themselves and then analyze it within their own context, PRA calls for local people to facilitate information gathering and analysis of shared issues among stakeholders. Exercises are often hands-on and action-oriented (e.g., village walks where different types of land use are pointed out and discussed en route). PRA is also intended to facilitate collaborative learning between all stakeholders (not just majority, rich, or powerful groups) and outsiders, who may be state employees, NGO fieldworkers, or development aid donors. PRA uses informal interactions (e.g., brainstorming sessions), mixed group, open meetings, and/or games to draw out community knowledge about resource access and problems from indigenous populations. PRA tools include interviewing, focus groups, preference rankings, mapping, and diagramming. Learning-by-doing, teamwork, and open-ended discussions are central tenets of PRA approaches. Flexibility is key to allowing local knowledge and solutions to surface as part of the process.

PARTICIPATION AS A FORM OF POWER

Flexibility is also necessary if a community participatory approach is intended to address existing power imbalances within and between stakeholder groups. Participatory approaches that accept the status quo in local societies may serve to sustain oppressive power relations existing within communities. Drawing on the work of Michel Foucault, participation has been framed as a discourse and a form of power. In contrast to viewing participation as a set of techniques and then offering advice on better implementation or training, conceiving of participation as a discourse enables participation to be explored for how it is deployed to further or hinder power.

Discourses of participation in different contexts and scales can be interrogated for what they contain and omit, and the ramifications of such inclusions and exclusions for both environments and affected citizens. Within a framework of participation as a form of power, the actions of individuals and institutions, comprising the context in which discourses are created and operationalized, are examined for the ways in which participation might be used in an illegitimate exercise of power. Still further, participation as a form of power interacts with other operations of power. For example, participation combines with patriarchy to reinforce the marginalization of women when participatory approaches address women only in their roles as housewives.

Before participation became popular, approaches to knowledge gathering were criticized for answering the agenda of those who came in from the outside to collect information and for failing to access and question groups on the margins of their communities, e.g., women, the poor. Although participation is now standard as an approach, scholars and practitioners have realized that choices made by local people and participation facilitators are shaped by the relationships and discourses in which they are immersed.

Simply setting a participatory approach in motion may lead to the furthering of a particular environmental agenda held by the facilitators or believed by local communities to be favored by the facilitators. For example, NGO fieldworkers asking questions about forest use may inadvertently steer local people's answers in directions that suit the technical solutions that the NGO can offer. NGO fieldworkers make choices about participatory practices based on constraints and opportunities present within their NGO and the community with whom they are conducting participatory planning. Powerful groups within local communities may try to influence the process. Individuals navigate social pressures within their communities about what to reveal or omit, or whether to speak or stay silent. Strict definitions of participation will not resolve these issues of power. The dynamic social context in which participatory approaches are practiced means that participation will always be influenced by relationships of power.

Participation is also a method of research gathering for scholarly purposes, with many of the same attributes, criticisms, and pitfalls. Ultimately, researchers decide which information is most valuable to report. An analysis of participation becomes further complicated when implementing organizations reflexively begin to take note of their own practices of inclusion and exclusion. Participation may begin as a method imposed from the outside, as part of ensuring long-term resource sustainability. But validating participation as an approach may force organizations to evaluate the treatment of their own employees and examine who has been incorporated and who has been omitted from decision making and planning.

GENDER AND PARTICIPATION

Gendered approaches to participation were also codified at UNCED. Principle 20 states: "Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development." Women's participation is widely recognized as critical to sustainable development and environmental management. Women's participatory approaches will access women's knowledge about sustainable environmental practices and draw on women's abilities to protect the environment. In their roles as housewives, mothers, and resource managers, women's participation in resource-use planning will maximize the benefits of intended improvements. Women can also increase project efficiency by contributing their labor.

As the role of the state in resource provision (e.g., water supply) or management (e.g., of forests) has come to be seen as inefficient and expensive, gendered approaches to participation are intended to increase local women's investment in resource control and management. Women's empowerment-through-participation is also sought through a "bottom-up" approach that incorporates women in decision making and planning at its earliest stages. Women's participatory approaches often pursue an agenda of creating lasting social change, e.g., sustainable resource management and social equality through women's participation and empowerment.

Gendered participatory approaches have similar goals to participation in general; but without specific attention to gender, community participatory approaches to natural resource management may increase women's exploitation, constrain self-determined change, and repress local, gendered meanings of resources. Participation may make a difference for women if approaches challenge assumptions about gender, environment, and relationships between women and nature. But participation has been criticized for taking for granted gendered relationships to natural resources, thereby reproducing inequality. Participatory interventions involving natural resources often base themselves on existing gender-resource relations. Women's work and roles involving environmental resources are accepted as the norm, instead of being interrogated for the ways in which they are exploitative. Without calling these assumptions into question, women's work burdens are increased, or their reasons for their practices are misunderstood. Too often women are targeted as a category, i.e., as a unified group with unchanging, essential characteristics, powerless and without agency. Participatory approaches that do not seek to question existing gender roles, nor view women as individuals (e.g., consider class, race, age, etc.) are likely to reproduce existing social inequalities.

SEE ALSO: Development; Ecofeminism; Environmentality; Feminist Political Ecology; Gender; Nature, Social Constructions of.

BIBLIOGRAPHY. Bina Agarwal, "Participatory Exclusions, Community Forestry, and Gender: An Analysis for South Asia and a Conceptual Framework," *World Development* (v.29, 2001); Robert Chambers, *Whose Reality Counts? Putting the First Last* (Intermediate Technology Publications, 1997); Bill Cooke and Uma Kothari, *Participation: The New Tyranny?* (Zed, 2001); Samuel Hickey and Giles Mohan, *Participation: From Tyranny to Transformation* (Zed, 2004); Ann Long and Norman Long, *Battlefields of Knowledge: The Interlocking of Theory and Practice in Social Research and Development* (Routledge, 1992); Majid Rahnema, "Participation," in W. Sachs, ed., *The Development Dictionary: A Guide to Knowledge as Power* (Orient Longman Limited, 1997).

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Passenger Pigeon

THE PASSENGER PIGEON (*Ectopistes migratorius*) was once probably the most numerous bird on earth but became extinct through an extraordinary case of massive overhunting and habitat loss.

This striking blue-gray pigeon, closely related to the mourning dove, was highly social, living in huge flocks across the great deciduous forests that once covered eastern North America. At the time of the arrival of Europeans, there may have been up to 5 billion passenger pigeons, representing 25 to 40 percent of the entire continent's bird population. Their range stretched from Alberta to Nova Scotia, and south to the Gulf states, covering more than 7.25 million square kilometers. They wintered in the southern states and in the spring made spectacular migratory flights northward to their breeding grounds in the eastern mixed hardwood forests. Migrating flocks over one kilometer wide and 400 kilometers long were commonly observed well into the 19th century. Some great flocks were reported to have darkened the sky as they flew overhead, taking an entire day to pass a single point. Passenger pigeon nesting colonies could contain 100 million birds across 100 square kilometers, with dozens of nests per tree. After breeding season, large flocks of pigeons would move through the northern forests, seeking their preferred food—the mast of beech, oak, and chestnut—but also seeds, berries, worms, and insects.

Passenger pigeons had a significant impact on forest ecology. When hundreds of thousands made a long-term roost in a hardwood forest, they would consume great quantities of acorns and other tree seeds, damage or kill trees with their collective weight, and deposit tons of droppings on the forest floor. It took decades for such areas to recuperate, so the great flocks of pigeons needed vast new areas of hardwood forest each year for food, shelter, and raising their young.

When European settlers cleared the eastern forests for farmland, passenger pigeons began to lose some of the vast woodlands that they needed. It was intense commercial hunting in the 19th century, however, that caused the passenger pigeon to be essentially eaten into extinction.

The birds had long been hunted for food by indigenous peoples. In the 1800s, the demands for cheap food in the growing cities of the east led to large-scale, unregulated hunting for profit. The birds were netted, shot, or gassed with pots of burning sulphur at roost sites. Young squabs were knocked out of nests with long sticks. Tens of thousands of birds were killed daily and shipped in box cars to East Coast markets where they might sell for as little as fifty cents a dozen. Game dealers in New York, for example, took in 100 barrels, or approximately 55,000 pigeons, a day.

Several thousand workers were employed in the pigeon meat industry by 1850. Thousands more were hunters. When observers noted in the 1860s that pigeon numbers appeared to be decreasing, the response was to move further inland to the still game-rich Midwest. Market hunters took advantage of the latest technology, learning the location of flocks through telegraph communications and travelling to nesting sites on the railroad. Season by season, county by county, the "pigeoners" eliminated the birds. One of the notorious last large hunts took place in Petoskey, Michigan, in 1878. Hunters killed over 50,000 birds per day over several months, then tracked and killed the survivors when they attempted a second nesting.

In the 1890s, conservationists pushed for legislation to control pigeon hunting, but it came too late. The gregarious passenger pigeon would only breed well in large colonies. Attempts at breeding the surviving captive birds failed. The last wild passenger pigeon was shot by a 14-year-old boy in Ohio in 1900. The last known bird died at the Cincinnati Zoological Garden in September 1914. The only positive effect of the destruction of the passenger pigeon was heightened public interest in conservation laws. In 1916, for example, the Migratory Bird Treaty was enacted in America and Canada to control the hunting of migratory birds.

SEE ALSO: Dodo Bird; Extinction of Species; Hunting.

BIBLIOGRAPHY. D.E. Blockstein and H.B. Tordoff, "Gone Forever: A Contemporary Look at the Extinction of the Passenger Pigeon," *American Birds* (v.39, 1985); E.H. Bucher, "The Causes of Extinction of the Passenger Pigeon" in D.M. Power, ed., *Current Ornithology 9* (Plenum Press, 1992); Joshua Ellsworth and Brenda Mccomb, "Potential Effects of Passenger Pigeon Flocks on the Structure and Composition of Presettlement Forests of Eastern North America," *Conservation Biology* (v.17/ 6, 2003); A.W. Schorger, *The Passenger Pigeon: Its Natural History and Extinction* (Blackburn Press, 2004 [1955]).

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Pasteur, Louis (1822–95)

LOUIS PASTEUR WAS a polymath French scientist who made many important contributions to modern medicine, including the use of vaccines for anthrax and rabies. He also contributed to the area of stereochemistry, and the term *pasteurization* carries his name. Pasteur was born the son of a once-indentured tanner and showed early promise as a boy, but primarily in art. He took a second degree in science and then a doctorate, with early work involving crystallography. This work resulted in his discoveries concerning asymmetry within biological molecules and the understanding that the structure of the molecules, as well as their composition, help to determine their properties. This was achieved through dividing crystals into their right- and left-handed states, which were mirror images of each other. Pasteur moved from one topic to the next, steadily progressing through careful science and logical deduction in new but related fields of study.

Pasteur continued his work on molecular asymmetry during his early academic career. When he was appointed dean of the faculty of science at the university in Lille, France, he became involved in the study of alcohol fermentation, since that was an important industry in his new home city. Pasteur's work with asymmetrical molecules had persuaded him that such asymmetry was congruent with the presence of life. Systematic examination of yeasts and other biological inputs helped him to identify the microorganisms that were responsible for impurities that had proven harmful to health and industry. He subsequently determined that heating beer and wine would kill those microorganisms and produce a pure flow of the outputs through the process of pasteurization. His methodical approach led to brilliant results and he was also asked to investigate the silk industry in France, which was close to collapse as a result of two diseases suffered by the silk worms. Pasteur investigated with his microscope and was able to identify the agents causing the diseases and suitable methods for combating them. By helping to create industrial guidelines and supervising the training of workers, Pasteur saved the European silk industry.

Pasteur's work with alcohol fermentation helped him definitively solve the so-called self-generation problem, which had perplexed scientists for thousands of years. This concerned the reason why biological matter should seem spontaneously to come into being, as for example the growth of molds or the eruption of maggots from a corpse. Pasteur identified the presence of microorganisms as instrumental in these events and proved this through systematic experimentation. Using a similar concept as other scientists in the field, he came to the understanding that such microorganisms or germs were responsible for the spread of many diseases and infections. From this understanding and the application of empirical science, Pasteur was able to develop vaccines for anthrax and rabies, among other diseases, that have helped save millions of lives.

SEE ALSO: Disease; Microbes; Vaccination.

BIBLIOGRAPHY. Patrice Debré, *Louis Pasteur,* trans. by Elborg Forster (Johns Hopkins University Press, 2000); Gerald L. Geison, *The Private Science of Louis Pasteur* (Princeton University Press, 1995).

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Pastoralism

PASTORALISM IS BROADLY defined as a land use system where communities raise livestock, such as camels, goats, cattle, sheep, llamas, or yaks, to make a living. It involves herding on natural pastures and implies that animal husbandry is the dominant strategy in an economic and cultural sense. In reality, pastoralism is more complex to define due to the diversity of pastoralist systems as adaptations to local conditions. The composition of herds, management strategies, and social organization vary significantly between regions. Pastoral societies include the Maasai in eastern Africa, Bedouin in the Middle East, Navajo in North America, Raika in India, Chukchi in Siberia, and Mongols in north-central Asia. There are an estimated 100 million pastoral people worldwide, while Africa has the largest pastoral population with 20 million.

In general, commonly used factors to distinguish pastoral systems are dietary patterns and herd mobility. Pure pastoral systems are those where livestock constitute at least 50 percent of the economic portfolio of a household. Pastoral systems are distinguished by varying degrees of movement of people and herds, ranging from nomadic, to semi-nomadic, to semi-sedentary systems. Nomadic pastoralism is considered the most mobile system, where herders exclusively rely on animal products for subsistence, exchange, and trade. Livestock are not only a source of livelihood, but constitute cultural significance, providing a wide range of functions such as: milk, meat, traction, manure, blood, skin, and religious and cultural meaning. Generally, meat production is a minor component, as this involves killing the investment.

ORIGINS

It is believed that recognizable pastoralist systems date back several thousand years. While the differentiation between wild and domestic livestock in archeological evidence remains challenging, most studies suggest that the presence of domestic cattle goes back at least 6,000 years (for example, in northeast Africa). One of the most prominent views of the origins of pastoralism in the earlier literature suggests that pastoralism is an evolutionary stage in human history, directly derived from hunting and gathering and followed by farming and sedentarization. However, archaeological evidence and historical documents suggest that the origins are more complex. For instance, evidence suggests that agriculture started earlier than pastoralism.

MANAGEMENT

Pastoralists live mostly in marginal areas. They inhabit regions of the world in which the natural environments provide little potential for cultivation due to their rainfall or temperature regimes, or terrain. These marginal areas include drylands, rangelands, savannas, steppes, tundra, and mountains. The natural resource base in pastoral environments is generally characterized by patchiness of resources across time and space. Temporal variation of biomass is closely tied to climatic conditions that are often highly variable and unpredictable; this is particularly true in drylands. Here, vegetation has adapted to variable rainfall by accumulating seed reserves in the soil that germinate when rainfall conditions allow. In cold environments, the limiting factor is temperature and a short growing season restricts access to fodder and requires its conservation for the winter.

The resource management system of pastoralists is considered one of the most effective strategies for utilizing drylands and a well-adapted strategy to sustain human populations in environments with limited resources. The most important component of pastoralist systems is mobility—an adaptive resource use strategy to manage risk by exploiting highly variable natural resources (water and forage). It is aimed at minimizing the effects of drought. A range of other considerations play a role in determining movement patterns: for example, soil conditions, environmental factors (dew, shade, predators), avoiding pests, disease, and damage to crops, proximity to markets, household labor availability, cultural gatherings, territorial boundaries, political insecurity, and social relations. Mobility is determined by a detailed environmental knowledge, and a complex system of rules and regulations that determine whether communities can negotiate access to resources.

Herd management and diversification is also important. Pastoralists keep diverse herds to provide for their needs and to optimally utilize available resources. Diversification increases the range of products and spreads risk. The main aim is to accumulate large herds to have enough females to supply milk. For instance, east African pastoralists commonly keep cattle to provide milk and as a form of investment, and additionally small stock for its meat supply and to be sold on the market. Pastoralist systems can rapidly respond to changing environmental conditions by switching to different strategies (such as other species, or opportunistic cultivation).

SOCIAL ORGANIZATION

The resource management system is closely intertwined with complex social organization that regulates the use of resources. While decisions about livelihood strategies are made at the household level, the community plays a crucial role. Decisions about access to water and pasture are made by the community and animals are often herded communally. Informal and formal institutions govern access to the common resources of pasture and water and act as checks against overuse. Social control mechanisms are enforced through traditional leadership. The concepts of reciprocity and mutual dependence are particularly important during times of scarcity. Individuals will then call upon relatives and alliances in other regions, distributing parts of their herds among them in anticipation of future losses.

PERCEPTIONS OF PASTORALISM

Scientists and policy makers attempted to describe pastoralist systems in the light of three interrelated paradigms—range equilibrium, backwardness of pastoralists, and tragedy of the commons. These paradigms have influenced interventions in pastoral environments. The range model was based on equilibrium, which assumes that livestock density is limited by forage availability that is constant in space and time. When herds expand to exceed carrying capacity, they cause overgrazing and degradation. While this may be an adequate model for temperate zones, it is flawed in its applicability to drylands. The assumptions include that drylands are potentially stable ecosystems, that they are often destabilized by improper use, and that interventions are needed to return these systems to a productive state.

Colonial and postcolonial governments in Africa interpreted pastoralism as a maladaptive, destructive system. Pastoralists' obsessive concern with livestock was called premodern and accused of obstructing development. Policies showed a strong bias toward agriculture, and consequently, pastoralists were relegated to the periphery of economics and politics. Throughout the 1980s the focus remained on the need to modernize and settle pastoralists and turn them into more efficient land users.

Pastoralism was also perceived within the concept of common property resources, coined by Hardin in 1968 as the Tragedy of the Commons. It engages property rights to explain environmental degradation. The Tragedy of the Commons assumes that individual herders maximize profit by fielding as many cattle as possible on common land; this will ultimately lead to overgrazing and stocking densities exceeding carrying capacity. The concept assumes that individuals maximize herd size for individual gains, while bearing only a fraction of the costs imposed on the common resource. Once the resource is exploited, pastoralists avoid the consequences by moving into another area. This scenario led to the conclusion that with limited grazing areas, demographic growth will eventually exceed the carrying capacity of the land.

These paradigms have long been considered a viable way of explaining pastoralism. However, mainly due to the failure of interventions based on these paradigms, they are increasingly questioned. Little evidence actually supports overstocking claims on a wider scale. A new understanding includes that pastoral environments are characterized by non-equilibrium and heterogeneity, that pastoralist strategies are not aimed at maximizing production, and that pastoralism is a sustainable response to harsh environmental conditions. Alternative approaches to common property resources are emphasizing decentralized systems of self-management. Institutions and behavioral norms that have evolved over time in pastoral communities are considered more appropriate than imposing new institutional frameworks.

CONSTRAINTS TO PASTORALISM

Pastoral communities worldwide share a common difficulty of interacting with the state, neighboring land users, and markets. The relationship between them and the state has often been ambivalent, characterized by hostility and suspicion. Pastoralists have become marginalized within national borders due to remoteness from the capital and the segmentation of pastoral groups during the creation of nation-states after colonialism; this has limited their ability to represent their interests at a national level.

The wider economic, ecological, demographic, and political context in which pastoralists operate has significantly changed in recent decades, creating unprecedented pressures and leaving pastoralists more vulnerable. While climate variability is becoming more severe, pastoralists are exposed to more frequent droughts. Their traditional grazing lands are shrinking due to tighter national borders, political conflict, growing competition over land amongst pastoralists, spreading cultivation and conservation areas, urbanization, mining, and notions of private property. There is growing evidence of increasing land degradation at local scales. At the same time, population growth remains high in pastoral areas, adding more people to a system with scarce resources. Mobility is severely restricted, and increasing numbers of pastoralists diversify by incorporating cultivation or migrating into urban areas. National strategies to reduce poverty do not effectively reach pastoralist areas, and access to education, health care, and infrastructure is only slowly improving.

Pastoralists have a comparative advantage in exploiting marginal environments—supplying animal products to meet global demands may be an economic opportunity. Additional opportunities may arise from the production of niche products (like exotic species), comanagement systems of conservation areas, and ecotourism. Realizing these opportunities, however, will require a concerted effort by national and international governments to provide an enabling environment. As long as pastoralists remain marginalized, without access to markets, and perceived as backward, they may not be able to effectively exploit the advantages they have. Moreover, commercialization and globalization will inevitably transform the system with unknown social and cultural consequences. It will also affect the environment, as growing populations are leaving their trace on the landscape, with increasing evidence of resource degradation and scarcity.

Increasing vulnerability and continuing marginalization indicate that pastoralists are not able to respond to the pressures effectively. Recognizing these challenges, there are voices that call for the abandonment of this way of life altogether. Others argue that pastoralism should be supported into the future on the basis of human rights, the right of communities to preserve their cultures, and environmental concerns that argue for pastoralism as sustainable land use. Current vulnerability should be considered as a policy failure, rather than a failure of pastoralism itself. Major shifts in policy are needed to support pastoralists. Pastoralists need to be recognized as rational decision makers. Within the context of decentralization policies an effort has to be made to integrate pastoral communities into decision-making processes. Ultimately, it is for the pastoralists to decide whether their way of living is viable, or whether it will be more beneficial to give up pastoralism for another way of life.

SEE ALSO: Carrying Capacity; Cattle; Colonialism; Herders; Overgrazing; Postcolonialism; Ranchers.

BIBLIOGRAPHY. J.E. Ellis and D.M. Swift, "Stability of African Pastoral Ecosystems: Alternate Paradigms and Implications for Development," *Journal of Range Management* (v.41/6, 1988); E. Fratkin, "Pastoralism: Governance and Development Issues," *Annual Review of Anthropology* (v.26, 1997); J.G. Galaty and D.L. Johnson, *The World of Pastoralism: Herding Systems in Comparative Perspective* (Guilford Press, 1990); G. Hardin, "The Tragedy of the Commons," *Science* (v.162, 1968); J. Markakis, *Pastoralism on the Margin* (Minority Rights Group International, 2004); *Pastoralism in the New Millennium.* FAO Animal Production and Health Paper (Food and Agriculture Organization, 2001); A.B. Smith, *Pastoralism in Africa: Origins and Development Ecology* (Hurst & Co., 1992); A. Warren, "Changing Understandings of African Pastoralism and the Nature of Environmental Paradigms," *Transactions of the Institute of British Geographers* (v.20/2, 1995).

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Patkar, Medha (1954–)

MEDHA PATKAR IS one of the world's foremost anti-dam activists and a leading Indian environmentalist. She is the founder of Narmada Bachao Andolan (the Save Narmada Movement). The Narmada River flows through central India; millions of people rely on it for nourishment and economic activities. Large dams built on the Narmada threaten their livelihoods. Patkar, together with a number of like-minded people, has led campaigns against the dams and similar projects. These campaigns have drawn upon the tradition of nonviolent protest pioneered by Mahatma Gandhi. Hunger strikes have hurt Patkar's health but have heightened public awareness and sympathy for her causes. Following one hunger strike, the authorities arrested Patkar for attempted suicide, which is considered a crime.

The Indian government treats nongovernmental organizations with suspicion. In June 2006, the Supreme Court of India ruled that Narmada Bachao Andolan had accepted money from overseas sources and was involved, therefore, in unpatriotic acts funded by non-Indian sources. This accusation is a common tactic among governments of the developing world: Nongovernmental organizations (NGOs) are typically characterized as working to undermine the home country and nationals supporting them are treacherous. This enables the government to take action against identified NGOs and their supporters and to demonize them in popular media. Legislation, either from a previous struggle against insurgents, or else resulting from the war on terror, is then used to suppress public dissent.

Nevertheless, large-scale protests by members of the public, when allied with support from influential political interests and international audiences, can force governments to make concessions. This was the case with the Narmada Dam, as state officials accepted the need for a review of its height and construction details. However, obstructionism and opaque decision making might still be deployed to delay final decisions not favored by funding partners. The struggle for Narmada was not over at the end of 2006 as the government began another attempt to bring the dam into service; more protests were anticipated. Medha Patkar is an example of the modern form of popular protest, employing networks, vivid public demonstrations, and innovative public relations. The use of information technology, particularly the internet, has helped local protests become global in scope and support.

SEE ALSO: Dams; India; Narmada Dam.

BIBLIOGRAPHY. Renu Agal, "Dam Protester's Health Gets Worse," *BBC News* (April 4, 2006); "Dam Work Begins in Total Violation of People's Rights," *NBA Press* (October 3, 2006); Friends of the Narmada, www.narmada.org (cited October 2006); Salman Rushdie, "India's Courts Flounder as Dam Pressure Builds," *The Guardian* (August 11, 2001); Vandana Shiva, *Water Wars: Privatization, Pollution, and Profit* (South End Press, 2002).

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Peasants

THE TERM *PEASANT* is imprecise, but it has much historical significance. It could hardly be otherwise when the defining characteristic of the modern economy has been the gradual transformation of a world dominated by peasants and landlords (of various kinds) into a world dominated by waged labor and capitalists (of various kinds).

The contradictions within the modern project—a project predicated on the expansion and control of national territories and resources, on urban industrial development as the hallmark of progress, and on the construction of certain kinds of citizens—have turned peasants into a contradictory group, both theoretically and in practice. Throughout the modern period they have been alternately seen as backward, ignorant throwbacks to a primitive period (even today, the second definition of peasant in most English language dictionaries is buffoon or simpleton) or as independent, communitarian stalwarts of a more socially just and humane period.

In 1776 Adam Smith bemoaned the loss of the small farmer trained in all the various tasks of the farm, but he believed that peasants would not be able to withstand the competitive advantages of scale reaped by a greater division of labor on large farms. This argument would carry important political and policy weight in the post–World War II development period when industrial development was predicated on the incorporation of "underemployed" rural producers.

A hundred years after Smith, an influential Marxist argument suggested that smallholders were inherently allies of the propertied classes but that as differentiation occurred (the transition to wage labor), small farmers would become proletariats on their own land and would align with the urban worker. Another populist argument suggested that small-scale agricultural (and industrial) production was the best way to guard against the evils of large-scale capitalism. A final argument, rhetorically embodied by Thomas Jefferson but captured in many other countries where territorial settlement figured prominently, such as Brazil and Mexico, suggested that national development would be propelled forward by the small farmer, an independent, hard-working class of subsistence providers who would civilize (and in some cases whiten) the land in the interests of national development and control.

The peasantry as a class became the subject of heated academic debate in the 1960s and 70s when they were rediscovered as active political subjects playing major roles in national liberation struggles from Vietnam to China. One problem inherent in the discussion of the peasantry was the conceptual difficulty of defining exactly who or what was a peasant.

Without reaching a definitive conclusion, peasants are usually defined as agricultural producers who are primarily organized as a family unit geared toward subsistence and characterized by partial, subordinate integration into relatively incomplete markets. Although the generalizing term "peasant" has been disputed, it is still used by peasant activists and by academics attempting to lend analytical or representational coherence to the group.

Interest in the peasantry in the 1960s and 70s paved the way for research analyzing their "moral economy," the circumstances under which peasants would rebel, the political affinities of rural producers, the relationship between the peasantry and the modern nation state, and more. Debates continue about the nature of the relationship between peasants and production, between peasants and political systems, between peasants and the household, and between peasants and the greater society.

Today peasants continue to be important political actors (even as their economic influence has lessened). Antidotes to globalization are often "back-to-the-land" calls for a return to sustainable agricultural production and coherent local communities, rooted in the nostalgia that British Marxist historian Raymond Williams once traced back to the beginning of the first millennia. The Zapatista uprising of southern Mexico in January 1994 is often considered the symbolic birth of the contemporary counter-globalization movement. The Zapatistas are joined by other movements in Brazil, India, South Africa, the Philippines, and more in an umbrella organization called Via Campesina. Local groups within Via Campesina work toward alternative modernities based in sustainable development, agro-ecological production methods, food sovereignty, and coherent local communities. These alternatives are explicitly based in a rejection of industrialized agricultural production that emphasizes output over process and export profits over local nourishment.

SEE ALSO: Marx, Karl; Smallholders; Subsistence.

BIBLIOGRAPHY. Robert H. Bates, *Markets and States in Tropical Africa: The Political Basis of Agricultural Policies* (University of California Press, 1981); Carmen Diana Deere and Alain de Janvry, "A Conceptual Framework for the Empirical Analysis of Peasants" *American Journal of Agricultural Economics* (v.61/4, 1979); Karl Kautsky, *The Agrarian Question* (Zwan Press, 1988); Gavin Kitching. *Development and Underdevelopment in Historical Perspective: Populism, Nationalism and Industrialization* (Methuen, 1982); Vladimir Lenin, "Preliminary Draft Theses: On the Agrarian Question (For the Second Congress of the Communist International)," in *Lenin's Collected Works*, 4th English ed., v.31 (Progress Publishers, 1965); Joel Migdal, *Peasants, Politics and Revolution: Pressures Toward Political and Social Change in the Third World* (Princeton University Press, 1974); Barrington Moore, Jr., *The Social Origins of Dictatorship and Democracy* (Beacon, 1966); Walter Nugent, "New World Frontiers," in David J. Weber and Jane M. Rausch, eds., *Where Cultures Meet: Frontiers in Latin American History* (Scholarly Resources, Inc., 1997); Jeffrey Paige, *Agrarian Revolution: Social Movements and Export Agriculture in the Underdeveloped World* (The Free Press, 1975); James Scott, *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia* (Yale University Press, 1977); Adam Smith, *The Wealth of Nations* (Penguin Books, 1997 [1776]); Raymond Williams, *The Country and the City* (Chatto & Windus, 1973).

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Perception, Environmental

LIVING ENTITIES PERCEIVE environments by interacting with them. There is no perception without organism–environmental engagement. Consequently, the basic unit of analysis in the study of perception is always the organism *plus* its surroundings. For many centuries, especially under the influence of Cartesian premises, people in Western societies believed that perception was the result of the brain's processing of raw, concrete, and objective information about the external world that was delivered directly through sensory organs and the nervous system. In the 20th century many studies showed that what reaches the brain is actually information that has already been partly processed by sensory apparatuses and nervous systems. An example of this phenomenon is what happens when the human eye is exposed to images that play with the ambiguity of people's perception. These are images in which, depending on what an eye "chooses" to focus on, a person will either see a young woman or an old lady. Another example are images where the eye can alternate between seeing a vase or the lateral view of two human faces in front of one another.

Whereas in previous centuries philosophers and neurologists believed that the mind was exclusively in the brain, many scholars currently conceptualize the mind as operating within the connections that exist between sensory organs, the things that are being sensed, the nervous system, and the brain. They contend that the mind is immanent in these pathways. Scholars argue that through perception, organisms "bring forth" certain aspects of the world while other aspects are ignored and, therefore, remain unknown. Following this theory one can say for instance, that when interacting with their environments, dogs bring forth a world that is heavily imbued with smells. Humans tend to be more attuned to bringing forth visual aspects of the world and, even then, only in terms of what the human eye is capable of detecting.

BATESON AND SENSORY PERCEPTION

One of the scientists who most contributed to a more complex understanding of perception was Gregory Bateson. Bateson was unsatisfied with the notion that the brain directly receives concrete information about the world, which it subsequently interprets. This would be too simple a process for highly complex organisms. He suggested instead that perception emerges from relations that organisms establish with their world, as well as from relations among sensory organs, nervous systems, and the brain. Bateson was also suspicious of the notion that perception is based on the passive transmission of discrete bits of information from the senses, through the nervous system, and on to the brain. Bateson's point is that perception is not initiated by the arrival of mirror-like images of the world in the brain. Rather, perception is directly associated to the arrival of news of difference and that news of difference is not possible unless the organism interacts with its surrounding environment. These differences are not first detected by the brain, which means that there is some processing of information at the sensory level.

Visual percepts provide an illustration of this idea. Bateson proposed that perception begins with eyes detecting a difference between the white of the page and the black of the text's fonts. The fact that you are reading this text illustrates this argument. When a person reads a text that is typed on a page, the person engages with the text by using his or her eyes in a context where the necessary conditions for such engagement exist (for example, there needs to be enough light in the room for the person to be able to read). Distinguishing between the black text and the white page is a form of information processing that starts in the eye. If there is no significant difference at all between the two, the eye cannot see the text, and the person cannot perceive that she or he is looking at a text.

The same goes for the perception of temperature. Noticing whether a surface is or is not cold entails using the skin's sensory capabilities to compare that surface with others that are hotter or colder—even if it means comparing that with sensory memories of other surfaces and their temperatures. A person who puts his or her hands in lukewarm water after being exposed to extremely low temperatures will sense that water as if it were very hot. Alternatively, if a person is exposed to a smell that stays relatively constant—that is, without oscillations in its intensity—will eventually decrease levels of smell-perception or even stop him or her from smelling it altogether. The assertion that perception is a multilevel system is so fundamentally correct that neurologists have discovered that without sensory engagement with environments, the human mind cannot function properly. Sensory deprivation is—at least for humans—a highly cruel form of torture.

PERCEPTION AND SOCIAL RELATIONS

Social scientists working on the basis of these premises add to this knowledge by explaining the role that culture and social relations play in the mediation of perception. Rather than contradicting the findings mentioned above, they complement them and take them even further. A case in point is the work of the anthropologist David Howes. He has done extensive research on the relations that exist between sensory perception and sociocultural contexts. First, Howes shows that there is a distinction to be made between sensory capabilities and their use. This implies that there is no universal natural sensory state. Instead, sensory potential is exercised differently depending on a person's social background. Each society specifies the appropriate uses for people's senses. For example, in North America it is generally considered rude to sniff a person's smell.

Second, Howes shows that the notion of "sense" is to a great extent cultural. In Western societies people normally talk of five senses, but there are other societies where people refer to the existence of many more senses. There are societies where people are encouraged to use additional senses, including some that allow them to make statements about another person's soul.

Third, Howes's research shows that contrary to dominant assumptions that each sense operates individually, sensory perception actually emerges out of the interaction of various senses. The end result is that perception is more than the sum of the bits of information that are provided by each sense alone. This means that sensory perception is synergistic. Howes's major argument is that any discussion of human environmental perception must begin with an account of the realm of the sensuous in active interaction with surroundings. This in turn must be understood in the context of social practices that lead to particular types of habitual, embodied sensory practices.

INDIVIDUAL VARIATIONS

Tim Ingold, another anthropologist, has studied the ways in which human beings, who are endowed with sensory capabilities and who are influenced by culture, perceive the environments they live in. Ingold argues that notwithstanding people who have disabilities, all contemporary humans are endowed with similar perceptual capabilities. However, the extent to which people actually exercise these abilities is related to the perceptual habits they develop through life as well as to the extent to which the person learns to be aware of his or her perceptual practices. This means that on the one hand, people become accustomed to using some of their perceptual capabilities more often—and better—than they use other capabilities. The possibility is there at birth that people use all of their sensory potential but, as they grow up, they become accustomed to relying mainly on specific combinations. For example, there are societies in which most people develop the habit of using mainly their eyes in order to engage with the world, to the point where information about the world is not real to them unless it can be visually verified.

In Western societies, a person's mood is often determined by looking at the person's face and seeing whether she or he looks happy. This is often taken as more informative than listening to what the person has to say about his or her emotional state. In fact, expressions like "she says she's happy but I can see she is not" are illustrative of how Westerners privilege the visual over the auditory.

On the other hand, as people go through their lives, they become aware of the ways in which they perceptually engage with their surroundings. This allows them to fine-tune their perceptual capabilities. The typical bird-watching beginner is not capable of noticing differences between the sounds of distinct bird species, nor is she or he capable of detecting the physical and behavioral nuances that separate various subspecies from one another. In fact, many beginners are not even capable of seeing birds when they walk through the woods. In time, however, beginners learn how to become aware of more aspects of their surroundings.

LEARNING AND CULTURAL TRANSMISSION

People develop this awareness by learning to discover different levels of perceptual engagement with environments. According to Ingold, and very much along the lines of what Bateson had proposed before him, this information entails more than having images of the world copied into a person's head. It also means that in this process of learning it is insufficient to receive instructions from someone else on how to perceive. This is a process that normally falls under the label *enculturation,* whereby a person is informed of the knowledge and ways of living that characterize his or her society. The person must instead be actively involved in engaging with his/her surroundings and, in so doing, discover how to use his or her perceptual potential. Ingold shows that the latter is a process of *enskillment.* It contrasts with enculturation in that while enculturation occurs by means of information transmission from one person or society to another, it is instead achieved by learning to pay attention to environmental cues. The latter is what Ingold calls a dwelling perspective. It is based on the notion that acting and perceiving are inextricably connected.

A bird-watching beginner, for example, may receive instructions from a teacher on how to proceed toward having a better chance to see birds on trees, or information about how the sounds of different species might best be recognized. Their instructions are helpful, but not enough to render a novice bird-watcher a proficient bird-spotter. Instead, the novice must acquire corresponding perceptual skills in order to see, listen to, distinguish, and appreciate birds.

Ingold's work goes even further by explaining how these processes occur, and what are the related roles that culture and social context play. Ingold considers two main contrasting forms of cultural understanding of perception, identifying two distinct epistemologies or general theories concerning the validity, scope, and anatomy of human-knowledge processes—including perception. First, there is the orthodox Western understanding of perception. As mentioned above, it is based on Cartesian premises.

Cartesian premises assume that there are clearly demarcated boundaries between the external world, a body's perceptual apparatus, and a central information-processing unit—the brain. It is typical of Cartesian thinking to believe that the senses play a minor role in relation to the brain's mental processes. At best Cartesians see the senses as mere vehicles that passively transport direct information from the outside world. For them it is the brain and the brain alone that displays properties of mind: that is, the capability to know the world. From this perspective, it makes perfect sense for Cartesians to argue that human knowledge can be effectively and successively transmitted abstractly in the form of verbal and written information.

To some extent this proposition is indeed true. A good portion of the average Westerner's knowledge is acquired this way. However, humans would hardly be able to cope with living in the world if this were the only way they knew the world. As anyone who ever had problems learning mathematics or abstract philosophy knows, it can be extremely difficult for humans to learn things that they cannot relate to the worlds they are engaged with. In turn, most of the practical knowledge that humans require in order to deal with the demands of their daily lives is embodied knowledge, not abstract and conceptual. One could spend hours describing to someone else all the theory that comes with bicycle riding, but the prospective rider would still fall many times before learning balance.

Ingold contrasts this epistemology that dominates the Western world with the epistemologies of many cultural examples from societies that exist around the world. His work shows that hunter-gatherers, for example, differ from most Westerners in that they understand perception as emerging from the simultaneous conceptual and bodily engagement with the world. They do not operate on the basis that the world is an external reality that passively waits to be known. Following a dwelling perspective in the terms described above, hunter-gatherers conceptualize knowledge as the combined result of thinking and acting within environments. For them, the two cannot be separated; mind and environment are two connected processes.

The process of hunting illustrates this point. In many non-Western societies, such as the Cree of northern Canada, knowledge of how to hunt always entails a reciprocal interaction between hunter and prey. Certain aspects of this knowledge must be passed conceptually from one person or society to another, but the actual hunting encounter will fail for the hunter unless he or she is attuned to the animal's responses and responds accordingly. Certain actions by the hunter will lead to certain responses by the animal. These, however, depend on the environmental context wherein hunting takes place. For instance, animals will respond differently depending on whether they are in the proximity of their herd, or depending on whether it is windy or not. Consequently the hunter must learn to align his or her perceptual apparatuses such that they can be adjusted to oscillating conditions during the hunting event as well as to the animal's responses to both the environment and the presence of a human being. Perceptual knowledge is thus "spread around knowledge" in that it resides in the interactions that take place among the hunter, the prey, and the environment. Clearly, this epistemology contrasts with Cartesian premises that knowledge is fixed in the brain as a set of concepts about an external world.

In short, environmental perception is a complex biological process that entails the active interaction of sensory organs, nervous systems, and the brain. This, however, is only a fraction of the process. A person's biological perceptual systems give him or her the potential to know the world. This potential is not exercised until the person actively engages with the environment. In this process of engagement certain aspects of this potential will be used, while others will not. In so doing people bring forth some features of the environment, while others remain unknown. To a great extent this is the result of culturally acquired sensory habits whereby humans learn to use some senses more than others. In addition, sensory perception tends to be synergistic—different senses cooperate and interact such that perception emerges as a combined product of individual sensory capabilities.

Finally, environmental perception is influenced by social and cultural context. Some societies and cultures operate on the basis of an epistemology that encourages members to be particularly attuned to feedback information from the environment while others do not. Recent scientific studies from neurology, psychology, anthropology, and sociology show that, regardless of epistemological belief, the fact remains that perception is not possible without environmental engagement.

SEE ALSO: Anthropology; Nature, Social Construction of; Sociology.

BIBLIOGRAPHY. Gregory Bateson, *Steps to an Ecology of Mind* (University of Chicago Press, 2000 [1972]); Frijof Capra, *The Web of Life: A New Scientific Understanding of Living Systems* (Anchor Books, 1996); Peter Harries-Jones, *A Recursive Vision: Ecological Understanding and Gregory Bateson* (Toronto University Press, 1995); David Howes, *Sensual Relations: Engaging* *the Senses in Culture and Social Theory* (University of Michigan Press, 2003); Tim Ingold, *The Perception of the Environment: Essays in Livelihood, Dwelling, and Skill* (Routledge, 2000); Uriah Kriegel and Kenneth Williford, *Self-Representational Approaches to Consciousness* (MIT Press, 2006); Katja Neves-Graca, "Investigating Ecology: Cognition in Human-Environmental Relationships," in P. Meusburger and T. Schwan, eds., *Humanökologie: Ansätze zur Überwindung der Natur-Kultur-Dichotomie* [Human ecology: toward overcoming the nature-culture dichotomy] (Steiner Verlag, Stuttgart, Erdkundliches Wissen, vol. 135, 2003).

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Permits, Tradable

A TRADABLE PERMITS system represents an attempted solution to problems arising from the use of common property resources, such as air and water, either as a source of value or a sink for pollutants or waste. Since such resources are freely available to everyone and costs of their overuse, depletion, or damage are not borne directly by the user, there is a tendency toward unsustainable usage (a Tragedy of the Commons).

A tradable permit system limits the amount of the resource that can be used or the quantity of pollution that can be emitted, but then allows this quantity to be freely exchanged. Tradable permits are licenses issued by a competent authority that give the holders the right to use the resource specified (e.g., producing pollution or catching fish). They may be traded with other institutions or individuals, generally, but not necessarily, for money. Tradable permits have been considered a success in tackling some environmental issues. In theory, their advantage is to create an incentive for increased efficiency, allowing those who pollute less in production, for example, to sell their unused rights for a profit. Tradable permits have been used largely in the areas of water management, fisheries control, air pollution, and land use. The Kyoto Protocol on atmospheric emissions is perhaps the best-known example. The Chicago Climate Exchange has emerged in the United States in anticipation of carbon trading to control global warming.

Market-oriented approaches appeal to those who are opposed to the concept of governmental control of the use of natural resources. Governance is essential for such systems to work, however, since caps and limits must be set and enforced and trading must be organized and regulated. It is necessary to ensure that all participants have confidence in the system and that it is transparent.

There are transaction costs involved in the trading process and inevitable asymmetries of information may make the pricing mechanism inefficient. In order to improve the efficiency of the process, additional features have been implemented in some cases, in the same way that derivative or future options are used in financial markets to enable parties to manage their exposure to risk (such as the inefficient use of resources). These include by-catch quotas, safety values, and zero revenue auctions. These market-based mechanisms can be effective when properly regulated, although there is always the concern of collusion or other disreputable behavior on the part of participants.

SEE ALSO: Common Law; Kyoto Protocol; Marketable Permits; Tragedy of the Commons.

BIBLIOGRAPHY. Tom Tietenberg, "The Tradable Permits Approach to Protecting the Commons: What Have We Learned?" Paper Presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) (Venice, December 3–4, 2001); Ada Wossink and Cornelis Gardebroek, "Environmental Policy Uncertainty and Marketable Permit Systems: The Dutch Phosphate Quota Program," *American Journal of Agricultural Economics* (v.188/1, 2006).

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Persian Gulf

LOCATED IN A politically volatile region at the center of the world's most important and accessible oil deposits, the Persian Gulf is one of the most environmentally vulnerable bodies of water in the world. Within the past few decades small fishing villages on the Trucial Coast, the coastline of the United Arab Emirates, Qatar, Bahrain, Oman, and Saudi Arabia, have experienced phenomenal economic growth. Dubai, for example, has become a hub for air and sea transport, finance, and trade throughout Eurasia. This development has led to a significant increase in pollution and ship traffic in the gulf.

The Persian Gulf wars in Iraq and Kuwait and Saddam Hussein's destructive environmental warfare have left a harmful environmental legacy. Crisscrossed by oil pipelines, dotted by refineries and sulfur stations, the Saudi coastal oil facilities are a ripe target for terrorists wanting to cause global economic panic. The prospect of conflict with Iran and its development of nuclear technologies have also made the Gulf vulnerable on its northeastern shore.

The Persian Gulf, barely connected to the Arabian Sea by the narrow straits of Hormuz between Oman and Iran, functions almost as its own ecosystem. It is some 1,000 kilometers long and 300 kilometers wide, but is only 35 meters deep on average. Any oil spills or pollutants that enter the gulf take a long time to exit the straits and dilute. With mangroves, salt marshes, mudflats, coral reefs, and sea grass along its shore, the warm waters of the Gulf are home to a great diversity of marine life, one of the richest in the world. Large numbers of migratory seabirds flourish in the warm, shallow marshy habitat. The dugong—a large, rare, slow moving sea mammal—is found in significant numbers near the coast. Sea turtles are also commonly found nesting on the Trucial sands.

The potential for conflict in the Persian Gulf region remains high and the risk of environmental fall out from large-scale warfare does not seem to be ending any time soon. The unbridled development of oil-producing states will continue to threaten fragile marine environments on the coasts. The Persian Gulf is too often referred to as "the Gulf," as a purely political entity and as a potential center of international political crisis and change. The potential for environmental crisis in gulf waters, however, is perhaps just as high. It remains to be seen if either the political or the environmental consequences of recent Western intervention in the region can be managed.

SEE ALSO: Iraq; Petroleum; Persian Gulf Wars.

BIBLIOGRAPHY. Haim Bresheeth and Hira Yuval-Davis, eds., *The Gulf War and the New World Order* (Zed Books, 1991); Micah Sifry and Cristopher Cerf, eds., *The Iraq War Reader* (Touchstone, 2003); United Nations Environment Programme, *A Strategy for Protecting the People and the Environment in Post-War Iraq*, postconflict.unep.ch (cited April 2006).

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Persian Gulf Wars

THE PERSIAN GULF Wars—the first fought between Iraq and Iran between 1980 and 1988, the second fought between a U.S.-led coalition and Iraqi occupying forces in Kuwait in 1991, and the third fought between the United States and the Iraqi Army in Iraq itself and later against insurgents from 2003 to the present—are no exception to the tragic rules of environment and war.

Success in war is highly dependent on very immediate, short-term considerations. A slight change in tactics or position on either side can have serious consequences for the ultimate outcome of a conflict. Success in environmental policy, in contrast, must develop over the long term. War is fought in highly unstable situations where there is often a lack of clear government. Without a government, there is no way to regulate or to manage environmental crises. Rather than attempting to save the environment, both sides in the conflict may destroy the enemy's environment for immediate tactical advantage.

Destruction of the environment around enemy troops has an ancient history, going back to the destruction of crops and the poisoning of besieged cities' water supplies. One of the most dramatic examples of this was the spraying of Agent Orange in Vietnam by U.S. forces to kill the jungle and root out the Vietcong. When Iraqi dictator Saddam Hussein faced resistance from southern Iraqi Arabs, he drained marshes and destroyed ecosystems. His use of mustard gas against Kurds in the north also had serious environmental, let alone humanitarian, consequences.

The sheer presence of a military can lead to large quantities of garbage and waste. In the case of U.S. troops stationed in the arid zones of Saudi Arabia during the first gulf war, much of the waste was buried or burned. The Iraqi military, without sufficient logistical or planning support, caused serious damage and often relied on burn and run tactics. The most famous image of the first gulf war was of oil fires set alight in Kuwait by Iraqi forces, and possibly by some coalition bombing. Some 600 fires raged after the first war, causing serious respiratory diseases, and the soot from the fires scavenged large quantities of ozone. This has been called one of the worst deliberate environmental disasters, causing an oil slick in the fragile and overstretched gulf ecosystem, one of the most productive marine environments in the world. The dugong, a threatened species of manatee, is especially vulnerable to the destruction of coastal marine vegetation. Several washed up dead on the Saudi beaches after the oil spill. The second gulf war also led to the release of harmful chemicals and pollutants into the gulf.

The bombing of poorly constructed chemical and nuclear facilities led to the leaching of harmful wastes into the Tigris River, source of most of Baghdad's water supply. The present lack of central control in some areas of Iraq has lead to further serious environmental consequences. As insurgents target trash collectors, waste and sewage builds up in the cities and slums. The looting of nuclear and chemical facilities after the U.S. occupation in 2003 has led to serious concerns about the whereabouts of dangerous nuclear fuel and radiation. Some looted nuclear barrels were allegedly used to store milk and food. Even as some areas—such as the marshlands—have been restored, the lack of infrastructure, water, power, and development has led to desperate measures in a civilian population exposed to pollution and poverty.

SEE ALSO: Iran; Iraq; Persian Gulf.

BIBLIOGRAPHY. Haim Bresheeth and Hira Yuval-Davis, eds., *The Gulf War and the New World Order* (Zed Books, 1991); Micah Sifry and Cristopher Cerf, eds., *The Iraq War Reader* (Touchstone, 2003); United Nations Environment Programme, *A Strategy for Protecting the People and the Environment in Post-War Iraq*, postconflict.unep.ch (cited April 2006).

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Peru

FOR MUCH OF its history, Peru has been beset by political strife and government corruption. From 1533 to 1823, residents lived under oppressive Spanish rule. In modern times, governments have vacillated between military and democratic. This political instability has led to a weak infrastructure with major economic and environmental problems. The per capita annual income of Peru's 27,925,628 people is $6,000, resulting in a ranking of 122nd among nations of the world. Inequality is widespread in Peru, and the top 10 percent of the population hold 37.2 percent of resources. At the other end of the spectrum, 54 percent of the population live below the poverty line. The United Nations Development Programme Human Development Reports rank Peru 79th among 232 nations on overall quality-of-life issues. Long an important part of the national economy, the illicit coca leaf crop has declined by about 40 percent over the last decade, further hampering the regional economy.

Bordering on the South Pacific Ocean, Peru has 2,414 miles (3,887 kilometers) of coastline. The climate ranges from tropical in the east to dry desert in the west and temperate to frigid in the Andes Mountains. The terrain is varied: Coastal plains cover western Peru, giving way to the Andes in the center and to the lowland jungle of the Amazon Basin in the east. Earthquakes, tsunamis, flooding, landslides, and mild volcanic activity are common in Peru, and some disasters have a major human impact. For instance, the 1983 El Niño was devastating to Peru. Many people lost their main source of food when fishing was suspended as the river flooded and sea levels rose during five months of nonstop rain.

Two of the world's most significant geographical features are found in Peru. Lake Titicaca (shared with Bolivia) is the highest navigable lake in the world. The Amazon River also reaches its ultimate source on a remote slope of the Nevado Mismi. Peru is rich in natural resources that include copper, silver, gold, petroleum, timber, fish, iron ore, coal, phosphate, potash, hydropower, and natural gas. However, overdependence on minerals and metals has adversely affected the country.

Extensive deforestation in the Amazon Basin of Peru has occurred as peasants migrate into the area, encouraged by land tenure laws that allow five-year occupants of the land to retain it. More problematically, deforestation also follows logging, intensive commercial plantation agriculture, mining, and the state-sponsored road construction that engenders these activities. Municipal growth and mining have resulted in soil erosion and extensive pollution in rivers and coastal waters.

In the industrial area of Lima, air pollution threatens general health. Peru produces 0.1 percent of the world's emissions of carbon dioxide even though there are only 30 cars per 1,000 people. The HIV/AIDS virus is also posing considerable health risks in Peru. With a prevalence rate of 0.5 percent, it is estimated that 82,000 people are living with the disease, and 4,200 have died. Further threats to health derive from the fact that almost one-fifth of the population lack access to safe drinking water and almost 40 percent have no access to improved sanitation.

The impacts of climate change are reaching crisis proportions in Peru. Some scientists believe that the tropical glaciers will disappear by 2015, leaving the population with a shortage of freshwater resources. Environmentalists around the world have campaigned against the Camisea gas pipeline project that became operational in August 2004. The pipeline stretches over the Andes Mountains from the Amazon River to the Pacific Coast. During the first 18 months, three major ruptures occurred. Extending for 700 miles (1,127 kilometers), the project threatens Amazonian ecosystems and poses great health risks to tribal communities in remote areas such as the Nahua-Kugapkakori Reserve.

Approximately 51 percent of Peru is still forested, and the government has protected 6.1 percent of all land. Although Peru continues to maintain biologically diverse ecosystems, many are at risk. Of 460 mammal species endemic to Peru, 49 are in danger of extinction. Likewise, 76 of 695 bird species are threatened. In 2006, a study by scientists at Yale University ranked Peru 65th of 132 countries on environmental performance, in line with the relevant income group but below the geographic group average.

Historically, Peru's environmental protection framework has been weak. During the mid-1980s, enacted legislation proved difficult to enforce. In the early 1990s, Congress passed the Environmental and Natural Resource Code that spelled out environmental policy without providing sufficient funding for implementation. The National Environmental Council was created in 1995 with the authority to levy civil and criminal penalties for noncompliance. Again, enforcement proved difficult. The Peruvian government enacted stiff laws restricting the activities of the timber industry in 1999 and began working with the private sector to develop environmental programs. In 2004, Congress passed a law designed to bring all environmental agencies together in a single tribunal.

Peru has signed the following international agreements: Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Amazon River Basin; Andes Mountains; Cocaine; Deforestation; El Niño–Southern Oscillation; Endangered Species; Global Warming; Indigenous Peoples; Pollution, Air; Pollution, Water; Poverty; Titicaca, Lake.

BIBLIOGRAPHY. C.A. Bowers and Frédérique Apffel-Marglin, eds., *Rethinking Freire: Globalization and the Environmental Crisis* (Lawrence Erlbaum, 2005); Central Intelligence Agency, "Peru," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental Issues* (ABC-CLIO, 2004); One World, "Peru: Environment," uk.oneworld.net (cited April 2006); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of

Michigan Press, 1995); United Nations Development Programme, "Human Development Reports: Peru," hdr.undp.org (cited April 2006); World Bank, "Peru" *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Pesticides

PESTICIDES ARE CHEMICALS or biological agents (such as viruses or bacteria) used to control or eliminate pests. Pests can be anything that disturbs human life, agriculture, horticulture, or domestic animals. Pests are most often insects, but they may be bacteria, fungi, weeds, unwanted fish, rodents, nematodes (roundworms), deer, or rabbits. Pests may be native to a local environment or invasive species. Pesticides are often classified according to the type of pest they are designed to control or eliminate. There are five kinds of pesticides: fungicides, herbicides, insecticides, rodenticides, and a miscellaneous category.

Fungicides are used against pathogenic fungi to either prevent the spread of the fungus or eliminate the infection. Fungi may infect plants, animals, and humans, damaging crops or human health. The damage may cost great sums of money, cause the loss of plants, damage the health of animals, or even kill humans. Contact fungicides are sprayed or used as an ointment on the infected area(s). Systemic fungicides kill fungi through an absorption mechanism that induces the fungi to absorb the fungicide, then sicken and die. Many cleaning products are fungicides. In some situations, a fungicide may be applied to garden or farm seed as a prophylactic. Usually, seed treated with a fungicide can be easily recognized because it is tinted a bright pink color to alert people to the danger of eating the seed. Fungicides (often containing mercury) have caused death, paralysis, or brain damage when people ate fungicide treated seed.

Herbicides are pesticides that are used to kill unwanted plants. There are two basic types of herbicides—general and specific. General herbicides, such as the commercial product Roundup, are nonspecific: All of the plants sprayed with a general herbicide are killed. Some general herbicides have been developed from plant hormones. They are applied to plants and are able to confuse hormonal growth patterns. Some plants are natural herbicides, such as walnuts (genus *Juglans*). Herbicides are used in enormous quantities in landscaping, landscape turf management, agriculture, and highway maintenance. Herbicides are also used extensively in the management of wildlife areas, in lakes, in forestry, and in pasture management systems. Specific herbicides kill only a specific type of plant; there are many commercial herbicides that can be applied to crab grass, poison ivy, or poison oak. Without these products, whole areas would have to be cleared by hand or with mechanical devices. There are some organic herbicides, which are usually expensive, confined to noncommercial uses, and less effective than synthetic chemical herbicides. Examples of organic herbicides include some spices, vinegar solutions, steam, and fire.

Insecticides are pesticides designed to eliminate crawling bugs, such as cockroaches, ants, fleas, flies, mites, and arachnids—ticks, mites, scorpions and spiders. Spiders and scorpions can be dangerous, and insecticides may be sprayed to make areas safe for human activities. Pyrethrums, which are obtained from chrysanthemums, and piperonyl butozide, derived from sassafras trees, are natural biological insecticides. Synthetic pyrethrums are currently finding wide use. Insecticides have improved human health and longevity by controlling insects that have plagued humans for millennia.

Rodenticides kill mice and rats. Those developed in the middle of the 20th century were usually composed of toxic substances such as arsenic, strychnine, cyanide, and even some chemicals developed for use as chemical weapons. Contemporary rodenticides are those that block the production of vitamin K. This compound plays an important role in coagulation. When rodenticides kill rodents, they may cause secondary poisoning in dogs or cats if they eat the weakened or dead rodent. Warfarrin and other rodenticides are designed to be toxic to rodents, but far less toxic to humans or larger animals.

Rodents carry fleas, which are carriers of numerous diseases. Bubonic plague and some hemorrhagic diseases are spread by fleas on rats and mice or by their droppings. Among rodentborne diseases are arenavirus, hantavirus, leptospirosis, lymphocytic choriomeningitis, murine typhus, plague, rat bite fever, and salmonellosis. Cleansing human habitations and food stocks of pests is important to preserve human health.

The miscellaneous category of pesticides includes slug pellets (molluscicides), which kill snails, and various repellants for insects, birds, and animals. Rabbits in Australia have no natural predators. After their introduction, they multiplied enormously to the point where they were eating much of the existing vegetation. They were eventually controlled with a pesticide in the form of a virulent virus that is deadly to rabbits. Pesticide agents used in swimming pools remove health hazards, bacteria, and algae. A "trick" pesticide used to drive away birds or animals that become pests is to spray areas with the urine of their natural predators. Coyote urine has been used as nontoxic repellant; it is a biochemical pesticide, but also a naturally occurring substance that is otherwise harmless in nature. It has been used to repel armadillos, beavers, domestic cats, deer, elk, and wild pigs.

Without pesticides, crops would be lost and health improvements would be difficult. When crops are infested with a pest such as cabbage loopers, an entire crop can be destroyed or rendered unfit for use. Many localities use mass spraying of insecticides to control mosquitoes. The use of DDT (dichloro-diphenyl-trichloroethane) aided great reductions in typhus, malaria, and other insectborne diseases in World War II and afterward.

In 1962 Rachel Carson, an American biologist, published *Silent Spring,* which claimed that DDT was causing cancer and destroying bird populations. Her work was an important factor in the rise of the environmental movement and efforts to ban the use of insecticides. After the political controversy that arose following the publication of *Silent Spring*, Congress created the Environmental Protection Agency in 1971. It assumed control of pesticide regulation, taking over responsibility from the Department of Agriculture. One of its first actions was to ban DDT in 1972.

Environmentalists' claims that chemical companies and other manufacturers of pesticides are producing dangerous products have been substantiated. Scientists, engineers, farmers and other agriculturalists also have a vested interest in not poisoning the land. Since the 1980s, pesticide research has sought out safer biological controls, such as pheromone traps and microbial agents. Modern pesticides used in urban areas have been found to pose little risk to human populations and are important defenses in the effort to control mosquito-borne diseases and destructive pests. Biological pesticides or those with reduced risks of side effects are being approved by the EPA in growing numbers.

SEE ALSO: Carson, Rachel; DDT; Fungi; Herbicides; Insects; Integrated Pest Management; Malaria; Organic Agriculture; Pests, Agricultural; Weeds.

BIBLIOGRAPHY. Rachel Carson, *Silent Spring* (Houghton Mifflin Company, 2002 [1962]); J.R. Coats and Hiroki Yamamoto, eds., *Environmental Fate and Effects of Pesticides* (American Chemical Society, 2003); Peter Hough, *Global Politics of Pesticides: Forging Consensus from Conflicting Interests* (Earthscan, 1998); Robert Krieger et al., eds., *Handbook of Pesticide Toxicology: Principles and Agents* (Elsevier Science & Technology Books, 2001); N.B. Mandava, ed., *Handbook of Natural Pesticides: Methods, Theory, Practice and Detection* (CRC Press, 1985); Jorgen Stensersen and Steven Strauss, *Chemical Pesticides: Modes of Action and Toxicology* (CRC Press, 2004); William Vorley and Dennis Keeney, eds., *Bugs in the System; Redesigning the Pesticide Industry for Sustainable Agriculture* (Earthscan, 1998); M.F. Waxman, *Agrochemical and Pesticides Handbook* (CRC Press, 1998); David Weir and Mark Schapiro, *Circle of Poison: Pesticides and People in a Hungry World* (Food First, 1981).

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Pests, Agricultural

PESTS ARE LIVING organisms that damage and destroy agricultural produce. Pests include mobile threats such as locusts and other insects, viruses, fungi, and bacteria. The threat of pests has existed for as long as humanity has practiced agriculture, and also affects nonagricultural growth. The consequences of pest infestation are physical and economic, as well as psychological, resulting from fear and panic spread by the influx of pests. Those pests that have led to animal disease, including bovine spongiform encephalopathy and foot-and-mouth disease, have led to the mass slaughter of livestock.

Pests can be very destructive. The *Phytophthora* fungus, which arrived in Ireland from North America in the 1840s, stimulated blight among the potato crop for several successive years. The Irish population, especially the rural poor, had become dependent on a small number of species of potatoes for food. With the almost complete destruction of successive potato crops, compounded by the inadequacy of the British government that administered Ireland at the time, more than one million people starved to death and more than another million people fled overseas.

The example of the potato blight in Ireland reveals the confluence of several factors that make pest infestation particularly severe: The sudden introduction of a previously unknown organism, unusual climatic conditions that enable the pest to flourish to unusual extents, and the reliance on too narrow a range of foods. As globalization of trade increased during the 18th and 19th centuries, international trade in grains increased to feed growing cities. This caused pest infestations to become endemic throughout the world. States were required to introduce new legislation, and government agencies tried to combat such pests. One of the earliest examples of this was the Destructive Insects Act of 1877 enacted in Britain and aimed at removing the threat of the Colorado potato beetle.

Farmers have fought pests throughout history. Early infestations of locusts, as recorded in the Bible, were met by as many workers as could be mustered to pick the creatures off plants by hand and for some quite primitive forms of spraying. Earlier farmers also responded by selecting more resistant seeds for sowing, although in many cases this process was not well understood.

In the early modern age, the application of the scientific method enabled farmers to mobilize more effective means of combating pests, including chemical sprays and pesticides. These technologies have proved very effective in killing many pests, and even people when used in warfare; organophosphate pesticides, in just one example, are the progenitors of modern nerve gas. However, there have been a number of cases when the use of chemical pesticides has produced poor results, either because other, necessary organisms have also been destroyed or else chemical residue has contaminated food. In some developed countries, the routine use of chemicals has led to the regularization of the size and shape of food and vegetables, to the detriment of their nutritional value. Meanwhile, there are dangers that pests will become resistant to the chemicals used to try to eradicate them. Aerial spraying of chemicals also poses a health threat to people caught within the area of spraying.

SEE ALSO: Insects; Ireland; Organic Agriculture; Parasites; Pesticides; Potatoes.

BIBLIOGRAPHY. Food and Agriculture Organization, *The State of Food and Agriculture, 2001* (FAO, 2001); Cormac O'Grada, *The Great Irish Famine* (Cambridge University Press, 1995); Larry P. Pedigo and Marlin E. Rice, *Entomology and Pest Management* (Prentice Hall, 2005).

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Petroleum

PETROLEUM, OR CRUDE oil, is a nonrenewable natural resource that has had a tremendous beneficial influence on human society. With a name derived from Latin *petra* (rock) and *oleum* (oil), petroleum represents the world's most important energy resource. Such fuels as gasoline, diesel fuel, jet fuel, heating oil, and related oils power the world's transportation system, provide electrical power for industrial production, and produce heat for human populations residing in cold-weather climates. In addition to its many energy uses, petroleum is also an important raw material resource used in the manufacture of a wide array of products that provide significant societal benefits. Petroleum is the raw material input in the production of many fertilizers and pesticides, which are largely responsible for increased agricultural production and efficiency.

Most of the world's consumer products contain plastics and other materials derived from petroleum. Petroleum has positively impacted most segments of human life; for example, the medical industry has developed life-saving, petroleum-based implants. While the vast benefits of petroleum energy and products are clear, the production and consumption of oil has come at a price to the natural environment (e.g., pollution and oil spills) and to human populations themselves (e.g., war and production facility accidents).

ORIGINS

The formation of petroleum can be traced back hundreds of millions of years to ancient microscopic plants and bacteria. These living organisms were able to convert the energy from the sun directly for their own sustenance. These organisms, residing in the ancient seas that covered the earth, sank to the sea floor upon death. Over time, sedimentary layers of silt trapped the nondecayed organic matter in what would later become source rock. Sedimentary layers accumulated above the organic materials, and combined with the weight of the ocean, exerted great pressure and heat. Over time, this pressure and heat transformed the organic source material into the hydrocarbon we now know as petroleum. This process is similar to the formation of natural gas, which is a reason why petroleum and natural gas are often found at similar locations in the earth's crust today.

Over time and under extreme pressure, petroleum was squeezed into the crevices of relatively porous sandstone or limestone, called reservoir rock. Subsequent deformation of the earth's crust acted to trap petroleum into pockets under dense, impenetrable cap rock like marble or granite. The three main geologic forces trapping petroleum into pockets within the earth's crust are folding, faulting, and pinching out. Folding results from horizontal pressure being exerted on the cap rock, forming a fold (or anticline). The resulting bell-shaped fold in the cap rock serves to trap petroleum. Faulting represents a fissure in the cap rock, with a large section of cap rock slipping down, forming a petroleum-trapping cavity. In the pinching out process, impenetrable rock is forced upward into the reservoir rock, resulting in petroleum-trapping pockets. Each of these geologic formations has the potential to hold reservoirs of petroleum, allowing geologists today to predict the possible locations of underground reserves.

As with other natural resources, petroleum's status as a resource began with its recognized use and value to human populations. Ancient civilizations located petroleum seeping to the surface of rivers and lakes. Over time, medicinal uses for petroleum, such as for skin ailments, were realized, and petroleum was used to waterproof canoes and water buckets and provide a base for paint.

THE MODERN INDUSTRY

While the first oil wells were drilled in China as early as the 4th century, the modern petroleum industry in the United States began in 1859 near Titusville, Pennsylvania. "Colonel" Edwin Drake struck oil nearly 70 feet below the earth's surface using a wooden derrick and drill, and stored the oil in wooden whisky barrels and vats. At this time, petroleum ("rock oil," as kerosene was called) was used primarily as a fuel for illumination, a cheaper alternative to whale oil. By 1879, the development of the electric light bulb by Thomas Edison provided a cleaner, safer alternative for illumination. Soon electricity-generated lighting forced the oil industry to the brink of extinction.

A new market, however, appeared in the form of the automobile. Henry Ford's "horseless carriage" was powered by the internal combustion engine, which in turn was powered by petroleum-derived gasoline. The automobile would come to transform American society, increasing mobility while also increasing dependence on petroleum. The geopolitical importance of oil became fully realized during World War I and II. Oil soon powered ships, planes, tanks, and troop transports. While securing oil figured prominently in Japanese and German war plans, America's plentiful supply of oil proved decisive in allied victories in Europe and the Pacific.

The post-war suburbanization of the United States was largely enabled by the automobile and an improved highway system. During the 1970s, the energy crises stemming from the oil embargo by the Organization of the Petroleum Exporting Countries (OPEC) and the Iranian revolution sent prices of oil and gasoline to new heights, causing global panic. Between 1980 and 1988, the Iran-Iraq war was fought largely for control of oil fields. Iraq's invasion of Kuwait in 1991 was also an attempt by Iraq to garner additional oil fields, as well as to acquire Kuwait's superior port and oil export facilities. The U.S.-led invasion of Iraq in 2003 and the ongoing war has contributed, in tandem with the threat of terrorism in the Middle East, to geopolitical uncertainties that have helped drive up the current price of oil.

EXTRACTION AND REFINING

The process of moving crude oil from its location within the earth's crust to delivering the final product to the consumer is a complicated process involving upstream (exploration and extraction), midstream (refining), and downstream (distribution to customers) activities. Each of these steps takes place in different (and often distant) locations, forming an intricate pattern of trade and capital flows.

Exploration is done to locate possible petroleum deposits. Most exploration is done using seismology, sending a seismic wave through the earth's crust, recording the reflecting waves, and mapping the underground geologic formations. On land, seismic waves are produced by vibrator trucks, which stomp the ground with a large rectangular foot. Offshore, a compressed air gun is used. Technological innovations, using advanced computer developments, have enabled geologists to construct three- and four-dimensional images of the crust's geology, increasing the success rate of finding productive oil deposits. Such computer-assisted exploration is costly; a 100-square-kilometer exploration area costs $1 million.

Refining, which transforms crude oil into usable products, is yet another costly and involved process. Physical (heating and boiling) and chemical (cleaning and additives) processes separate crude oil into its usable products. For a given barrel of crude oil, nearly half ends up in the form of gasoline. Other important by-products are diesel fuel, jet fuel, residual fuel oil, liquefied gasses, petroleum coke, asphalt oil, lubricants, and kerosene. Other by-products serve as "feederstock" for fertilizers and petrochemicals.

SUPPLY AND CONSUMPTION

As petroleum was formed under certain circumstances, and petroleum reserves trapped by certain geologic processes, oil is found in certain locations in the earth's crust. As a result, some countries have sizeable reserves of petroleum, while most do not. An appropriate measure of potential supply is the amount of proved reserves. These represent the amount of identified and usable petroleum that is available at current market prices and under current extraction technologies.

The Middle East houses approximately 67 percent of the world's petroleum reserves, making this volatile region vital for the future supply of oil to world markets. The largest proved reserves of petroleum in the world are found (in descending order) in Saudi Arabia, Canada, Iran, Iraq, United Arab Emirates, Kuwait, Venezuela, Russia, Libya, Nigeria, and Kazakhstan. One measure of current supply is production, the actual extraction of crude oil ready for processing or export. The largest oil producers in the world are (in descending order) Saudi Arabia, Russia, the United States, Iran, Mexico, China, Norway, Canada, Venezuela, and Nigeria.

In terms of demand, the best measure is consumption. The United States is by far the world's major user of petroleum, consuming an astounding 25.5 percent of total world consumption. This figure is particularly large in comparison to the second-largest consumer, Japan, which consumes 6.8 percent of the world total. The other major oil consumers in the world (in descending order) are China, Germany, Russia, Canada, Brazil, India, South Korea, and France. The main variables explaining oil consumption are high levels of industrialization and/or large human populations.

REVENUES AND THE "RESOURCE CURSE"

The extraction, refining, and consumption of petroleum and petroleum-based products have stimulated astounding levels of revenue and wealth. The top oil companies rank among the world's largest and most profitable corporations. The countries of Kuwait, United Emirates, and Qatar owe their placement in the World Bank's "high income" category to the abundant amounts of petroleum that happen to lie underneath their territory.

While the economic benefits may be great, oil wealth has not always translated into economic prosperity. OPEC members Nigeria and Indonesia remain poverty-stricken countries with rampant corruption and instability. Even Saudi Arabia, the world's top oil producer and exporter, has income and development levels far below those expected given its oil endowment. Per capita gross domestic product in Saudi Arabia places this oil-rich country alongside Poland and Latvia in world rankings. The observation that oil wealth is not always a blessing for countries has led to the development of the concepts of the "resource curse" and "Dutch Disease." During the 1960's the Netherlands discovered extensive oil and gas deposits, creating a so-called "oil boom." Despite its newfound source of wealth, the Netherlands experienced slower economic growth and lower economic performance, as well as higher rates of inflation. These symptoms were later termed "Dutch Disease."

Other variants have resulted in countries where an increase in oil revenue has led to economic distortions, resulting in the inefficient use of human and monetary resources. Such distortions include corruption, abnormally high wages, over-borrowing, and complacency that emphasizes short-term gains at the expense of long-term planning. These distortions ultimately lead to economic inefficiencies, resulting in lower economic growth and performance. In many cases, oil wealth is distributed highly unevenly, leading to regional inequalities, and often heightening already existing regional conflicts, occasionally escalating into civil war.

ENVIRONMENTAL EFFECTS

The negative effects of the extraction, transportation, and use of petroleum on the natural environment are substantial. Perhaps the most visual negative impacts on the environment are oil spills from seagoing vessels. One of the most highly publicized spills was the 1989 *Exxon Valdez* spill off the coast of Alaska, which emptied more than 10 million gallons of oil. This was the worst oil spill in U.S. history, killing wildlife, disrupting entire ecosystems, and creating an unnatural eyesore. Images of oil-soaked sea otters and dead, oil-drenched cormorants united environmentalists around the world in their further disdain for large oil companies. Other notable spills include the 1991 deliberate release by Iraq of 240–460 million gallons of crude oil into the Persian Gulf, and the 2002 *Prestige* leak of 20 million gallons off the coast of Spain.

Further environmental problems associated with the burning of oil and gasoline include air pollution, smog, acid rain, and the human-induced greenhouse effect.

SEE ALSO: *Exxon Valdez*; Fossil Fuels; Greenhouse Effect; Greenhouse Gases; Natural Gas; Oil Spills; Organization of Petroleum Exporting Countries (OPEC); Persian Gulf; Persian Gulf Wars; Pollution, Air.

BIBLIOGRAPHY. Tim Appenzeller, "The End of Cheap Oil," *National Geographic* (v.205, 2004); Fadhil J. Chalabi, "OPEC: An Obituary," *Foreign Policy* (v.102, 1997); Public Broadcasting Service, "Extreme Oil," www.pbs.org (PBS, 2004); Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, and Power* (Free Press, 1991).

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Pets

A PET IS not just an ordinary animal; it is an animal conceived, bought, and given a home for the joy of humans. For instance, a white pet mouse in a cage may delight a child, while at the same time unwanted mice running somewhere in the house are a nuisance. Popular pets are dogs, cats, small birds, hamsters, reptiles, fish, and rabbits. Pets can be considered a sociological phenomenon, particularly in places like the United States, where more than half of all households own at least one pet. There are more than 60 million pet dogs and nearly 70 million pet cats in the

United States according to the American Veterinary Medical Association.

Pet ownership can contribute to human health and well-being. Researchers who studied the dynamics in a cat shelter to see how people fared in a place crowded with pets found that they seemed to be calmer. Many veterinarians and researchers have explored the healing effects of animal-assisted therapy (AAT) on various patient populations. They have also found that retired persons living with pets engage in more exercise and have more social relationships as a result of caring for their pets. Some species and breeds of animals are used to assist specific patient populations (such as the blind, the disabled, mentally ill individuals, AIDS patients, and children).

Another social phenomenon is pet loss. The mourning of an animal who was an everyday companion is quite difficult for some pet owners, and not just children. Strong feelings for their lost pets lead people to seek support groups or books to help them through the grief process. Some authors explore psychological dimensions, while other experts question the spiritual issues.

In the United States there are more than 60 million pet dogs and nearly 70 million pet cats.

Businesses exploit the fact that people are responsive toward animals in marketing. An image of a dog, for example, can be very effective in marketing products that have little to do with animals, such as Hush Puppies shoes that bear a Basset Hound as a logo. Animals kept as pets lack freedom, but when properly cared for they gain shelter, regular meals, veterinary care, and protection. In the 21st century, pet owners face similar choices and issues for their companions as for themselves in terms of consumption, health, birth control, vaccines, organic food, and even homeopathic medical care.

There are many organizations dedicated to animal rights and the fight against cruelty toward animals, such as the American Society for the Prevention of Cruelty to Animals (ASPCA). Those who advocate animal rights are often vegetarians. As for cultural restrictions, there is a food taboo against eating cats and dogs in Western civilizations, but not in societies like China. Although no law prohibits it in the United States, very few people eat horse meat. These meals are quite popular in some countries, however, and the meats can be bought in supermarkets in Canada, France, and Japan.

In recent years, people have experimented with nontraditional pets and exotic (and dangerous) animals such as crocodiles, panthers, and boa constrictors. When owners of these exotic animals abandon them, they can introduce hazardous species to new environments, thus disrupting the ecological balance—an example is the thoughtless discarding of living turtles or piranhas in a lake.

SEE ALSO: Animal Rights; Animals; Aquariums; Dogs; Vegetarianism; Zoos.

BIBLIOGRAPHY. American Veterinary Medical Association, *U.S. Pet Ownership & Demographics Sourcebook*, www.avma.org (cited December 2006); The Association for Pet Loss and Bereavement, www.aplb.org (cited December 2006); Leslie Irvine, “Pampered or Enslaved? The Moral Dilemmas of Pets,” *International*

Journal of Sociology and Social Policy (v.24/9, 2004), socsci.colorado.edu (cited December 2006); Y.-F. Tuan *Dominance and Affection: The Making of Pets* (Yale University Press, 1984).

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Philippines

THE REPUBLIC OF the Philippines is an archipelago of 7,107 islands, approximately 700 of which are inhabited. Its total land area is approximately 300,000 square kilometers (116,600 square miles). The islands are usually divided into three groups, from north to south: Luzon, Visayas, and Mindanao. Luzon has the two largest cities, Quezon City with 2.2 million inhabitants, and Manila (the nation's capital) with 1.6 million people. Both are part of Metropolitan Manila (or the National Capital Region), a large conurbation of 636 square kilometers with 12 million people (a density of 17,751 people per square kilometer). Total population is about 85 million, roughly two thirds of whom reside on the island of Luzon. Population growth is about 1.8 percent per year, with 24.89 births per 1,000 people (2006 estimate).

Since independence on July 4, 1946, the Philippines have experienced economic and political instability. Ferdinand Marcos was elected in 1965, but subsequently extended his power and tenure illegally. In 1986 the People Power Revolution overthrew Marcos, and Corazon Aquino (widow of murdered Senator Benigno Aquino, Jr.) assumed power. Since then, government corruption, ongoing civil unrest, and Muslim separatist movements have continued to hamper the economic and political life of successive democratically elected governments. Gloria Macapagal-Arroyo succeeded Joseph Estrada, who resigned following massive street protests after allegations of government corruption and cronyism.

Total Gross Domestic Product (GDP) is $91.36 billion ($451.3 billion, or $5,100 per capita PPP, 2005 estimate). In 2005 agriculture accounted for 14.8 percent of total GDP, industry 31.7 percent, and services 53.5 percent; 36 percent of the labor force work in agriculture, 16 percent in industry (particularly labor intensive industries including garments and footwear), and 48 percent in services. Forty percent of the population lives below the poverty line. The Philippines suffered less from the 1997 Asian Financial Crisis than its neighbors,

Mount Pinatubo

On June 15, 1991, Mount Pinatubo in the Philippines erupted after 500 years of dormancy. The volcano is part of a chain that stretches across the western part of the island of Luzon. It seemed that an eruption was so unlikely that the United States built their Clark Air Base only 25 miles away. At the time of the eruption there were about 500,000 people living within 30 miles of the volcano, with 20,000 at the air base, and 150,000 at nearby Angeles City.

On March 15, 1991, a number of earthquakes were felt on the northwestern side of the volcano. By April 2, small eruptions near the summit had begun; they continued for a few weeks. By this time scientists were studying the earth tremors closely. In early June the tremors grew more pronounced, and on June 7 magmatic eruptions took place and a lava dome formed at the summit of the volcano.

At 3:41 A.M. on June 12, an eruption began and a large eruption cloud up to 12 miles (19 kilometers) in height appeared; it was followed by other activity. At 1:42 P.M. on June 15 the seismographs at Clark Air Base went wild, and within 45 minutes they had been rendered inoperable. A massive eruption had begun. An ash cloud from the volcano covered about 50,000 square miles, with ash falling as far away as Cambodia and Malaysia. More than two million people were directly affected, and the Clark Air Base was destroyed. The eruption ruined 200,000 acres of rice farmland and killed 800,000 head of livestock or poultry. Because of the early seismic activity and warning, only 300 people were killed; the rest managed to flee.

partly because of remittances from its workers overseas. Over eight million Filipinos live overseas, and the remittances they send back ($12 billion a year) are a very important contribution to the national economy. Since 2002 economic growth has been quite consistent at about five percent per year.

Over 170 languages are spoken in the country, most of them belonging to the western Malayo-Polynesian language group of the Austronesian language family. The 1987 constitution gave Filipino and English the status of official languages. About 92 percent of Filipinos are Christians (81 percent Roman Catholic), and about five percent are Muslims who predominantly live on the island of Mindanao and in the Sulu archipelago.

The archipelago lies on the northwestern fringes of the Pacific Ring of Fire, and is of volcanic origin. There are frequent seismic and volcanic activities, and many active volcanoes, such as Mayon Volcano (a stratovolcano that has erupted around 50 times over the past 400 years), Mount Pinatubo (which erupted in June 1991 after 500 years of dormancy), and Taal Volcano. The highest point is Mount Apo on Mindanao at 2,954 meters. The climate is tropical marine with a northeast monsoon from November to April and a southwest monsoon from May to October. The Philippines have relatively high temperatures (mean annual temperature is 26.6 degrees C), high humidity (between 71 percent in March and 85 percent in September), and abundant rainfall (mean annual rainfall varies from 965 to 4,064 millimeters). Five or six cyclonic storms strike the Philippines each year.

SEE ALSO: Climate, Tropical; Hurricanes; Monsoon; Pacific Ocean; Ring of Fire.

BIBLIOGRAPHY. P.N. Amoroso and D.J. Abinales, *State and Society in the Philippines* (Rowman & Littlefield Publishers, Inc., 2005); A.M. Balisacan and H. Hill, eds., *The Philippine Economy: Development, Policies, and Challenges* (Oxford University Press, 2003); E.L. Hedman and J.T. Sidel, eds., *Philippine Politics and Society in the Twentieth Century: Colonial Legacies, Post-Colonial Trajectories* (Routledge, 2000).

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Pinchot, Gifford (1865–1946)

GIFFORD PINCHOT, ARGUABLY the progenitor of modern American conservation and forestry, was born to a wealthy family in Connecticut in 1865. Upon graduating from Yale University, Pinchot went on to the French National Forestry School, learning techniques and concepts that would later develop further through German and British Imperial forestry, and which underpin modern natural resource management. After two years as a member of the National Forest Commission, he later served as the first chief of the United States Forest Service (1905–10). Pinchot also founded the Yale University School of Forestry and was elected governor of Pennsylvania for two terms. Owing to his lifelong efforts to reform management of natural resources, he engendered many controversies. Nevertheless, he helped to bring conservation issues to the forefront of politics.

With the help of President Theodore Roosevelt, Pinchot gave meaning to the word *conservation* and advocated the wiser use of natural resources. Defined in its historical context, conservation was understood to mean management of natural resources to maximize utilitarian benefits (e.g., timber) without depleting them unnecessarily over time. Pinchot asserted that if there was not proper state-led oversight of the use of natural resources, monopolies and corporate control might lead to overexploitation of public goods, especially forests, whose “sustainable yield” might be surpassed by overaggressive logging.

Pinchot was opposed on two fronts. More libertarian views about natural resources, oriented more exclusively toward markets, made conservation unpopular in some political circles. William Howard Taft, who succeeded Roosevelt in the White House, terminated Pinchot for speaking out against his policies as well as the policies of Secretary of the Interior Richard Ballinger. In what was later to be known as the Ballinger-Pinchot controversy, Pinchot showed his shrewd management of public opinion by subverting public confidence in Ballinger’s beliefs and character, forcing the latter to leave office.

On the other side, the dawning preservation movement (most prominently represented by John Muir) challenged the utilitarian philosophy at the core of conservation. The suspicion of preservationists about commercialization of nature caused ongoing public debates with Pinchot, not only over forestry but also the damming of rivers, most prominently in the Hetch Hetchy controversy.

Determined in his beliefs and efforts, Pinchot founded the National Conservation Association and served as its president for the group's first 15 years. In 1914 Pinchot expressed his interest in the U.S. presidency and ran for the Senate as a candidate of the Progressive Party. During his campaign, he ran against President Woodrow Wilson's World War I neutrality platform; Pinchot promoted the American movement to get involved in the war. After Wilson was reelected for a second term, Pinchot turned to Pennsylvania state politics and was appointed the Commissioner of Forestry in 1920. Pinchot's interest, however, was in the office of governor.

Proposing popular reforms, he won a close gubernatorial election. At the end of his first term, Pinchot took a seven-month leave from office but returned when he was elected for a second term. At the age of 72, Pinchot attempted to gain another term as governor but was defeated due to lack of support from the leaders in his own party. Toward the end of his term, Pinchot was hospitalized, and his wife became the acting governor for the remainder of the term. Setting his sights on the Senate, Pinchot failed for the third time to win a seat.

In his final years, Pinchot retired from politics but still gave advice to the president. As a retired politician, Pinchot unflaggingly supported his conservation beliefs and wrote a book about his own life as a forester. He was not only knowledgeable in the forestry field—he also introduced a very useful fishing kit that was later used in lifeboats during World War II. Gifford Pinchot died from leukemia on October 4, 1946, at the age of 81. The Pinchot family left their mansion, Grey Towers in Milford, Pennsylvania, to the U.S. Forest Service to be used as a museum for forestry education.

SEE ALSO: Conservation; Forest Management; Hetch Hetchy Dam; Maximum Sustained Yield; Muir, John; Preservation; Roosevelt, Theodore Administration.

BIBLIOGRAPHY. J.N. Clarke and D.C. McCool, *Staking Out the Terrain: Power and Performance among Natural Resource Agencies* (State University of New York Press, 1996); S.P. Hayes, *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920* (Harvard University Press, 1959).

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Plantation

PLANTATIONS ARE FARMS covering a large land area that are usually devoted to growing a single crop that will be sold for cash. They are classified according to the manner in which they employ laborers, or according to the kind of crop that is grown. The crops grown are usually something other than a cereal grain or pasture for cattle. Sometimes, orchards may be classified as plantations, especially if nuts are grown.

The English in Northern Ireland first developed plantations. Colonists were "planted" in Ireland on land that had been lost by the Irish in fighting against the English and the Scots. These and other Europeans and their descendants brought the plantation system to the Americas. These plantations resembled ancient latifundia in the Mediterranean, which were worked by slaves for the growing of olives for oil. In the 19th century plantations were established in Asia and Africa and on many Pacific islands. A common factor in almost all plantations is the necessity of gaining and maintaining a reliable source of affordable labor. The number of laborers required has usually been sizeable.

In the United States, plantations developed during colonial times. African Americans who had been imported as part of the slave trade and free whites worked on these plantations, which often grew tobacco. Tobacco was grown first in Virginia, and then in other colonies. Soon after tobacco cultivation began, slaves were introduced into the Virginia colony. However, many of the laborers on the early plantations were indentured servants who had to work for a number of years in order to pay for the cost of their passage to the New World. However, smaller farms that were sometimes "glorified" with the name *plantation* raised other crops besides tobacco, such as corn. Rice was first grown in the colonies in South Carolina's Low Country plantations. Slaves worked the coastal indigo and rice plantations for generations until the abolition of slavery. After the emancipation of the slaves, freed African Americans continued to work the rice plantations until new rice lands were developed in southwestern Louisiana and eastern Texas, where mechanical rice farming took the place of manual labor.

Cotton plantations developed rapidly in the south after the invention of the cotton gin. Plantations developed on the coastal plain, and later on the southern coastal plain of the Gulf of Mexico. Any plantation that was over 1,000 acres was considered large. As settlers moved inland to the Piedmont Region of the southern states, they established cotton plantations there as well. These upland cotton plantations were somewhat smaller than the coastal plantations, but they were usually devoted to producing crops that maintained the people on the farm, and cotton served as the cash crop of the plantation.

When the Civil War ended, slavery plantations changed from slave plantations to plantations using "free" labor. In effect, the people on these plantations were trapped. They would sell their labor to the owner of the plantation where they worked in exchange for a share of the crop. However, in order to pay for the seeds, fertilizer, farm tools, and other supplies needed to maintain themselves until the crop was harvested, they had to buy on credit. If the harvest was poor, they were still in debt after the harvest. If the harvest was good, they usually found that what they earned from their labor was barely enough to cover their debts.

Around the world, plantations developed to grow other crops. In many Caribbean countries such as Cuba, Haiti, and Jamaica, and also in Brazil, sugarcane was the plantation crop, and slavery was used extensively. The end of slavery did not see the end of plantations. In Hawaii, pineapple plantations developed along with the sugarcane plantations. In Central America, Ecuador, and other countries, banana plantations were developed with free labor.

Europeans developed plantations in the 19th and early 20th centuries in their colonies. The people of India worked many British plantations in Guyana and in the Polynesian Islands. Large numbers of their descendants now populate these areas. Other European countries using plantations included the Portuguese, French, and Dutch. Tea plantations were established in Ceylon, India, and China. Development of the motorized vehicle generated an enormous growth in the demand for rubber for tires. Rubber plantations where the trees could be tapped for their sap arose in Central and South America and in Malaysia.

MODERN PLANTATIONS

Modern plantations continue to produce a great many crops, and there are now even "environmental plantations" devoted to preserving a watershed area. The laborers who work on modern plantations are increasingly well educated and employ machinery in the production of their respective crops. Many of the problems posed by modern plantations are environmental. The development of plantations in places such as Indonesia threatens tropical forests. Palm oil, for example, is produced on land that could be left as wilderness preserves; palm oil could be grown on older, but less suitable land and still be profitable. Developing both policies and a culture that will abide by these policies is an ongoing task.

Industrial plantations are those that are devoted to a single crop (monoculture). In the southern United States, pine tree plantations (tree farms) covering vast areas supply the demands of pulp mills that produce paper. A major problem faced by any plantation is that growing only one crop is a specialization of the species. This single species growth invites different kinds of pests—for example, the boll weevil once nearly destroyed cotton production in the southern United States. The concentration of a single crop on plantations over a wide area requires pesticides to protect the crop, and the use of pesticides can have a negative environmental impact.

SEE ALSO: Bananas; Colonialism; Cotton; Monoculture; Plantation Forestry; Sugar; Tobacco; Rubber.

BIBLIOGRAPHY. J.C. Rodrique, *Reconstruction in the Cane Fields: From Slavery to Free Labor in Louisiana's Sugar Parishes, 1862–1880* (Louisiana State University Press, 2001); E.C. Royce, *Origins of Southern Sharecropping* (Temple University Press, 1994); R.J. Scott,

Slave Emancipation in Cuba: The Transition to Free Labor, 1860–1899 (Princeton University Press, 1986).

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Plantation Forests

China, the United States, Russia, India, and Japan grow 65 percent of the world's plantation forests.

PLANTATION FORESTS ARE cultivated through the processes of afforestation (or reforestation). Afforestation refers to tree planting in areas not previously forested, while reforestation refers to tree planting on previously forested spaces. Asia has the highest proportion of plantation forests, comprising 45 percent of the global total. Five countries—China, the United States, Russia, India, and Japan—account for 65 percent of the plantation forests.

Plantations produce wood products such as lumber for construction material, furniture, or pulp for paper production. Most plantation forests use nonnative tree species. The most common species is pine (pinus), followed by eucalyptus. These species have biological and ecological characteristics, such as fast growth, that make them the world's most successful timber trees.

The plantation ecosystems are managed through "silviculture" practices. Most plantations are monocultures, with the trees planted in evenly spaced rows. Due to the heavy management of plantation forests, most researchers do not consider them natural forests; instead, they are viewed as an agricultural product similar to maize or wheat.

Plantation forests are primarily planted to meet the demand for wood worldwide. In addition, plantation forests sequester carbon, and many policy makers are encouraging their expansion to help mitigate our increasing use of fossil fuels. Both business and government organizations advocate tree planting as an activity that could offset many current environmental problems. Many researchers, however, disagree.

Studies on the ecological impacts of plantation forestry focus on the loss of flora and fauna species due to the monoculture nature of plantations. Most of the studies conclude that both flora and fauna biodiversity decrease in plantation forests. Furthermore, other studies show that recovery of the land after trees have been cut can take several years, and even longer if the land is to be restored to its previous grassland state. Pine and eucalyptus plantations acidify the soil, which is toxic to some plants. In many countries where plantations are common, another environmental threat caused by plantations is the spread of species to nonplantation areas. Eucalyptus, for example, is considered an invasive species in many parts of Africa.

Many international organizations, such as the World Bank and the United Nations (UN), have clear policies for their funding programs that support plantation forests. The UN Report on the Environment and Development from the 1992 Earth Summit acknowledges that both natural and planted forests "should be sustainably [*sic*] managed to meet the social, economic, ecological, cultural, and spiritual needs of present and future generations." The World Bank also has a forest policy, revised in 2002, which specifically mentions plantation forests: "The Bank does not finance plantations that involve any conversion or degradation of critical natural habitats, including adjacent or downstream natural habitats." While these organizations recognize the need for plantation forests, they also recognize the possible adverse ecology impacts of monoculture plantations.

SEE ALSO: Forests; Forest Management; Plantation; Timber Industry.

BIBLIOGRAPHY. P. Marchak, *Logging the Globe* (McGill-Queen's University Press, 1995); D.M. Richardson, "Forestry Trees as Invasive Aliens," *Conservation Biology* (v.12, 1998); J.W. Turnbull, "Eucalypt Plantations," *New Forests* (v.17, 1999); *United Nations Non-legally Binding Authoritative Statement of Principles for a Global Consensus on the Management, Conservation, and Sustainable Development of all Types of Forests* (United Nations, 1992); World Bank, "Operational Policies: Forests," www.worldbank.org (cited April 2006).

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Plants

THERE ARE AT least 400,000 known species of plants in the world. Vast numbers of plants have existed in earlier geological eras, a great number of which are now extinct. Of the plants that exist today, most belong to a group of "higher plants" that have roots, stems, and leaves, and that produce seeds in order to reproduce. Plants range in size from a single cell to giant sequoia trees, which can grow up to 240 feet (80 meters) tall.

Biologists have classified all living organisms into two kingdoms—the animal kingdom and the plant (Plantae) kingdom. Plants are distinguished from animals because most animals can achieve locomotion at will, while plants are rooted and cannot move to a new location unless carried by water or wind. Plants compensate for this lack of mobility by giving movement to their seeds. Many plants produce fruits that are eaten by birds and then deposited elsewhere. Some plants simply drop their seeds to the ground where they are moved by water, insects, or animals; others, such as cottonwood and maple trees, use the winds to broadcast their seeds.

Plants also differ from animals in their growth cycles. While animals stop growing at maturation, plants continue to grow until they die. They grow thicker in their stems, their roots deepen, and new growth is added. Some plants have short life spans while others live for centuries. Some trees live for thousands of years; there are trees that are estimated by biologists to be 5,000 years old.

PLANT FOOD PRODUCTION

Another difference between plants and animals is that plants can produce their own food, while animals eat either plants or other animals. The roots, stems, and leaves of plants are used to manufacture food. Roots take in water and minerals like calcium, iron, nitrogen, phosphorous, and potassium, then use these and other chemicals to make food. In order to do so, the water and nutrient chemicals have to reach the leaves. Because the nutrients travel through the stem of the plant the process can be a long journey in tall trees. In most cases the stem has vascular tissue through which the nutrients travel. As the water moves from one cell to another it eventually reaches xylem, which is a complex plant tissue. Xylem is formed into long tubes or vessels through which the water carries dissolved salts of the nutrient chemicals.

Eventually the fresh nutrient supply reaches the leaves of the plant. At the same time, food from the leaves of the plant, often in the form of some type of sugar, moves down the xylem in a liquid watery solution in tube-like cells called sieve cells. These cells have little holes in the wall of the tube that act like a sieve, allowing food to pass to the plant. The sieve cells are supported by phloem cells. These are plant tissues that are in parallel with the xylem tissues. A third type of plant tissue called cambium separates them. This tissue provides support and also keeps the nutrient solution separate from the food solution.

Plants also have a variety of stems—the trunks of trees, for example, are large stems. Some are underground stems, such as rhizomes, which send roots deeper into the soil while forcing branches to the surface, where leaves can grow. Some stems are climbing stems and use tendrils for support, like ivy plants; other plants, such as tulips and daffodils, have bulbs as stems. Plants are the only organisms that can convert inert matter into living matter. Plants absorb nutrients from the earth, from water in which they grow, or even from the air. An example of a plant that absorbs nutrients from the air is spanish moss. Some plants, such as fungi, do not manufacture their own food. Some of these are parasitic, such as the dodder plant, which begins life rooted in the ground, but then grows like a vine around its host plant, sucking water and nutrients from the host. Meanwhile, its own root dies and it becomes permanently attached to its host.

PHOTOSYNTHESIS

The leaves of plants convert carbon dioxide, water, and nutrient chemicals into plant food via a process called photosynthesis. Without this process there would be little or no life on the planet. Most leaves have two parts: The lamina is the leaf's blade; the petiole is its stalk. There are plants that have leaves that grow directly from the stem—these plants do not have a petiole. The petiole extends to the tip of the leaf and branches out to form its veins. Water and chemical nutrients flow through the veins of the leaf where they will be used in the making of the plant's food.

Leaves vary widely in shape and placement upon the stem. A cross section of a leaf would show that it has layers of different kinds of tissues. The epidermis is the leaf's surface. Below the epidermis surface layer are the palisade layers, which have long, food-producing cells containing chloroplasts. There are also palisade cells and spongy cells. Thousands of holes called stoma allow air to circulate between cells. Leaves usually have a glossy or waxy side that faces the sun, and many plants have leaves that can move to face the sun. Sunflowers have a large flowering head that moves with the sun during the day. Leaves absorb sunlight through the lamina, which also takes in carbon dioxide directly from the air.

Respiration takes place continually in a plant as the cells use energy, in the form of glucose, to make food. It happens in a nucleus where a jelly-like substance, cytoplasm, is surrounded by a cell wall. The nucleus uses its coded information to make a new plant, and it also can control energy production in the cytoplasm. Aerobic respiration in plants uses oxygen for the air, as do animals, but plants produce more oxygen than they use. The surplus oxygen is used by other organisms. While some plants use respiration, others do not. There are plants that breathe with anaerobic respiration. This process breaks down carbohydrates to form other chemicals; among the chemical by-products are alcohol and lactic acid.

The food making process of photosynthesis is a complex chemical process that can only take place in daylight. The leaves of the plant trap sunlight with chlorophyll. The green pigment chlorophyll is located in the chloroplasts, where the photosynthesis process takes place. Plants have pigments in their leaves other than chlorophyll, but the green chlorophyll so dominates the leaf that other pigments, such as the reds, browns, and yellows of fall foliage, are not seen until the chlorophyll is destroyed.

The structure of a chloroplast begins with a membrane on the outside. It has a stroma, which is a layer covering the thylakoid and the grana. The thylakoid is composed in sheets, as is the grana, which contains the chlorophyll. Through the photosynthesis process the plant makes carbohydrates and oxygen. The oxygen is expelled through the stoma air holes and the carbohydrates are dissolved in watery solutions that are transported to other parts of the plant to be used as sugars or starches.

FOOD AND WATER STORAGE

Sugars or starches may be stored in the plant as pigments or fats. For example, the avocado plant produces fruits that are fatty in content. Others, such as dates, beets, or sugarcane, are high in sugar content. Plants store food in roots, leaves, and seeds. An example of a plant that stores its food in roots is the potato plant. The mature tubers are very high in starch content, having grown as the plant stored food from the photosynthesis process as carbohydrates in the tubers.

After the plant has converted nutrients, water, and carbon dioxide into food through photosynthesis, it also uses a process called transpiration. The water that the plant has drawn to its leaves is used to make food and also to deliver it to the plant's cells. However, a great deal of the water is breathed out as water vapor through the plant's leaves. A tree can expel or breathe out hundreds of quarts (or liters) of water a day.

Some of the water that a plant transpires is lost through its stem, and some is lost through flowers. However, the bulk is lost through stomata. The water that is lost evaporates, cooling the leaves of the plant and regulating the plant's temperature. The stomata, through which respiration and transpiration take place, are flanked by guard cells that control their closings and openings. Opening allows air to enter into a sub-stomal chamber. The leaves of plants from moist or humid climates have flat surfaces that allow water vapor to easily pass through the stomata opening and into or out of the leaf.

In order to control their use of water, plants have adapted many mechanisms and leaf structures. In the winter deciduous trees lose their leaves and go dormant. The process of shedding leaves annually is called abscission. In temperate and polar seasons the leaves are shed during the autumn in preparation for winter; in wet-dry climates the abscission takes place in the dry season.

Evergreen trees and plants are sometimes called semi-deciduous. In winter, conifers keep their needle-like leaves, which are adapted to continue respiration and transpiration even in winter. In desert climates cacti function well without leaves, storing water in their stems. The waxy surface of the plant reflects the sun and regulates the temperature of the plant, allowing little water to escape.

REPRODUCTION

Gymnosperm plants do not use ovaries to enclose their seeds, while angiosperms have flowers that are pollinated to produce seeds enclosed in an ovary. Conifers such as pine trees and fir trees are the best known of the gymnosperms. They enclose their seeds in woody cones, which are male or female. Ovules form on the scales of female conifer cones, while pollen forms on the scales of the male cones. Wind carries the pollen from the male cone to the female cone.

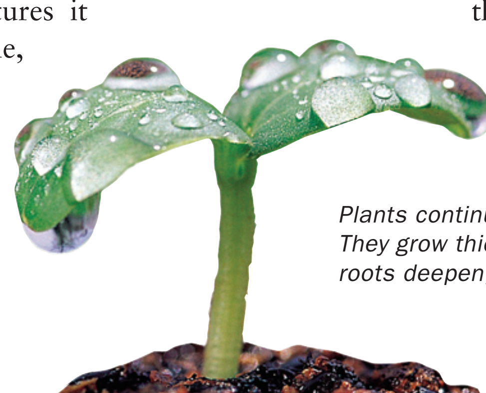
There are two groups of angiosperms. The dicotyledons have two seed leaves; monocotyledons have only one seed leaf. Wheat seeds are monocotyledon because upon germination only one leaf appears at first. However, beans are dicotyledons because as the seed embryo matures it has two seed leaves. For example, roasted peanuts when split reveal what looks like the head of a man with a bow tie—the bow tie is actually two cotyledons, which means the peanut seeds will germinate as dicotyledons.

The flower is the main reproductive part of the angiosperm. When the flower is mature it opens anthers in order to let out pollen grains. Many plants use insects to assist with pollination; others allow their pollen to be carried by the wind. Western junipers and southern pine trees will emit so much pollen that cars and other surfaces will be coated in yellow pollen dust for days during pollination. Some plants are capable of self-pollination, but others need a pollinator. Varieties of plums or pears are good at pollinating, while other fruit trees will not produce unless pollinated. Some trees such as holly have males that provide pollination for the females, which have the characteristic red berries.

A flower usually has a male and a female part. The stamen is the male part and has delicate filaments that hold grains of pollen that contain the active sex cells of the plant. The pistil is the female part of the flower. It has at least one carpel; the carpel has an ovary, inside of which are ovules that contain sex cells. At the far end of the pistil is the sticky surface of the stigma, which receives the pollen grains with the sex cells of the male portion of the flower. Protecting the stamens and the carpels are the sepals and the petals, which together form the corolla. When fertilization takes place, the pollen is transported from the flower's stamen to its stigma. After the pollen falls on the stigma, it forms a long tube that goes down though a structure called a style until it reaches the flower's ovule, where fertilization takes place. Once the ovule is fertilized, the flower will shed its petals.

The ovary takes food from the plant's leaves, and as it does, the seed or seeds develop rapidly. The seed is covered in a tough protective coating and contains an embryo plant made up of a root, a shoot, and one or more shoot leaves (cotyledons).

There are many ways in which the ovaries of plants develop after fertilization. Some dry out. Others become fleshy or develop filaments that are so delicate they can be blown about on the winds—dandelions, for example, use the wind to spread their seeds. Others plants,



Plants continue to grow until they die. They grow thicker in their stems, their roots deepen, and new growth is added.

such as wisteria, use an explosive rupturing of the seed pod to propel seeds some distance from the parent. Plants may also depend on animals such as birds. Birds eat the seed, but only the fleshy outer portion is digested; the seed with its thick protective coating is passed from the bird to a new location where it puts down roots after germinating. Some seeds stick to the coats of animals—burrs and other "riders" may be carried miles before they are dropped.

After the seed reaches a moist spot it germinates. Water softens the coating and allows it to take up the water and begin growing by putting down its tap root and sending up shoots. Sometimes fruit flesh serves as a built-in fertilizer. The fleshy part is covered with a skin. A drupe is a fleshy fruit with a stone-like pit or seed that is covered with a fleshy fruit. The skin is called the epicarp and covers the fleshy mesocarp, which in turn covers the hard shell that contains the seed. The seed is an endocarp and it contains the embryo plant.

A few plants do not produce seeds but instead reproduce using spores. Lichen, which is a form of algae living in a symbiotic relationship with fungi, reproduces with spores. Lichens grow on a number of surfaces including on rocks and tree trunks. Other plants such as ferns or mosses have spore capsules on the underside of the leaves or fronds. When a moss spore capsule is mature it drops to the ground and germinates; each spore then develops a thin branch or protonema on which a bud grows.

ADAPTATION

From mountaintops to seas, from deserts to swamps in the tropics, plants have found ways to adapt to the enormous climatic variations of the earth. They have also adapted to soil and moisture conditions. For a vast number of plants, conditions in temperate zones are nearly ideal, except for the presence of other plants that compete for soil, moisture, and sunlight. In other environments, such as jungles, the hot, moist growing conditions are too favorable. Enormous numbers of plants crowd together to capture every bit of space for rooting, for water, and for sunlight. Taller plants will capture the sunlight and shade out small growing plants. To meet this challenge, some plants grow as vines to reach the sun.

Orchids are epiphytic plants that grow in the heights of trees. Some grow on branches and others on tree trunks in order to reach the sunlight. These types of plants have no roots for obtaining moisture so they get it through their leaves or through fine-haired roots that hang in the moist air. Their aerial roots also capture minerals, especially when the plant is near oceans that cast water vapor into the atmosphere containing salts that the plant can use. Others plants use leaf structure to capture water—the bromeliad has a leaf that forms a basin shape in which water is retained for the plant's use.

Some plants, such as mangrove trees and willows, have adapted to living in or next to water. Others, such as the herb water crest, live in water with their leaves on the surface. Water lilies are rooted in the muck of ponds but have a stem that supports a leaf that floats on the pond's surface. Other plants live completely under water—many seaweeds never reach the surface. In order to gather nutrients in a nutrient-poor environment, plants have adapted a number of strategies. Insectivorous plants feed on insects. The pitcher plant uses a scent to attract insects, then traps them in a watery solution where they drown and are dissolved for their nutrients. Others use traps that spring shut or have sticky hairs that trap the insect much like a spider's web.

CULTIVATION

Agriculture is the human activity of growing plants for use. Because of the usefulness of plants, people have been cultivating them for at least 12,000 years. Cultivation of plants depends upon the character of the plant. For example, viticulture—the cultivation of grapes—involves more that just planting grape vines. The vines have to be pruned each year in order to stimulate growth of grapes. Otherwise all of the growing energy would be put into new vines and leaves. Plants such as coffee or tea are grown for their stimulating effects; others are grown for the intoxication value. Beer is brewed from wheat and a great many other plants such as rice, coconut, chocolate, and fruit juices can be used to produce alcohol. Plants such as marijuana and poppies can produce addictive drugs that can also be used medicinally.

Plants are uniquely important in the ecology of the earth because they supply life-giving materials to other creatures. They make their own food by combining water, carbon dioxide, and mineral salts with sunshine. Green leafy plants are the beginning of the food chain. Some of these exist in the oceans or other bodies of water. Herbivores are animals that eat only plants; they include deer, buffalo, cows, rabbits, and many others. Carnivores, in turn, eat the flesh of herbivores. The waste materials of both are returned to the soil as droppings that can be used later by plants.

Plants also provide humans with food, fiber, and shelter; people have been using plants for the entire history of the human race. The earliest humans gathered nuts and berries and used vegetation for shelter. This is still the case with millions of people living close to nature even now.

SEE ALSO: Agriculture (including Agricultural Revolution); Biodiversity; Carbon Dioxide; Desert; Ecology; Food Webs (or Food Chain); Gardens; Greenhouse Effect; Greenhouse Gases; Herbicides; Organic Agriculture; Oxygen; Urban Gardening and Agriculture.

BIBLIOGRAPHY. J.N.B. Bell and Michael Treshow, eds., *Air Pollution and Plant Life* (John Wiley & Sons, 2002); Tom Brown, *Tom Brown's Guide to Wild Edible and Medicinal Plants* (Penguin Group, 1995); Brian Capon, *Botany for Gardeners* (Timber Press, 2005); Peter J. Davies, *Plant Hormones* (Springer-Verlag, 2004); P.M. Dey and Jeffrey B. Harborne, eds., *Plant Biochemistry* (Elsvier Science & Technology Books, 1997); Matthew J. Dickinson, *Molecular Plant Pathology* (Taylor & Francis, Inc., 2003); Michael A. Dirr, *Manual of Woody Landscape Plants: Their Identification, Ornamental Characteristics, Culture, Propagation and Uses* (Stipes, 1998); Linda E. Graham, Lee Warren Wilcox, and Jim M. Graham, *Plant Biology* (Prentice-Hall, 2002); Stephen J. Lippard and Jeremy M. Berg, *Principles of Bioinorganic Chemistry* (University Science Books, 1994); Richard H.H. Liva, Joseph C. Neal, and Joseph M. DiTomaso, *Weeds of the Northeast* (Cornell University Press, 1997); Henry Marc et al., eds., *American Horticultural Society A to Z Encyclopedia of Garden Plants* (DK Publishing, 2004); James D. Mauseth, *Plant Anatomy* (Benjamin-Cummings Publishing Company, 1987); James D. Mauseth, *Botany: An Introduction to Plant Biology* (Jones & Bartlett Publishers, 2003); Murray W. Nabors, *Introduction to Botany* (Benjamin Cummings, 2003); Peter H.H. Raven, Ray F. Evert, and Susan E. Eichhorn, *Biology of Plants* (W.H. Freeman Company, 2004); Thomas L. Rost et al., *Plant Biology* (Thomson Brooks/Cole, 2005); Louis M. Schoonhoven, J.A. van Loon Joop, and Marcel Dicke, *Insect-Plant Biology* (Oxford University Press, 2006); Wayne A. Sinclair and Howard H. Lyon, *Diseases of Trees and Shrubs* (Cornell University Press, 2005); George W. Symond, *Shrub Identification Book* (HarperCollins, 1973); George W. Symond, *Tree Identification* (HarperCollins, 1973); Alan Toogood, ed., *American Horticultural Society Plant Propagation: The Fully Illustrated Plant-by-Plant Manual of Practical Techniques* (DK Publishing, 1999).

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Plastics

PLASTICS ARE MATERIALS that can be molded, spun, or shaped to make products for human consumption. Plastics may be natural or synthetic. Natural plastics are materials such as asphalt, bitumen, cellulose, horn, rubber, shellac, tortoise shell, and waxes. Humans have crafted products for millennia using natural plastics. Ancient peoples in all parts of the globe used natural plastics for decorative or functional purposes. The ancient Egyptians soaked the winding cloths for mummies in natural resins to protect the body of the deceased from decay. Musical instruments, parts of weapons, or other devices have been made in part or in whole from the horns of sheep, cattle, or other animals.

In the 1850s, shellac, a resinous secretion of the lac insect, was imported from southern Asia into the United States, where it was patented as a natural plastic. Another natural plastic from southern Asia was gutta percha, which is sap from trees of the same name in Malaysia. It was used to insulate electric wires that were just coming into use. In 1897, milk was used to develop casein plastics. Other natural plastics materials derived from tropical forests, such as rubber, began to be employed by manufacturers.

By 1900, scientists were finding more ways to manufacture modified natural plastics, such as artificial horn, celluloid film, and cellophane. While natural plastics were useful, there were drawbacks to using them. The supply was insufficient and unreliable. They were not always amenable to being molded, and they were prone to degrading or, in the case of celluloid, were highly flammable.

In the early 1900s, developments in the coal and oil industry made available vast quantities of material that could be employed in the manufacture of synthetic plastics. In 1909, Leo Hendrik Baekeland, an American chemist, created Bakelite. Baekeland developed a thermosetting synthetic resin (phenolic resin). His invention was commercially successful and was employed in telephones, pot handles, and many other products. As research into the chemistry of long chain organic polymers expanded enormously, many new ways to combine or modify them to make synthetic plastics were developed. In Germany, the I.G. Farben Company discovered how to make polystyrene and polyvinyl chloride by 1932. In the mid-1930s, it patented polyepoxide (epoxy). In 1937 Friedrich Bayer & Co. invented polyurethane. Du Pont's research team, led by Wallace Carothers, discovered how to synthesize vinylacetylene with chlorine to make synthetic rubber (neoprene) in 1930. In 1935, Carother's team found that a polyamid formed by combining hexamethylene diamine and adipic acid produced nylon. His discovery of nylon made parachutes available in vast quantities.

After World War II, more new plastics were invented. The textile industry began to use many plastic fibers, which were blended with natural fibers and marketed as polyester blends. Among the new products were Tupperware, plastic bottles, film, and safety helmets. Thermoplastics (polysulfone) were used in facemasks or in hospital equipment. Everything from spacecraft parts to artificial body parts are now made with plastics.

While plastic manufacturing has been refined in the last 50 years, biodegradability is still in experimental stages.

MANUFACTURE

Plastics are made from synthetic resins. The resins are made from chemicals manufactured from natural sources such as coal, petroleum, salt, water, and limestone. Chemically, synthetic resins are long chain polymers. Monomers are used to build the polymers by combining them together with chemicals such as ammonia and benzene. The process of polymerization joins the monomers into long chains of atoms and molecules.

Plastic products are manufactured by molding, casting, laminating, extruding, or calendaring. Other methods include vacuum forming and press forming. Molded plastic products are formed by squeezing a molten resin into a mold that will be hardened by pressure and by chemical reactions. Thermoplastic resins harden when they are allowed to cool, while thermosetting resins harden under heat and pressure. Once set, the plastic object is permanently molded.

Casting is similar to molding, but the plastic resin is poured instead of squeezed into the mold. This method is useful when using thermosetting and thermoplastic resins. Other casting resins contain acrylic, polyimide, polyurea, and silicone adhesives. Often, the casting resins are mixed with a hardener. They are used to make semiconductors and insulated parts for generators, transformers, switches, and circuit breakers, and even in artwork. Some photonic and optical equipment made with casting resins use polymers and elastomers. Formica table or counter tops are made with the laminating method of applying plastics. Vast quantities of laminating plastics are sold to businesses and home users.

Extruding forces solid resin material into a heating device that then pushes (extrudes) it out through an opening to form products such as fibers, garden hoses, piping, gaskets, or tubing. The extruded material may be forced through a rectangular opening that will form molding. The textile industry uses vast quantities of synthetic fibers for products such as carpet. Calendaring pushes plastic resins between rollers to coat different products, such as plastic cards used in business or other services. Plastic film is made by extrusion and by calendaring.

ENVIRONMENTAL IMPACT

The amount of plastic consumed every year has grown greatly over the last 50 years. Unfortunately, so has the negative impact of plastics upon the environment. Apart from the petroleum and other materials used to make plastics, discarded plastic products remain in the environment for a long time. Large amounts of waste are dumped into landfills. Also, large amounts scatter as unsightly trash. Efforts to reduce the amount of plastics have focused on recycling. Great quantities of plastics are reused after they have been melted and recast into other products. Plastics are also incinerated for energy.

Some progress has been made toward making plastics much more biodegradable. Nylon naturally degrades in direct sunlight because the light breaks some of the bonds in the polymers; researchers are seeking ways to ensure that more plastics will degrade in sunlight. Another way to ensure that plastics degrade is to add starch-based resins to the formula. However, the "rotting" is only partial. Researchers are also experimenting with plastic-eating bacteria to create biodegradable plastics, and two nylon-eating bacteria have been identified. These methods are in the experimental stage because of costs and the danger that bacteria could evolve and end the age of plastics.

SEE ALSO: Consumers, Economic; Packaging; Petroleum; Recycling; Rubber; Waste, Solid.

BIBLIOGRAPHY. A.J. Clarke, *Tupperware: The Promise of Plastic in 1950s America* (Smithsonian Institution Press, 1999); Daniel Imhoff and Roberto Carra, *Paper or Plastic?: Searching for Solutions to an Overpackaged World* (Sierra Club Books, 2005); J.L. Meikle, *American Plastic: A Cultural History* (Rutgers University Press, 1995); Nabil Mustafa, *Plastics Waste Management: Disposal, Recycling and Reuse* (Marcel Dekker, 1993); National Research Council, *Clean Ships, Clean Ports, Clean Oceans: Controlling Garbage and Plastic Wastes* (National Academies Press, 1995); J.W. Plunkett, ed., *Plunkett's Chemicals, Coatings and Plastics Industry Almanac: The Only Complete Guide to the Chemicals, Coatings and Plastics Industry* (Plunkett Research, Ltd., 2005); T.L. Richardson and Erik Lokensgard, *Industrial Plastics* (Thomson Delmar Learning, 2003); Trevor Starr, *Composites: A Profile of the World-Wide Reinforced Plastics Industry, Markets and Suppliers* (Elsevier Science Publishing Company, 1999).

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Poaching

POACHING IS THE act of stealing animals or plants from areas in which they are protected. The motive for poaching may be food or economic gain. The latter reason has gained in significance since the beginning of the 20th century, when international trade in animals and plants was stimulated by rising demand and prices and, concomitantly, falling supply of the creatures involved. The intensive poaching of, for example, elephants and rhinoceroses, for ivory and horn respectively, have led to the almost catastrophic decline in numbers of those animals. This has had a broad negative impact on the environment in which they live.

Poaching may provide a profitable living for many people but, in addition to its illegality, it is not a sustainable practice as market forces lead to the extinction of the creatures concerned. In many countries in Africa and elsewhere, there is constant conflict between poachers and local authorities seeking to stop the poaching. Violence is often a part of this conflict because of the availability of weapons customarily used in capturing animals, and because of the high stakes nature of the activity.

Poaching extends around the globe. In Siberia and Myanmar, poachers aim to log precious hardwoods; in many oceans, illegal whaling takes place for culinary purposes. In British waters, fishing boats from mainland Europe and farther away take large catches of the dwindling supply of fish in acts that many people consider poaching. It is estimated by some that there will be no more edible fish in the world's oceans within two decades. However, these figures are contested. Most economically important fish species have quotas imposed to try to prevent overfishing, but while sustainable quota levels are also contested, it is apparent that many involved in fishing are routinely exceeding their quotas, while also destroying many other species through bycatch. The value attached to fish products in some markets justifies the risks that poachers take.

The prices of abalone, shark's fin, and tuna in some East Asian markets represent attractive opportunities for would-be poachers. The same is true for those who seek to kill and harvest body parts from animals for use in traditional remedies and tonics, such as those in Chinese medicine. Although markets have opened in other countries, rapidly rising affluence in China has made it particularly significant in the context of poaching. A number of Chinese people have responded to increasing affluence by seeking to obtain expensive medicines and exotic bush meat. It is believed that the crowding together of so many different species of animals in unsanitary surroundings in southern China brought about the conditions in which the lethal virus SARS first originated.

Designating poaching as illegal requires that property rights of some sort be enacted by the state, both to regulate access to land and to give the state rights to ownership of animals and plants within designated areas. Alternatively, private property rights can be used by landowners to claim the same protection from poaching. In countries such as Britain, where an aristocratic elite has historically dominated land ownership, poaching was legally met with armed responses. Poachers, who were motivated primarily by hunger, were liable to severe punishment and even execution. Landowners' control of the creatures resident on their lands has contributed to popular revolutions in a number of countries. In recent years, attempts to end poaching have focused both on prevention, possibly through the use of armed wardens and high technology monitoring equipment, and on persuading potential poachers to undertake other activities.

Since the absence of suitable alternatives led people to take up poaching in the first place, reducing poaching often means developing new forms of work and income for local people. This can be an expensive undertaking and some people will consider it unfair when extra resources are devoted to people who have turned to crime. An additional way of inhibiting poaching is through education and through ratification of the Convention on International Trade in Endangered Species (CITES), the relevant international contract.

SEE ALSO: Animal Rights; Animals; Convention on International Trade in Endangered Species of Wild Fauna and Flora; Endangered Species; Extinction of Species; Hunting; Overfishing.

BIBLIOGRAPHY. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), www.cites.org (cited November 2006); Carolyn Fischer, "The Complex Interaction of Markets for Endangered Species Products," *Journal of Environmental Economics and Management* (v.48/2, 2004); Anne Borge Johanessen and Anders Skonhoft, "Tourism, Poaching and Wildlife Conservation: What Can Integrated Conservation and Development Projects Accomplish?" *Resource and Energy Economics* (v.27/3, 2005); World Wildlife Fund, www.wwf.org (cited November 2006).

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Point Source Pollution

FOLLOWING THE PASSAGE of legislation in the 1960s and 1970s aimed at cleaning the air and waters in the United States, rigorous efforts have focused on point source pollution control. The term identifies sources of pollution that emanate from a discreet and clearly identifiable point. The Environmental Protection Agency lists the following structures that fit the definition: pipes, ditches, channels, tunnels, conduits, wells, rolling stock concentrated animal feeding operations (CAFO), landfill leachate collection systems, water-borne vessels from which pollutants may be discharged.

Point source is distinguished from "non-point" source pollution, such as precipitation runoff from an urban area that is not caught in a sewer system, or agricultural pollution from the seepage into the soil of fertilizers and insecticides. Discharge from a power plant smoke stack is an example of point source pollution. Other sources include discharged waste water from industrial plants and municipalities through pipelines. If the materials that are being discharged are not treated to remove pollutants, the effects on air and water can be degrading. Even treated effluents can still have a measure of pollutant material in them. It is the amount of pollutant material in treated water that demands regulation.

REDUCING WATER POLLUTION

In the case of water pollution, the Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) in 1972. This agency issues permits to regulate the amount of pollutants carried in water discharged from industries and municipalities into surface waters. Under the NPDES legislation, licenses are issued specifying the quantity and quality of pollutants that may be legally discharged. Staff members of the Environmental Protection Agency will periodically monitor the sites and collect sample of the effluent to determine if discharges are within the legal limits. Since the enactment of the NPDES, the amount of point source pollution has significantly decreased nationwide.

A case in point is the reduction in point source pollutants entering the Expansive Chesapeake Bay on the Atlantic seaboard. In the 1987 Chesapeake Bay Agreement, a document that addressed the immense value of this body of water, a goal was set to reduce the level nitrogen and phosphorous by 40 percent by 2000 from the 1985 levels. This degree of reduction of these chemicals would not only cut pollution but also increase oxygen levels in the waters and stimulate the growth and survival of aquatic life. In the 1992 amendment to the agreement, it was agreed to continue the 40 percent reduction in pollutants beyond 2000. The agreement is a complex one given that three states (Pennsylvania, Maryland, and Virginia) and the District of Columbia each developed strategies to achieve the reduction goals.

The process involved in implementing the reduction goals is also complex. Pont sources in each municipality located on Chesapeake Bay were required to implement a Biological Nutrient Removal (BNR) program. In this process, nutrients are removed from municipal waste water in addition to solid waste. The BNR process for removing nitrogen begins with the conversion of ammonia to compounds of nitrites (nitrification), which stimulates the growth of nitrogen consuming bacteria. The next step (denitrification) transforms nitrites to nitrogen gas through the action of nitrite converting bacteria.

Similar reductions in point source pollution have occurred in Texas. Since the enactment of the NPDES, the state has seen a 70 percent reduction in the amount of pollution from municipality waste water. At the same time a number of firms in the state were issued "no discharge" permits due to the degree of pollutants contained in the effluent. In these cases, the retained waste water is evaporated or used in irrigation systems. For a number of agricultural activities in Texas (poultry, dairy and feedlot operations), "no discharge" permits have been issued. This precludes the discharge of animal waste into surface water and mandates its retention in secure ponds.

SEE ALSO: Clean Air Act; Clean Water Act; Polluter Pays Concept.

BIBLIOGRAPHY. D. T. Chapman and A. E. Shaarawi, eds., *Statistical Methods for the Assessment of Point Source Pollution* (Springer, 2001); Hassan Daud, *Protecting the Environment from Land-Based Sources of Pollution: Towards Effective International Cooperation* (Ashgate Publishing, 2006); John Smol, *Pollution of Lakes and Rivers* (Hodder Arnold Publications, 2002); J. Jeffrey Pierce, P. Arne Vesilind, and Ruth Weiner, *Environmental Pollution and Control* (Butterworth-Heinemann, 1997); Ian L. Pepper, Charles P. Gerba, and Mark Brusseau, *Pollution Science* (Academic Press, 1996).

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Poland

HISTORICALLY, POLAND HAS had to struggle to maintain its independence from its more aggressive neighbors. After World War II, Poland became a member of the Soviet bloc; but the Solidarity movement, which gained momentum throughout the 1980s, led to a resurgence of nationalism. After the dissolution of the Soviet Union, Poland instituted major political reforms. Poland's market economy is still evolving. A per capita income of $12,700 places Poland 73rd among world incomes. Unemployment is high at 18.3 percent, and 17 percent of the population live below the poverty line. The United Nations Development Programme Human Development Reports rank Poland 36th among nations of the world on overall quality-of-life issues.

Bordering on the Baltic Sea, Poland has 304 miles (491 kilometers) of coastline. The temperate climate produces cold, rainy, moderately severe winters. Summers are mild with frequent precipitation. Flooding is a common threat throughout the year. Except for mountains along the southern border, Poland's terrain is mostly flat. Around 46 percent of the land is arable, and over 16 percent of the workforce is engaged in the agricultural sector. Other natural resources include coal, sulfur, copper, natural gas, silver, lead, salt, and amber.

The Soviet presence in Poland resulted in heavy industrialization and substantial environmental damage. The true extent of the environmental attrition was revealed only in the post-Soviet era with a legacy of heavily polluted air, water, and soil and severely damaged forests. Some 60,000 tons of banned pesticides continue to be stored in Poland, and 25,000 tons of these are stored on farms scattered around the country, creating a potential ecological disaster.

In 1991 the government recognized that the most extensive damage had occurred in heavily industrialized Upper Silesia, which is home to 11 percent of the Polish population. Studies revealed that infant mortality was nearly five times the rate of Western European nations and that total life span was four years lower than that of the rest of Poland. Cancer rates were also abnormally high. Rates of circulatory and respiratory disease were elevated, and high levels of lead were discovered in the bloodstreams of children in the area. Indiscriminate waste disposal in the area had also led to 29,653 acres (12,000 hectares) of land being declared unfit for future cultivation.

A study in 1990 revealed that 65 percent of rivers in Poland were polluted enough to corrode industrial equipment. The Vistula River carried these pollutants into the Baltic River, spreading contamination. Such contamination meant that river water could not be used for irrigation, and only 5 percent of river water was potable. Acid rain spread further pollution into the lakes and threatened two-thirds of the nation's forests. Major damage had also taken place on military bases where raw sewage had been released and vegetation had been annihilated by heavy equipment.

All national and regional parks and reserves had also been polluted. Today, some 12.4 percent of Polish land is protected. Fifteen of 84 mammal species endemic to Poland are threatened with extinction, and four of 233 endemic bird species are endangered. Overall cleanup costs of the Soviet occupation were estimated at $3.4 billion. Predictably, the Soviets refused to bear any of the expense. However, other countries offered assistance through grants, loans, and debt forgiveness and provided expert and technical advice.

In the 1980s, public activism accelerated in Poland in response to the ongoing environmental situation and to the construction of a Czech coking plant near the Polish border and the Chernobyl disaster in 1986. The government established the Ministry of Environmental Protection and Natural Resources and began passing new environmental laws. In 1990 Poland announced a new policy of "ecodevelopment" designed to force industries to modernize and restructure using environmentally friendly technology. The following year, the national policy was put in place, with an emphasis on polluters bearing responsibility for the damage they caused. With the help of the United States and several European nations, the ministry developed a list of 80 enterprises most responsible for the pollution and placed them on notice that they would be closed if pollution levels were not reduced. The State Environmental Protection Inspectorate was established to enforce environmental regulations.

Despite the new commitment to environmentalist, air pollution from sulfur dioxide is still emitted from coal-fired power plants, posing serious health risks. Acid rain generated from the same source persists in damaging forests and ecosystems. Almost 62 percent of the Polish population live in urban areas. With 259 cars per 1,000 people, Poland produces 1.3 percent of the world's carbon dioxide emissions. Water in Poland is still polluted from industrial and municipal sources. Efforts to meet European Union (EU) standards continue, but the costs of doing so remain high. In 2006 a study by Yale University ranked Poland 38th of 132 nations on environmental performance, in line with its economic group but below the geographic group average. Poland was ranked particularly low on biodiversity and habitat protection.

Poland's commitment to the global environment is demonstrated by its participation in the following international agreements: Air Pollution, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Seals, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. The Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, and Air Pollution–Sulfur 94 agreements have been signed but not ratified.

SEE ALSO: Acid Rain; Cancer; Carbon Dioxide; Chernobyl Accident; Coal; Industrialization; Lead; Pesticides; Polluter Pays Concept; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Central Intelligence Agency, "Poland," *The World Factbook,* www.cia.gov (cited March 2006); Country Studies, "Environment: Poland," www.country-studies.com (cited March 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); United Nations Development Programme, "Human Development Reports: Poland," hdr.undp.org (cited March 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); David Wallace, *Environmental*

Rebuilding Warsaw

The city of Warsaw was badly bombed by the Germans in their 1939 invasion of Poland and suffered greatly during occupation. The German plans to destroy the Jewish ghetto led to the Ghetto Uprising in April 1943; in August 1944 the Warsaw Uprising saw further damage to the city. When the Germans retreated from Warsaw soon afterward their soldiers destroyed much of what had survived. Adolf Hitler, in one of his last speeches to the German Reichstag, declared that Warsaw was no longer a name on the map of Europe. Some 850,000 inhabitants of Warsaw, or two-thirds of the prewar population, were dead or missing. General Dwight Eisenhower described the ruins of Warsaw as the most tragic sight he had ever seen. Some suggested that Poland should reestablish its capital in another city.

Nevertheless, in 1945 planning began for the rebuilding of the city, which took ten years. Much of the heart of the old city was rebuilt, with the master plan involving collecting information on all the historic monuments and buildings in the Old Town so that they could be rebuilt to look as they did before the war. In other parts, ruins were replaced by "socialist functionalism" and large numbers of industrial factories. The need to house tens of thousands of people immediately after the war resulted in many prefabricated concrete apartment blocks, giving some parts of the city a dismal quality. However, it was a remarkable feat of construction, and did provide housing for many people.

In recent years new steel and glass towers have appeared throughout the city, along with many other buildings that are providing colorful contrast to the gray of the suburbs.

Policy and Industrial Innovation: Strategies in Europe, the United States, and Japan (Earthscan, 1995); World Bank, "Poland," *Little Green Data Book,* lnweb18.worldbank.org (cited March 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited March 2006).

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Policy, Environmental

ENVIRONMENTAL POLICY CONCERNS the attitudes that states, representing their people, adopt toward the environment and the need to protect or exploit it in different ways. These range from the desire to maintain nature in a pristine state to the desire to exploit all resources of the land and atmosphere without regard for the future or side effects.

Most ideologies, in common with most forms of organized religious belief, derived from a period in which agricultural lifestyles, featuring sustainable use of resources as part of folk wisdom concerning husbandry of the land, were dominant. This might have been expressed either through sacred texts outlining the role of man as part of nature or through practical education such as that provided by Buddhist monks in forested parts of East Asia.

Political ideologies that have derived from more modern history, such as communism or libertarianism, tend to have been created in periods in which industrial activities dominated agricultural activities. They are therefore more likely to support extraction of resources to facilitate more production. In these cases, the purpose of nature is generally seen as supporting mankind's development and ascension.

As modern life has become more complex, environmental policy has both become a more recognized area of concern in its own right and broadened to engage with numerous issues. Solid waste management, apportioning fishing rights, controlling industrial pollution, and addressing global warming are all issues now included within environmental policy. Governments around the world have established specific departments to formulate and implement policies and to monitor changes. Evidence of global warming and the effects of pollution have sparked worldwide interest in environmental issues, leading to increased involvement in voluntary organizations and growing pressure on elected politicians to adopt what are perceived to be environmentally-friendly policies.

RELIGION AND ENVIRONMENTAL POLICY

Most large religions posit that the universe and all the aspects of nature within it are created by some kind of supernatural figure. Consequently, they deem it appropriate for mankind to respect nature and not damage it heedlessly. However, in the case of a religion such as Christianity, the sanctioned sacred text of the Bible explicitly gives wardenship of the earth to humanity and, hence, provides justification for exploitation of the world, although not to the extent of damaging it. Nevertheless, when there is controversy over the meaning of sacred texts and the means of interpreting them, there may be diversity in attitudes toward nature and its use.

Most religions embrace the concept of sacred areas or lands that should be sequestered from public use; these include taboo areas such as graveyards, sacred mountains, and areas where supernatural events are said to have occurred. In some cases, this is manifested in the building of sacred edifices such as cathedrals or temples or the preservation of the area in its original state. In the kingdom of Saudi Arabia, state-sanctioned sacred places are preserved, while those from other traditions are suppressed.

These religious practices demonstrate that belief patterns are held to be directly related to acceptable and unacceptable uses of the environment. Related to this are religious dietary practices and food taboos. Historical patterns of technology use and understanding probably helped inspire beliefs that some foods were taboo. This has led to different patterns of land use insofar as some animals are excluded from entering sacred territory or, as in the case of cows in Hindu India, are allowed to wander freely.

Humanist philosophies or natural religions have often featured a profound reverence for nature that is to be manifested in the unchanging worship of the land and the life that resides within it. The philosophies of Henry David Thoreau may be considered in this light, as might the English poets William Wordsworth and John Keats. The great visionary poet William Blake saw nature as God's expression of paradise on earth and, hence, it was all the better left in an unimproved state.

Chinese painting often depicted the harmonious relationships possible between mankind and nature. This was linked to the concept that the Chinese emperor was provided with legitimacy to rule through the Mandate of Heaven and could only rule as long as the mandate was maintained. Environmental phenomena were powerful signals from heaven that the mandate was at risk or might already have been withdrawn. Earthquakes, disease, or famine could all be symbols that the temporal, the environmental, and the spiritual were all linked. Across most cultures of the world, astrological phenomena such as eclipses or comets were also believed to betoken some kind of important temporal change as mandated by supernatural forces.

A final example of a quasi-religious philosophy is that of James Lovelock's Gaia, which posits that nature and indeed the planet exist in a kind of holistic and self-regulating system. This system can manage itself sustainably within certain parameters, but there are limits to what can be managed. The impact of man upon this system is believed to have exceeded the self-healing limits, making it time for more radical policies to remove or at least nullify that influence. In extreme cases, this has led some people to the position that no more use of environmental resources should be permitted and that all forms of industrialization are now unsustainable and should be ended. This policy would call for a huge reduction in the standard of living of the developed world so as to protect what remains of environmental resilience.

EXTERNALITIES

One of the central aspects of environmental policy is the concept of externalities. This concept refers to all of the additional impacts on the environment that a physical change can have. In terms of environmental change, forests provide a facility for sequestering carbon from the air and for providing aesthetic and recreational services for people. This is in addition to the physical impact of the forest, which provides valuable logging resources and a habitat for wildlife.

Understanding, documenting, and evaluating the existing externalities related to a physical phenomenon and understanding the impact of change and interaction with other physical presences is complex and only partly completed. Since ecosystems have been known to collapse quite suddenly, it is clear that the interaction can be unpredictable and complex. In terms of policy, therefore, the role and value of externalities is contested because of the difficulty in quantifying their importance and value. Simplistically, interests who wish to develop or exploit environmental phenomena on a commercial basis will tend to argue for a low value for externalities, while those opposed to commercial exploitation will argue in the opposite direction.

Attempting to quantify the value of environmental resources has been a difficult and complex task and the various attempts have not been accepted uncontested. However, economics presents some concepts that have been useful in this attempt. This has been assisted by the recognition that many of the world's resources are not only finite, but their final depletion can now be foreseen. In particular, projections that oil resources will be exhausted within 100–120 years, based on current rates of extraction and assuming (as seems likely) that no significant new finds will be made, has focused attention on the need for substitute fuels within a generation.

POLITICAL APPROACHES

While practical implementation of policies to address these issues are only beginning at the end of the first decade of the 21st century, attempts have started to be made to place extra tax on airplane travel and the use of overly large, fuel-inefficient personal automobiles. Tradeable carbon permits are the instrument most commonly used in international agreements; these are starting to become viable, although generally only developed countries are currently expected to have to participate. There is a need for these schemes both to broaden in scope and to become more effective—this will form the basis of many future policy debates.

THE 21ST CENTURY

As it has become increasingly apparent that global climate change and warming are having an enormous impact upon the entire world, environmental policy has focused on both the struggle to persuade climate change deniers of reality and the search for solutions to which all major parties would be willing to contribute. The Kyoto Protocol Treaty, for example, was an attempt to institute a carbon trading scheme to which all developed states could subscribe. The plan was that once leading states had so subscribed, then the treaty details could be expanded in terms of geography and the cost of carbon emissions. However, the refusal of the George W. Bush administration to sign the protocol has hamstrung the agreement, since the United States is the world's leading polluter. Further, it has become difficult to persuade important developing states such as China and India, where pollution and emissions are high and increasing, of the commitment that Western countries have to mutual reduction of emissions.

In the years since the 1960s, the majority of the developing countries of the world have entered into an economic paradigm that focuses on export-oriented growth, generally supported by import-substitution. Almost the sole measure of success has become growth in Gross Domestic Product (GDP), although there have been some exceptions. The consequence has been the dismissal of claims for the environment in promoting growth. Instead, the environment has been viewed as a stage on which GDP growth can be effected.

A coalition of different interest groups has formed to resist this way of thinking, including some faith-based groups who have allied with those ideologically inspired to campaign against the relentless exploitation of the environment. At the same time, as cities around the world develop to the extent that they can provide wealthy lifestyles for their middle-class residents, their populations become increasingly concerned about such problems as access to services for people with disabilities, road safety, and the need for public spaces for aesthetic and recreation purposes. In cities such as Taipei and Seoul, for example, much debate centers on the need to improve not just the immediate environmental vicinity of the cities, but also their hinterlands. There, awareness of the interdependence of environmental systems is beginning to permeate the public consciousness.

SEE ALSO: Kyoto Protocol; Permits, Tradable;

BIBLIOGRAPHY. William J. Baumol and Wallace E. Oates, *The Theory of Environmental Policy*, 2nd ed. (Cambridge University Press, 1988); Nick Hanley, Jason F. Shogren, and Ben White, eds., *Environmental Economics: In Theory and Practice* (Oxford University Press, 1996); James E. Lovelock, *Ages of Gaia* (Oxford University Press, 1988); Donald Worster, *Nature's Economy: A History of Ecological Ideas* (Cambridge University Press, 1994).

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Political Ecology

POLITICAL ECOLOGY IS an academic field that seeks to understand human societies and their relationship to nature. Political ecology posits that environmental problems are intrinsically political and need to be understood in a broader framework that takes local as well as global actors into consideration. An important overarching goal of political ecology is to understand and participate in the forces linking social change, environment, and development. Academic studies using political ecology perspectives of analysis are appearing with greater frequency in contemporary environmental scholarship. While geographers and ecological economists have taken the lead in this endeavor, other fields, such as anthropology, history, and sociology, are joining in this collective effort. However, different shades of political ecology draw from a number of academic subdisciplines including: cultural and ecological anthropology, development theory, environmental economics, environmental studies, gender studies, environmental history, human geography, rural sociology, and postcolonial studies. The origin of political ecology was influenced by political economy, which has roots in Marxism, and has drawn on post-structuralism.

Given that an increasing number of academic disciplines are engaging in political ecology frameworks of analysis, explanations of society-nature relations have likewise become increasingly fragmented along disciplinary lines. These explanations are characterized by dualistic thinking that all too often analytically isolates physical and social phenomena. Political ecology is an interdisciplinary, nondualistic strategy that remains under development, and perhaps deliberately so, seeking to describe the dynamic ways in which, on the one hand, political and economic power can shape ecological futures and, on the other, how ecologies can shape political and economic possibilities.

Often identified with political economy, political ecology frequently takes political economy's interest in the expression and influence of state and corporate power on environmental politics and combines this with insights derived from understanding and analyzing environmental influences on social activity. In this manner, political ecology extends theoretical inquiry beyond the insights of the conventional social and natural sciences. Political ecology's ability to engage the philosophy and values of ecological justice has made it attractive to many who expect analysis to facilitate social change.

Political ecology is a fast-growing multidisciplinary field of research. It focuses on human to nature relationships and has a particular interest in connections between politics and environmental change. Human beings have evolved out of and as a part of nature, but with the increasing determinacy of human culture on landscapes, highly visible since the Neolithic period, it is hardly possible to speak of virgin natures. Even the Arctic Archipelago, far from human settlements, is exposed to radiation from the gap in the ozone layer caused by human livelihoods in other parts of the globe. The uneven vulnerability of humanity to environmental crises is increasingly being recognized, as global capitalism affects place-based peoples and transnational, mobile elites in extremely different ways.

FORMS OF POLITICAL ECOLOGY

It is possible to recognize two primary forms of political ecology. The first represents a fusion of its predecessors: human ecology with political economy. The second form, in opposition to the previous form, is a political ecology informed by poststructuralist social theory and represented by the work of Watts, Rocheleau, and others. The first form of political ecology takes as its point of departure the existence of an unproblematic material/ecological base and a series of actors, differentially empowered but with clear interests, contesting the claims of others to resources in a particular ecological context. The second (or poststructuralist) form of political ecology is characterized by the perspective that it takes nature, as well as the identities and interests of various agents, to be both contingent and problematic.

Since the 1970s political ecology has advanced an interdisciplinary approach to complex human-environmental interactions, especially those related to economic development in the third world. A primary objective has been to understand the underlying causes of human and environmental crises and identify ways to ameliorate or eliminate them. Anthropologists, geographers, political scientists, and other scholars generally use the political ecology framework to understand how environmental and political forces interact to affect social and environmental changes through the actions of various social actors operating at different scales (levels of analysis).

Recently, political ecologists have expanded their domain to include considerations of history, gender, social movements, and discursive formations. Much of the analysis centers on the role of power in mediating the relations among diverse interest groups and/or social/cultural actors. Such power is manifest in the relative abilities of actors to control access to and use of environmental resources, to transfer environmental risk to other actors, and to affect certain policies and projects (often partly through the control of public discourse).

Political ecology also acknowledges the coproduction of environmental knowledge and politics and makes use of discourse analysis to explore constructions of nature and human interaction with nature. There are diverse socioecological processes that interact to create different scales of mutual relations, which subsequently result in varied political ecologies. One of the major attributes of political ecology is that it reveals the political aspects of environmental change. The political ecology framework developed by Raymond Bryant and Sinéad Bailey is useful in this regard, as it identifies different actors vying for access to natural resources, and then interprets the political role that actors play in human-environment interactions in three ways: (1) it situates local-level findings into a larger body of theoretical and comparative perspectives; (2) it details the motivation, interests, and actions of different actor groups, focusing especially on the strengths, weaknesses, and relative power they possess in relation to other actors; and (3) it places politics at the center of political ecology, emphasizing that all human-environment interactions are mediated by politics, and that all actors, even weak ones, possess some level of agency with which they pursue their own interests.

Political ecologists critique biologists and other naturalists working for the conservation movement in that they have been unable to solve environmental problems because the nature of the problems themselves are not biological, but rather political, economic, social, and ethical. Political ecologists also note that environmental problems stem from political and economic influences that lead to an inappropriate or unjust allocation of benefits (as well as negative consequences) of natural resources and their use. They also note that policy and market failures concerning sustainable resource use are not accidental, but instead are the manifestation of laws, policies, and institutions that are the product of political, social, and economic forces that benefit powerful actors.

DEVELOPMENT OF THE FIELD

Predecessors to political ecology include a variety of orientations in cultural and human ecology in vogue from the 1950s to the 1970s. The field of political ecology can be traced to Rappaport's 1968 study of the role of ritual in human ecology among the Maori people of New Guinea. In this work, Rappaport established a new framework for examining human-environment interactions in that he examined "extralocal" (or external) linkages to regional systems.

Borne out of Rappaport's examination of larger systems was the field of political ecology, which seeks to inform understanding of how people and their environment shape each other over time. Political ecology then emerged during the 1970s in conjunction with the growing environmental movement of the era. Eric Wolf was among the first to use the term political ecology in his 1972 critique of cultural ecology and ecological anthropology, in which he emphasized the need to contextualize local ecological realities within the broader political economy. The initial step was the infusion, in the 1970s, of cultural and human ecology with considerations of political economy.

Political ecology became more significant during the 1980s and into the early 1990s, as it was perceived to improve on the weaknesses in human ecology and ecological anthropology, as they were practiced during the 1960s and early 1970s. This improvement came via the incorporation of a more rigorous political-economic framework of analysis that was strongly influenced by political economy perspectives, including systems theory and Marxism.

By the mid-1990s however, political ecology began to absorb other elements, including post-structuralist analyses of knowledge, institutions, development, and social movements, and feminist insights into the gendered character of knowledge, environment, and organizations. This resulted in the emergence of a more nuanced account of nature-society relations and political ecology. It highlighted the interwoven character of the discursive, material, social, and cultural dimensions of the human-environment relation. While empirical studies based on these frameworks have been taking place for some years, the theoretical work of political ecology is still in its early stages.

FEMINIST POLITICAL ECOLOGY

Political ecology approaches have been used as a method for analysis for other ecologies that include feminist, deep, and social ecologies. Feminist political ecology treats gender as a critical variable in shaping resource access and control, interacting with class, caste, race, culture, and ethnicity to shape processes of ecological change, the struggle of men and women to sustain ecologically viable livelihoods, and the prospects of community for sustainable development. Feminist political ecology provides an invitation to examine the power relationships that shape the environment through the insights of gender analysis, and a set of frameworks for doing so. In this way, it identifies new ways of examining gendered power relations in the shaping and use of the environment.

EUROPEAN APPROACHES

Political ecology also differs depending on whether it is being discussed within Anglo-American or European contexts. Anglo-American perspectives on political ecology tend to create a distinct dichotomy between people and the environment. European, and especially French, perspectives on political ecology instead tend to use more of a systems approach, which identifies a more holistic relationship between people and the environment. A critique that Europeans have of Anglo-American academicians is that by creating a people-environment dichotomy, they inhibit the expression of new ways of thinking about and framing environmental issues.

Given that the French arrived relatively late to the people versus environment debate, their more holistic perspectives on the environment have allowed them to pursue a variety of strategies that are grounded in systems theory and which are not centered on ecological arguments. From the French perspective, the division of environmental debates into two distinct ontological zones (human and nonhuman) is modern (as opposed to postmodern) behavior leading to purification (which sociologist Bruno Latour uses to define the total separation of nature and culture, which is a primary objective of the modern constitution), which prevents us from fully understanding hybrids of nature and culture.

For Latour, political ecology is a philosophical project with two broad aims. The first is to overcome the concept of nature as an asocial, objective source of truth. In this way, political ecology is a critique of existing environmental politics, which claim to speak for nature. The second aim of political ecology, according to Latour, is to recognize the complex relations between humans and nature and, from that recognition, produce new facts, values, and practices that will allow various actors to speak about common issues of concern. In this sense, political ecology is a critique of current environment politics. According to Latour, the aim of political ecology is not to bring science into nature, but instead to destroy the concept of nature.

OTHER APPROACHES

Anthropologist Arturo Escobar extends the post-structuralist form of political ecology. Escobar defines political ecology as the articulation of biology and history. This definition does not rely on the common categories of nature, environment, or culture (as in cultural ecology, ecological anthropology, and much of environmental thinking) or on the sociologically oriented nature and society (as in Marxist theories of the production of nature).

Equally significant, the form of political ecology Escobar articulates brings together several disparate domains of environmental scholarship, most notably the study of social movements and explorations of the emergence of technonature, and provides a basis for the development of an engaged critical environmental praxis. Examples of political ecology range from those that can be gleaned from the prehistoric past, to the most contemporary and futuristic, from ancient articulations through agriculture and forestry to molecular technologies and artificial life. Each articulation has its history and specificity and is related to modes of perception and experience, determined by social, political, economic, and knowledge relations, and characterized by modes of use of space, and ecological conditions. It is the task of political ecology to outline and characterize these processes of articulation and to suggest more just and sustainable social and ecological relations. Another way to state this goal is to say that political ecology is concerned with finding new ways of weaving together the biophysical, the cultural, and the techno-economic for the production of other types of social nature.

In his treatment of the idea of nature, Escobar transcends the theoretical impasse that has developed over our long-standing adherence to the nature/culture dichotomy. Escobar articulates an anti-essentialist theory of nature, where the view of nature goes beyond the truism that nature is constructed to theorize the manifold forms in which it is culturally constructed and socially produced, while fully acknowledging the biophysical basis of its constitution. In his advocating for an anti-essentialist theory of nature, Escobar notes that it is a necessary condition for understanding and radicalizing contemporary social struggles over the biological and the cultural.

From this perspective, culture and especially discourse are seen as active agents that create and produce nature as well as frame knowledge and related conflicts associated with nature. This constructivist approach, along with its emphasis on discursive formations, has added a significant critical dimension to the earlier work of political ecologists. Especially important have been constructivist examinations of the role of science in environmental campaigns and debates and the role of discourse in framing environmental conflicts related to development, especially in the developing world.

CRITIQUES

Some have critiqued the field of political ecology and many of its research practitioners for being biased and predisposed to finding specific, assumed answers (especially political drivers to environmental problems) before research begins. Vayda and Walters have suggested that the field, whatever its merits, might be more profitably replaced by "event ecology," an empirical and inductive (or abductive) approach to explaining environmental problems.

While this debate continues, a large body of work continues to pursue political ecological research for the analysis of contested environmental issues, seeking deeper insights, avoiding superficial and erroneous conclusions, and challenging the unspoken assumptions, biases, and conventional wisdoms of powerful actors. This analytic lens acknowledges power differences among actor groups and tries to explore the degree to which actors (powerful or otherwise) exercise their agency in their day-to-day actions toward their environment as well as toward each other.

SEE ALSO: Ecofeminism; Ecological Footprint Analysis; Ecological Imperialism; Ecological Modernization; Ecology; Ecomanagerialism; Nature, Social Construction of; Perception, Environmental; Political Economy.

BIBLIOGRAPHY. T.J. Bassett, ed., *Political Ecology: An Integrative Approach to Geography and Environment Development Studies* (Guilford Press, 2003); Raymond Bryant and Sinead Bailey, *Third World Political Ecology* (Routledge, 1997); Arturo Escobar, "After Nature: Steps to an Anti-Essentialist Political Ecology," *Current Anthropology* (v.40/1, 1999); Tim Forsyth, *Critical Political Ecology: The Politics of Environmental Science* (Routledge, 2003); Bruno Latour, *Politics of Nature: How to Bring the Sciences into Democracy* (Harvard University Press, 2004); Nicholas Low and Brendan Gleeson, *Justice, Society and Nature: An Exploration of Political Ecology* (Routledge, 1998); Susan Paulson and L.L. Gezon, eds., *Political Ecology Across Spaces, Scales, and Social Groups* (Rutgers University Press, 2004); Richard Peet and Michael Watts, eds., *Liberation Ecologies* (Routledge, 1996); Paul Robbins, *Political Ecology: A Critical Introduction* (Blackwell Publishing, 2004); Dianne Rocheleau, Barbara Thomas-Slayter, and Esther Wangari, eds., *Feminist Political Ecology: Global Issues and Local Experiences* (Routledge, 1996); A.P. Vayda and B.B. Walters, "Against Political Ecology," *Human Ecology* (v.27/1, 1999); K.H. Whiteside, *Divided Natures: French Contributions to Political Ecology* (MIT Press, 2002).

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Political Economy

POLITICAL ECONOMY HAS come to represent a lengthy and diverse body of theoretical work often grounded in the nexus of relationships involving governance (i.e., the state) and economic activity. The term was coined by classical economists during the 18th century, notably Adam Smith and David Ricardo, who began to examine the changing production and distribution patterns of the late mercantilist period. Karl Marx (1818–83) is the one most often associated with the idea of political economy, particularly in regards to his critique of work by Smith and Ricardo. Unlike his predecessors of the classical economic era, Marx argued that capitalism as an economic mode of production was an inherently doomed institution. Although Marx openly recognized the productive potential of capitalism, he believed the roots of capitalism's demise lay in many of the same attributes that made it so productive (i.e., the falling rate of profit). He proposed that a new mode of production, heavily regulated by the state, was needed to guide humanity along the path to a communist utopia. The legacy of this line of thought has led many to question the perceived divide between political decision making and economic activity, reasoning that the two are so tightly bound they are theoretically indivisible.

Since Marx's time, inquiries have continued into the theoretical understandings of political economy in both the social and scientific spheres. Questions regarding the relationship between political economic modes of production and environmental issues have been investigated by numerous scholars in a wide variety of academic disciplines. Even Marx himself considered such questions, often remarking upon capitalism's tendency to degrade the natural environment. At a broad level, one could argue that issues of nature and the environment are always inherently bound within the realm of political economy; because modes of production are inevitably connected to environmental conditions in one form or another, a perceived division between political economic decision making and environmental decision making would be inaccurate. Every issue pertaining to the environmental landscape necessarily affects political economy, and consequently, the reverse is also true.

One of the more intriguing (and best-known) ideas within this topic is Neil Smith's notion that nature is something that is "produced" in modern capitalist society. In his landmark publication *Uneven Development* (1984), Smith proposes that nature is not only being materially produced in today's world (e.g., transgenic seeds), but that the *idea* of nature is also being produced for the benefit of capitalist accumulation.

According to this notion, the commonly accepted belief that nature and human society are two distinctly separate entities is one that exists for the benefit of some (i.e., capitalists), and that the way in which the idea of nature has been produced and what nature signifies and represents exemplifies capitalism's influence over ideology. Thus, nature as both an object and an idea can be harnessed by those with power and influence to fortify their dominant position in society.

Regarding environmental and ecological activism, the study of political economy has led to a multitude of different viewpoints regarding the role of economics and state policy in environmental decision making. Whether implicitly or explicitly, most environmental or ecological movements engage in political economic discourses at one level or another. Some examples include, although are by no means limited to, authoritarianism, corporate and state managerialism, pluralistic liberalism, conservatism, moral community, ecosocialism, ecofeminism, and decentralized communitarianism. By appealing to the broad array of issues situated within political or economic practices, these movements are able to ground their concerns within a context to which everyone is linked.

The study of environmental issues from a political economic perspective continues along many fronts in today's academic world. Recent work in political ecology, for example, shows the value in questioning the position of the state and economic modes of production in issues of nature and society. As a theoretical approach, political economy continues to offer fresh insights to researchers in the critical human and behavioral sciences.

SEE ALSO: Marx, Karl; Nature, Social Construction of; Policy, Environmental; Second Contradiction of Capitalism.

BIBLIOGRAPHY. Noel Castree, *Nature* (Routledge, 2005); David Harvey, *Justice, Nature and the Geography of Difference* (Blackwell Publishing, 1996); Karl Marx, *Capital—Volume I* (Penguin Books, 1976); Paul Robbins, *Political Ecology: A Critical Introduction* (Blackwell Publishing, 2004); Neil Smith, *Uneven Development* (Blackwell Publishing, 1984).

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Polluter Pays Concept

THE POLLUTER PAYS concept is a principle of international environmental law that argues that those who cause damage to the environment (i.e., polluters) should be liable for the costs of the damage. Although the Río Declaration on the Environment and Development supports this principle, its roots can be traced back to the early 1960s when some of the first instruments were drafted to address civil liability for damage resulting from hazardous activities, such as nuclear energy and oil pollution. The principle is an example of attempting to tackle pollution through economic instruments, internalizing the environmental costs of production. The Río Declaration contains the polluter pays principle only for nations and does not deal with transboundary pollution; the European Union's (EU) polluter pays principle does deal with transboundary problems.

DEFINITIONS

The first express definition of the principle was given by an Organisation for Economic Co-operation and Development (OECD) recommendation in the context of economic policy. In 1972, the OECD Council Recommendation on Guiding Principles Concerning International Economic Aspects of Environmental Policies stated:

> This [polluter pays] principle means that the polluter should bear the expenses of carrying out the [pollution control] measures decided by public authorities to ensure that the environment is in an acceptable state. In other words, the cost of these measures should not be accompanied by subsidies that would create significant distortions in international trade and investment.

This principle does not have a liability on any party, but is more of an economic instrument for allocation of pollution control costs on the party responsible for causing the pollution. The main objective of this fundamentally economic policy is to encourage the free market internationalization of environmental costs in preference to trade distortions effected by governmental subsidies.

An economic system is considered to be efficient when scarce resources are allocated to meet the needs and wants of consumers, though there are different types of efficiencies. If the consumer is willing to pay the price, which equals the cost of resources (price is equal to marginal cost), it means allocated efficiency has been achieved and economic welfare is maximized. Productive efficiency is achieved, however, when the production costs of the firm are applicable both for the short- and long-run—in other words, when producers minimize the waste of resources in their production process.

In this system, there has been no consideration of the cost of pollution, or of pastures that are overgrazed or oceans that are overfished, because they are not owned. Pollution in any form is considered to be an externality—the price of polluting the air or water is not considered or built into producing the goods. The cost to society of polluting the air and water increased in the form of ill effects on human health and well being.

It was a British economist, Ronald Coase, who came up with an elegant idea of creating markets for such goods in 1959–60. If property rights are defined, then the polluters and exploiters could bargain with the victims of pollution or over exploitation until a mutually acceptable solution was found. Depending on who held the property rights, the victims would have to bribe the polluters or the polluters would have to compensate the victims.

As an example, consider two neighbors—one of them likes to have a nicely-cut lawn and cuts it with a lawnmower, which disturbs the other neighbor in the evenings and Sunday afternoons. They negotiate and strike a bargain in which the neighbor who likes to sit on the deck and enjoy the evenings offers monetary compensation to the neighbor who likes shorter grass. In this case, as the property right is vested in the gardener—she has the right to cut grass when she likes—the sufferer has to pay the polluter (although this would not be true if a strict noise nuisance act was in place). Even though it is the body owning the property rights who has to be paid in the example above, according to the principle of polluter pays, the industries causing pollution or contamination are obliged to pay for their damage to the environment.

THE EUROPEAN UNION

In 1973 the EU included the polluter pays principle in its first program of action on the environment. The polluter pay principle in "Principles of a Community Environmental Policy" stated: "The cost of preventing and eliminating nuisances must in principle be borne by the polluter." A subsequent recommendation in 1975 provided guidance for member state implementation, and later endorsements in treaty amendments established a legal basis backed by the OECD instruments.

According to a strict reading of the polluter pays principle, funds collected by a national program from pollution charges, fees, or taxes should not be used as financial assistance to a polluter, as such activities would constitute a government subsidy. Each EU country, however, has developed unique re-interpretations of the polluter pays principle to justify its subsidy schemes as being compatible with the principle.

Differences in national environmental protection policies from country to country may have an impact on international trade. Countries that adopt strict environmental protection measures may increase the costs of production relative to their trading partners, thereby reducing the competitiveness of their manufacturing industries. As a result, cooperative efforts have been made by industrialized countries to equalize production costs by reducing governmental subsidies for private pollution control.

The polluter pays principle has been incorporated in some transboundary instruments such as the Climate Change Convention; the 1990 International Convention on Oil Pollution Preparedness, Response, and Cooperation; and the 1990 Amendments to the Montreal Protocol. Most of the time, the polluter pays principle is considered part of international environmental law.

SEE ALSO: European Union; Pollution, Air; Pollution, Water; Río Declaration on Environment and Development.

BIBLIOGRAPHY. Organisation for Economic Co-Operation and Development, *Polluter Pays Principle* (Organisation for Economic Co-Operation and Development, 1975); Philippe Sands, *Principles of International Environmental Law*, 2nd ed. (Cambridge University Press, 2003); United Nations, Río Declaration on Environment and Development, www.un.org (cited April 2006).

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Pollution, Air

THE STUDY OF air pollution encompasses an examination of pollution emissions from industrial, agricultural, household, and other sources; the fate, transportation, and interaction of multiple pollutants in the atmosphere; atmospheric conditions and ambient air quality levels; the health and environmental effects of air pollution; the political and economic strategies and consequences associated with air pollution legislation; and community level movements and activist responses to air pollution largely in the context of environmental justice.

TYPES OF POLLUTION

Air pollution can be categorized as gaseous or particulate matter, primary or secondary, and toxic or nontoxic. Air pollution and related formal and informal prevention measures are also generally divided between outdoor or indoor environments.

One of the most pervasive outdoor pollutants with serious health and environmental risks is particulate matter. Particulate matter is classified in two ways, having a diameter less than 2.5 micrometers ($PM_{2.5}$) and particulate matter with a diameter less than 10 micrometers (PM_{10}). Although both forms of particulate matter present serious health risks, $PM_{2.5}$ is generally considered more dangerous because of its small size—approximately 1/30 the width of a human hair. When breathed, $PM_{2.5}$ can lodge deep in human lung tissue and even enter the bloodstream, causing severe health problems. Smaller particulate matter also tends to have a longer residence time in the atmosphere. As a result, $PM_{2.5}$ can travel farther and affect a greater population.

The principle sources of $PM_{2.5}$ and PM_{10} include combustion from motor vehicles, power plants, and other industrial sources, as well as biomass burning. One of the most severe sources of particulate matter is diesel-powered vehicles. Airborne dust, soils, and salts are other common forms of large particulate matter that occur in areas susceptible to high winds. The combination of these sources can produce a haze in the sky in both urban and rural areas, often in the late afternoon.

The composition of the earth's atmosphere is 78 percent nitrogen (N_2), 21 percent oxygen (O_2) and

.9 percent argon (Ar). The other 0.1 percent of atmosphere consists of trace gasses such as carbon dioxide (CO_2), neon (Ne), helium (He), methane (CH_4), and water vapor. Except in extreme situations, most pollutants are considered trace gases and do not greatly alter the overall composition of the atmosphere. Even at extremely low levels, however, gaseous pollutants can have serious health and environmental consequences.

Important gas contaminants include: Carbon monoxide (CO), chlorofluorocarbons (CFCs), nitrogen oxides (NO_x), hydrocarbons (HC), sulfur dioxide (SO_2), and carbon dioxide (CO_2).

Carbon monoxide (CO) is formed when carbon-based substances are burned with an insufficient supply of air. The majority of CO in the United States is emitted from motor vehicles due to the incomplete combustion of gasoline. Areas within road and highway corridors are therefore subject to high levels of CO. When inhaled, the health effects of CO include headaches, respiratory illness, and—in extremely high doses—death. Carbon monoxide is a "criteria" pollutant as outlined under the Clean Air Act.

Chlorofluorocarbons (CFCs) were used historically as refrigerants, cleaning solvents, and as propellants in aerosol canisters. CFC use was largely banned under the 1987 Montreal Protocol due to its impact on the ozone layer. The State of Oregon banned CFCs as early as 1975. Their long atmospheric lifetime—ranging from 55 to 140 years—and regenerative capabilities make CFCs particularly devastating to the upper atmosphere.

Nitrogen oxides (NO_x) are a combination of nitric oxide (NO) and nitrogen dioxide (NO_2). Common in urban areas, they are produced from natural sources and fuel combustion. Over half of anthropogenic NO_x in the United States results from motor vehicle activity. The major health effects of NO_x are pulmonary-related. Nitrogen oxides are designated as a "criteria" pollutant under the Clean Air Act and contribute to the formation of acid rain and smog.

Hydrocarbons (HC) are chemical compounds that contain both elemental hydrogen and carbon (e.g., methane). Hydrocarbons such as benzene are varieties of volatile organic compounds (VOCs), which are characterized by their ability to vaporize easily at room temperature. Hydrocarbons are most commonly released into the atmosphere when petroleum fuel is only partially burned or unburned. The majority of this pollution occurs through the exhaust pipe of motor vehicles or as a consequence of fuel evaporation. Hydrocarbons react with NO_x to create smog, and in the case of benzene and other hydrocarbon varieties, may contain toxic compounds.

Sulfur dioxide (SO_2) exists in gaseous form and can react with other chemicals to create tiny sulfate particles. It is one of six "criteria" pollutants under the Clean Air Act. Roughly two thirds of SO_2 comes from fuel combustion at power plants, especially those burning coal. SO_2 contributes to acid rain and can cause respiratory illness when inhaled.

Carbon dioxide (CO_2) occurs naturally in the earth's atmosphere from the combustion of biomass, animal respiration, and outgassing from the earth's surface. Carbon dioxide is also emitted into the atmosphere through the anthropogenic burning of fossil fuels for energy and transportation purposes. While the presence of carbon dioxide at low concentrations is normal, CO_2 is an effective greenhouse gas that can alter the earth's atmosphere.

TOXIC POLLUTION

Toxic air pollutants, commonly referred to as hazardous air pollutants (HAPs), present acute risks to humans and the environment. Possible risks include cancer, birth defects, damage to the immune system, as well as serious neurological and respiratory ailments. While toxic pollution is typically breathed from the air, some toxins like mercury and lead can settle into soils and enter into plants and other animals and eventually be ingested up the food chain to humans.

The U.S. Environmental Protection Agency (EPA) works with state and local governments to regulate and reduce the release of 188 toxic pollutants. Some examples of toxic pollutants include perchlorethlyene, which is a common effluent of dry cleaning facilities; methylene chloride, which is found in many industrial solvents and paint strippers; and benzene, which is found in gasoline. Other common air toxics are toluene, dioxin, and asbestos and metals such as mercury and lead compounds.

Lead (Pb) is another of the six effluents designated as "criteria" pollutants by the Clean Air Act. Whereas in 1970 the vast majority of lead pollution came from motor vehicles, now most lead pollution is the result of metals processing activities such as lead smelters. Today, the biggest concerns regarding lead occur in "hot spots" immediately surrounding these processing facilities. Between 1980 and 1999, ambient lead levels in the atmosphere dropped 94 percent. The overall reduction in lead pollution since 1978 is attributed to the gradual phase out of leaded gasoline. The health effects of lead are severe and include organ, neurological, brain, and cardiovascular damage.

High concentrations of toxic air pollutants in impoverished and minority communities in the face of pro-business city planning agendas have galvanized grassroots environmental justice activists. Environmental justice organizations speak out against the inequitable distribution of air pollution within these neighborhoods. The goal of these movements varies from one to the next but usually promotes private polluting facilities moving to other locations or adopting cleaner practices; holding governments accountable to communities; and public involvement and control over decisions influencing air quality.

In order to gain political traction, these groups provide evidence of environmental injustices. Some communities practice "popular epidemiology" by locating and recording health incidents throughout neighborhoods, while others mobilize around air quality reports using data from Toxic Release Inventories (TRI). The TRI database caters specifically to the public and provides information on facility-specific toxic emissions into the environment.

INDOOR ENVIRONMENTS

In all areas of the world, people spend much of their time inside while at work and at home. The prevalence of indoor air pollution is therefore a serious problem that affects both developed and developing nations. Indoor air pollution consists of gas compounds and particulate matter, as well as toxics and nontoxics. Throughout the world, forms of indoor air pollution include: Radon filtering into the home from below ground; volatile organic compound (VOC) emissions from office supplies; furnishings, paints, and other household solvents; lead particles from dried paint; and particulate matter from wood burning fireplaces and secondhand smoke from cigarettes.

Asbestos is another serious health risk in indoor environments although a number of product bans and reformed building construction codes have eliminated the use of asbestos-based material in homes. Because it is carcinogenic (cancer causing), asbestos was one of the first hazardous air pollutants regulated under the 1970 Clean Air Act.

In developing nations the burning of biomass for heating and cooking purposes is a major health hazard for nearly 2 billion people. The World Health Organization (WHO) estimates that approximately 1.6 million people die each year as a result of exposure to indoor air pollution from biomass burning. The main groups impacted by indoor smoke are women and children because they are responsible for most cooking and heating activities. The 2002 World Summit on Sustainable Development in Johannesburg launched the Partnership for Clean Indoor Air. The principle aim of this coalition of organizations is to reduce indoor air pollution from household energy use around the world.

SECONDARY POLLUTANTS

Secondary pollutants are not directly emitted into the atmosphere. Rather, they are formed when primary pollutants react with other gases, sunlight, or water vapor and undergo a chemical change in the atmosphere. Two examples of secondary pollutants are tropospheric ozone and components of acid rain such as nitric and sulfuric acids.

Tropospheric ozone (O_3) is a photochemical oxidant and is formed through a reaction involving sunlight, NO_x, and hydrocarbons. Ozone is an important component of smog that impacts urban residents around the world. Respiratory and eye irritation are the most common symptoms of photochemical smog exposure. Mega-cities such as Beijing, Los Angeles, Mexico City, and Athens all suffer from pronounced smog levels. Wind and precipitation are two principal means for removing smog.

The formation of smog is aided by the presence of an inversion layer that creates a so-called "lid" trapping pollutants over the city. An inversion layer, which forms when warm air resides over cold air, prevents old, stale, and polluted air from escaping vertically out of an urban system. Under these stable atmospheric conditions, surface level pollution accumulates creating elevated smog levels.

In 2005, the American Lung Association used recent county-by-county air quality data to conduct a "State of the Air" report. County level data on two pervasive pollutants—ozone and particulate matter—were included in the report. According to the study, in 2005 over 52 percent of U.S. residents lived in counties with unhealthful levels of either ozone or particle pollution. (The results were based on the EPA's Air Quality Index.) Despite California's firm commitment to reduce dangerous air pollution, five-metropolitan areas around the state make the top 10 list for short-term particulate matter pollution while six make the ozone pollution top-10 list.

Nitric acid (HNO_3) is an easily soluble, acidic gas. It is formed when nitrogen dioxide (another secondary pollutant) reacts with water. Sulfuric acid (H_2SO_4) is also highly acidic and contributes to the formation of acid rain when reacting with water. Acid rain is typically most severe downwind from major power and industrial plants, although pollution from cities can also lead to acid rain. For example, areas of the Northeastern United States experience acid rain originating from Midwest industrial belts.

SOURCES OF POLLUTION

Pollution sources are both environmental and anthropogenic. Environmental sources include fires, volcanoes and other geothermal activities, livestock, trees (most notably species of pine), the earth's substrate (which can experience radioactive decay), and agricultural fields and deserts, both of which produce dust storms when exposed to high winds.

Anthropogenic sources are categorized as stationary, mobile, or area sources. Stationary sources (commonly referred to as "point sources") are generally fixed to a single location or point. These sources include industrial activity such as combustion-fired power plants, oil refineries, and other wood, natural gas, oil, and coal burning facilities. Other stationary sources include landfills and pollution directly resulting from agricultural activity such as loose soil, chemical applications, and controlled burns. Mobile sources include automobiles such as passenger cars, public transportation vehicles, heavy duty trucks, and mobile construction equipment. Aircraft, locomotives, and marine vessels are other varieties of mobile pollution sources. Area sources include stationary and nonroad sources that are too numerous or small to accurately account for in strict emissions inventories and are therefore assigned to a general area.

LEGISLATION AND MITIGATION

Air quality legislation can focus on the pollution source by regulating single-source or total regional emissions. Legislation is also often based on air quality standards, aiming to limit the ambient level of pollution in the atmosphere over a given period of time. Still other legislation is technology-driven and regulates facilities based on equipment standards. While these regulations ultimately target the polluting facility, they usually operate through a central air quality officer at the national, state, county, or municipal scale.

Air pollution in the United States is regulated at both the national and state scale. National Ambient Air Quality Standards (NAAQS) are established by the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards (U.S. EPA OAQPS). The standards establish maximum allowable pollution levels for a given area. The NAAQS consists of primary and secondary standards designed to meet human health and nonhuman health (crops, structures, and animals) requirements respectively.

The standards are directed toward six criteria pollutants: ozone (O_3), particulate matter ($PM_{2.5}$, PM_{10}), carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NO_x) and lead (Pb). The EPA was instructed to maintain records of ambient air quality levels in accordance with 1990 amendments to United States Clean Air Act of 1970.

The 1970 Clean Air Act (CAA) was a landmark legislative accomplishment outlining federal rules and regulations for stationary and mobile air pollution sources. Aside from mandating the NAAQS, the CAA also created standards for hazardous pollutants through the National Emission Standards for Hazardous Air Pollutants (NESHAPS). Through

In 2005 over 52 percent of U.S. residents lived with unhealthful levels of either ozone or particle pollution.

New Source Performance Standards, the CAA created strict stationary source emissions standards. Perhaps the most significant achievements of the act is that it allows states to devise their own air quality implementation and enforcement plans, assuming they are no less stringent than federal standards. States must submit a State Implementation Plan (SIP) to the EPA in order to demonstrate a capacity to achieve minimum pollution criteria.

California is a notable example of a state aggressively enacting numerous stringent air pollution regulations. For example, in 2002, California passed legislation known as the Pavley Bill, creating vehicle emissions standards requiring that greenhouse gas emissions from new vehicles be reduced by 22 percent by the 2012 model year and 30 percent by the 2016 model year. By 2006, ten other states had adopted these strict California standards, which in turn put pressure on car manufacturers to fill this growing "green" automobile market.

Mobile source emissions are also controlled by regulating vehicle fuel composition. Examples of fuel-based regulation are initiatives to reformulate gasoline by eliminating toxics such as benzene and the 1995 ban on leaded gasoline for passenger vehicles in the United States. Another set of measures intended to reduce mobile source emissions focus on zoning and land use ordinances that reduce total vehicle miles driven. Examples include "smart growth" initiatives such as carpool incentives and urban growth boundary designations.

Because air is fluid and political boundaries are porous (in terms of both the movement and eventual impacts of air pollution) national and subnational regulatory frameworks are insufficient alone. Multilateral Environmental Agreements (MEAs) have been created to govern cross boundary pollution between nations and international air-related environmental problems. One example is the 1979 UN Economic Commission for Europe (UNECE) Convention on Long-Range Trans-boundary Air Pollution. The 1987 Montreal Protocol banning the production of CFCs and the 1997 Kyoto Protocol designed to regulate global greenhouse gas emissions are examples of international accords that emphasize "local" pollution prevention measures to prevent potentially calamitous global impacts.

MONITORING AND ENFORCEMENT

Air quality modeling supports air pollution regulations and increases public awareness by predicting pollution concentrations and levels of human exposure. Pollution modeling requires synthesizing atmospheric inputs with emissions data from the National Emission Inventory (NEI). The EPA compiles NEI data on criteria and hazardous air pollutants from a variety of state and local agencies as well as industry.

A number of programs are used to mitigate pollution by enforcing standards, reducing the financial cost of compliance and improving levels of public awareness. Permitting programs help sources achieve mandated emissions standards. Permitting requirements are outlined under the Clean Air Act in two forms, construction permit programs and operating permit programs. Construction permits include New Source Review (NSR) permits. NSR permits are issued by air pollution agencies and regulate pollution through technological standards. New sources of pollution and significant emission increases at existing sources must satisfy certain state-of-the-art pollution control technology requirements in order to avoid penalties.

Under Title V of the Clean Air Act, operating permits are issued to certain pollution sources. These permits outline industry-based performance standards and require sources to monitor and share with the EPA their compliance with these requirements. A number of source monitoring measures are available for most facilities, although fugitive emissions (unaccounted for effluent releases) present an ongoing challenge to most monitoring efforts.

Emissions trading programs and "command and control" enforcement procedures are both used to enforce air pollution compliance. Emissions trading programs cap total emissions within a given region but allow sources with more expensive control costs to purchase pollution "credits" from sources experiencing cheaper control costs. The goal of these programs is to achieve emissions reduction in the most cost efficient manner. Command and control enforcement relies on government control to achieve emissions reductions. Under these programs, facilities that violate industry standards are fined by government regulatory enforcement bodies.

SEE ALSO: Clean Air Act; Fate and Transport of Contaminants; Fossil Fuels; Greenhouse Effect; Greenhouse Gases; Montreal Protocol; Permits, Tradeable.

BIBLIOGRAPHY. Devra Davis, *When Smoke Ran Like Water* (Basic Books, 2002); Thad Godish, *Air Quality* (CRC Press, 2004); Gerald Markowitz and David Rosner, *Deceit and Denial: The Deadly Politics of Industrial Pollution* (University of California Press, 2004); United States Environmental Protection Agency, "Office of Air and Radiation," www.epa.gov/air (cited May 2006); United States Environmental Protection Agency and Winrock International, "The Partnership for Clean Indoor Air." www.pciaonline.org (cited February, 2006).

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Pollution, Water

SOURCES OF WATER pollution in lakes, streams, rivers, oceans, and other water bodies include municipal sewage, industrial waste, agricultural runoff, and oil spills, among others. Waste may be dumped in water intentionally or accidentally. Although water pollution is usually caused by human activity, some natural phenomena—like volcanoes, storms, and earthquakes—cause changes in water chemistry. Sometimes, high saline or mineral content of water makes it unfit for certain uses, even though the water is not polluted in the traditional definition of pollution.

Many toxic synthetic chemicals cannot be broken down by natural processes and cause serious harm. These substances may be dissolved or suspended in water or deposited in sediments, but they do not go away. This results in the pollution of water—the quality of the water deteriorates affecting aquatic ecosystems. Pollutants can also seep down and affect groundwater deposits.

Water pollution has worsened since World War II with the advent of what is known as the "chemical age," which has impacted the quality of water worldwide with industrial and agricultural chemicals. Eutrophication of water bodies (caused by nitrates and phosphates from various sources, including fertilizer runoff) has greatly affected the quality of water in large parts of the world. The effects of water pollution are devastating for living beings. Contaminated water destroys aquatic life, reduces its reproductive ability, and results in ecosystems that can no longer support full biological diversity.

SOURCES OF POLLUTION

There are many sources of water pollution, such as city sewage, also known as sanitary sewage or domestic sewage, which refers to wastewater from households. This water contains a wide variety of dissolved and suspended impurities such as organic materials and plant nutrients, and human waste. It contains inorganic products such as synthetic detergents containing phosphates, which affect the health of all forms of life in water. Most cities do not have adequate facilities to treat wastewater and much of it is discharged into water bodies.

Bacterial contamination of surface water from sewage caused serious health problems in major cities in Europe and North America in the mid-19th century. Cities built sewer networks to route domestic waste downstream of drinking water intakes to prevent contamination of the drinking water. These sewage networks and waste treatment facilities expanded rapidly in the developed world. In the developing world, where governments sometimes lack financial resources to expand sewage and water infrastructure, outbreaks of waterborne diseases like cholera still occur.

Industrial waste or effluents, usually containing specific and readily identifiable chemical compounds, are another source of water pollution. Many plants (e.g., paper mills, tanneries, sugar mills, distilleries, and thermal power stations) generating these effluents do not have adequate treatment facilities because these small-scale industries cannot afford enormous investments in pollution control equipment. Major industries have treatment facilities for industrial effluents, yet enough small-scale operations pollute water to counter measures taken by major industries.

Agricultural runoff is another source of water pollution. Intensive cultivation of crops usually involves chemicals (nitrates, phosphates) and pesticides (such as DDT) and water from these fields containing fertilizers and pesticides not only drains into rivers or lakes, but also seeps into groundwater in a process known as leaching. Scientists also believe that massive and largely unregulated use of antibiotics in agriculture and aquaculture may present a great risk to the aquatic environment and human health.

Petrochemicals are also threats to water quality. One of the greatest disasters with petrochemicals was the 1989 oil spill of the *Exxon Valdez,* which contaminated about 1,500 miles of Alaska's coastline. It killed birds, mammals, and fish and disrupted the ecosystem in the path of the oil. Major spills like these are few, but they pollute water and cause damage to the aquatic ecosystem. Ships and tankers also discharge water taken on in one location in other locations, causing transmission of pollutants, diseases transmission vectors, and nonnative species, which can be disastrous for certain delicate aquatic ecosystems.

POINT AND NONPOINT SOURCES

Water pollution sources can be categorized in another way: as direct, or point, sources and indirect, or nonpoint, sources of pollution. Liquid effluents from factories, refineries, and waste treatment plants, which are emitted directly into water bodies, are called point sources of pollution. It is simpler to regulate the standards for such emissions, since they are identifiable and quantifiable. Even though there are regulations governing the emissions, it does not guarantee that these emissions are pollutant-free.

Rain water flowing from improperly disposed of waste, whether domestic or industrial, can also result in water pollution. Leachate from landfill sites also results in water pollution. These are examples of nonpoint source pollution. Indirect sources also include contaminants that enter water bodies from the atmosphere via acid rain, which contains emissions from cars and factories. Both point and nonpoint pollutants and contaminants can be many different types, including organic, inorganic, radioactive, and acid or base.

OTHER TYPES OF POLLUTION

Metals or other elements in water are also of great concern. Mercury can be released into the air by human activities such as metallurgical processing, municipal and medical waste incineration, and power generation from coal combustion. It is also released to the atmosphere by natural phenomena like volcanic eruptions, forest fires, and the weathering of geological formations. Once deposited in or discharged to water bodies, mercury can be converted by bacteria into mercury compounds, such as methyl mercury, which accumulate in the food chain. Fish consumption exposes humans to methyl mercury, as observed in Minamata Bay in Japan in the 1950s. Even though eating fish offers nutritional benefits, caution must be taken to avoid eating too much fish containing excessive levels of methyl mercury or PCBs.

Researchers are detecting trace amounts of pharmaceuticals in water, especially in the developed world, because of high consumption of medicines. Other chemical ingredients from cosmetics, toiletries, food additives, and veterinary drugs have also been found. As a group, these chemicals have been dubbed PPCPs (pharmaceuticals and personal care products). Scientists and policy makers have started worrying about the possible effect and harm to human health and environment of these chemicals, even though the amounts detected are minute—typically between 20 parts per billion and less than one part per trillion for each substance. Many drug compounds dissolve in water, but about one third dissolve only in fat.

This enables them to enter cells and move up through the food chain to become more concentrated. Deformities in the reproductive systems of fish and frogs show that these chemicals are not harmless. Recent research has shown that exposure to even very small amounts of toxic chemicals can be harmful to humans and other forms of life. A developing fetus, an infant, or an adult with a compromised immune system would be even more at risk. The Canadian government is pioneering approaches to the problem of PPCPs under a program called the Environmental Impact Initiative. The program includes research, public education, and the introduction of environmental assessment regulations.

MITIGATION

Both developed and developing countries have to deal with water pollution. In the developed world, different types of pollution occurred sequentially, with the result that most developed countries successfully dealt with major surface water pollution. In contrast, in developing countries (such as China, India, Brazil, and Mexico) both surface and groundwater pollution not only occurred simultaneously but also at such a rapid rate that these countries hardly had financial resources, technologies, or time to cope with them.

Legislatures all over the world have passed laws and developed regulations to combat water pollution. Governments alone, however, cannot solve the problem, especially during the present era when downsizing of governments to conserve funds has resulted in losses of environmental monitoring capability and capacity. Science is also seeking practical solutions to minimize the present level at which pollutants are introduced into the environment and for remediation of past problems. Individuals and communities can help minimize water pollution by planting trees, reducing household waste, disposing of household chemicals responsibly, recycling packages made with polluting dyes, and reducing the use of fertilizers and lawn chemicals. The developed world and developing countries must collaborate to prevent further pollution. Our leaders—whether political or industrial—must think of sustainable development rather than economic expansion.

SEE ALSO: Clean Water Act; Fate and Transport of Contaminants; Marine Pollution; Minamata Disease; Polluter Pays Concept; Polychlorinated Biphenyls (PCBs); Pulp and Paper Industry; Wastewater; Water Quality.

BIBLIOGRAPHY. A. Boczek, "Global and Regional Approaches to the Protection and Preservation of the Marine Environment," *Case Western Reserve Journal of International Law* (v.39, 1984); L.J. Puckett, "Identifying the Major Sources of Nutrient Water Pollution," *Environmental Science & Technology* (v.29, 1995).

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Polychlorinated Biphenyls (PCBs)

POLYCHLORINATED BIPHENYLS (PCBS) are a class of organic compounds composed of two interconnected phenyl rings, with a number (one to 10) of substituted chlorine atoms attached to these rings. There are a variety of variations, forms or congeners of PCBs, all of which have slightly different chemical properties.

PCBs are a member of a class of pollutants referred to as organochlorines and are conservative contaminants, that is, they persist in the environment for a long time, and they also bioaccumulate: PCBs that are not excreted build up in the tissues of contaminated organisms. As PCBs are lipophilic (fat soluble), they primarily tend to be stored in adipose (fat) tissues of organisms.

PCBs have been produced since the 1930s and have been used in insulating fluid for industrial transformers and capacitors; hydraulic fluids; surface coatings for copy paper; in synthetic resins, rubbers, paints, and waxes; and in lubricating oils, asphalts, and flame retardants. Due to environmental health concerns about this class of chemicals, many countries began banning the production of PCBs in the late 1970s and early 1980s. Until these bans, world production of PCBs was approximately one million tons—most of which has ultimately ended up entering the marine environment.

The structure of PCBs means that they can sometimes mimic hormones, which in turn leads to disruption of biological systems and health effects. As a result, reproductive failures have been recorded in several mammal species fed PCB-laced diets. Other PCB-induced reproductive defects include: altered menstrual cycles, embryo reabsorption, abortions, stillbirth, impaired infant survival or low birth weights, and impaired infant growth. PCBs can also affect the immune system, impacting lymphocyte production and increasing susceptibility to viral, bacterial, and protozoan infections. Other documented effects of PCBs include liver toxicity, thyroid and skin damage, cancer promotion, behavioral changes and impaired neurological development, and "reduced intelligence."

Two well-known outbreaks of disease related to PCB poisoning have occurred. In 1968 rice paddies in Japan contaminated with PCBs led to an outbreak of the disease *yusho,* affecting 1,700 people. Symptoms, which included darkening of skin and acne-like skin eruptions, were recorded with PCB doses of 0.07 milligrams per kilogram of victim body weight. Another PCB-induced disease outbreak occurred in 1979 in Yu-Cheng, Taiwan, affecting 2,000 people. A more recent poisoning event occurred in January 1999, in Belgium, when 500 tons of animal feed contaminated with 50 kilograms of PCBs (and one gram of dioxins) were distributed to Belgian, Dutch, German, and French farms. Very quickly decreases in egg production were noted in some poultry farms, and ultimately over two million chickens were slaughtered due to contamination fears. When the incident was publicized in May 1999, it led to a major political and economic crisis. It has been estimated that due to PCB contamination alone, up to 6,776 extra cancer deaths could occur in the Belgian population.

As noted above, PCBs are lipid soluble, and one notable lipid-rich substance in humans is breast milk. In several areas of the world relatively high levels of PCBs have been reported in human breast milk and concerns have been expressed about the potential effects. One particular concern is that the effects of vitamin K metabolism may result in hemorrhagic disease in newborn infants. However, although some studies have shown correlations between breast milk PCB concentration and thyroid hormonal levels and impaired neurological development in infants, other studies contradict some of these results. Nonetheless the situation is one that requires monitoring and consideration.

Studies showing high levels of human PCB contamination have often noted a high seafood diet. Since the majority of PCBs have ultimately ended up in the marine environment, fish and other marine species with fat-containing tissues are at risk of PCB contamination. In particular, PCB contamination is a problem for marine mammal species as they are often top predators with long life spans, and may bioaccumulate and biomagify higher levels of PCB contaminants in their tissues. The thick blubber layers of many marine mammal species may also act as a PCB store, and their fat rich milk may pass on high levels of contaminants to their offspring. Marine mammal species that consume other marine mammals may be particularly at risk from PCB contamination, and several studies have linked reproductive and immune system abnormalities, high neonatal mortality rates, and even mass mortality events in several species of whales, dolphins, and seals to high levels of PCBs and other organochlorine contaminants. In turn, human communities in Alaska, Canada, Greenland, or other areas who consume high concentrations of whale or seal tissues in their diet may also be at greater risk of elevated dietary intakes of PCB as a result of marine mammal contamination.

SEE ALSO: Disease; Food Webs (or Food Chain); Green Production and Industry; Marine Pollution; Whales and Whaling.

BIBLIOGRAPHY. A. Brouwer et al., "Report of the WHO Working Group on the Assessment of Health Risks for Human Infants from Exposure to PCDDS, PCDFS and PCBS," *Chemosphere* (v.37, 1998); J.E. Reynolds and S.A. Rommel, eds., *Biology of Marine Mammals* (Smithsonian Institution Press, 1999); S. Safe, "Polychlorinated Biphenyls (PCBs) and Polybrominated Biphenyls (PBBs): Biochemistry, Toxicology and Mechanisms of Action," *CRC Critical Reviews in Toxicology* (v.13, 1984); N. van Larebecke et al., "The Belgian PCB and Dioxin Incident of January–June 1999: Exposure Data and Potential Impact on Health," *Environmental Health Perspectives* (v.109, 2001).

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Population

AS OF MID-2006, the earth's human population stood at approximately 6.48 billion. In 1 C.E., it is estimated that the global population was between 250–300 million. Humans reached the first billion by about 1804; the second by 1927. The world population hit five billion around 1987, and six billion in 1999. This means that an estimated six percent of people ever born on earth were alive in 2002. The length of time it took to add an additional billion people to the planet shrank dramatically. Whereas it once took millennia to add a billion people, that number was added in just 12 years. The human population is expected to continue to grow for the next 70 years, peaking at 9.22 billion around 2075. At least seven more decades of growth are forecast, mainly because the average person is living longer, and because so many potential parents are already born, also called "population momentum."

Many people consider this inexorable rise in human numbers to be cause for alarm and immediate action to slow population growth. However, the rate at which new people are added to the planet has actually been decreasing for the last several decades. This rate of natural increase (RNI) is determined by the difference between birth and death rates. This rate peaked between 1965 and 1970, when the human population grew at over two percent per year—an astronomical figure unprecedented in human history. Since then, the gap between birth and death rates has slowly been closing; between 2000 and 2005, the global population grew by only 1.22 percent, and the rate continues to decline. This slowdown usually receives less popular attention—and is often confused with—the fact that human populations will continue to rise for the next 70 years or so.

The main reason for this slowdown has been a dramatic drop in fertility rates worldwide. The total number of children that the average woman is likely to have in her lifetime has been declining for several decades, and has done so much more quickly than most experts expected. Between 1950 and 1955, women on average had five children. By 2000–05, the global average had fallen to 2.7; in 2000, 42 percent of humanity lived in countries that had already achieved fertility below the replacement level of 2.1. This ongoing decline in fertility rates worldwide has been described as the biggest revolution in human population history.

There are multiple reasons for this fertility transition. Although it has varied in pace and magnitude by geographical region, a set of intertwined factors are generally recognized to be globally influential. These include: improved access to contraceptives, health care improvements that greatly enhance child survival, women's greater access to education and work outside the home, a widespread shift from rural to urban livelihoods, postponement of marriage, and reduced cultural and religious pressures for large families. In the vast majority of cases, fertility declines reflect women's desires to have fewer children. Only in rare cases has fertility reduction involved coercive practices, as, for example, with China's one-child policy or certain reproductive programs in India.

Fertility decline is the single most important factor for understanding why global population growth is slowing. But mortality rates are beginning to contribute to this slowdown too. Because women have been having fewer children than in the past, the cumulative effect is that the global population is slowly becoming older as children comprise a smaller portion of the overall total. Today, the median age is 26; by 2010, it is estimated to be 44 years. Thus, even as life expectancies continue to rise, the aging of the population will result in higher death rates. As the decline in fertility continues, mortality rates are expected to creep upward.

When the two rates intersect—which is projected to occur by 2075—then the population will stabilize. These estimates are based on recent calculations by the United Nations Population Division, and they represent the most informed answer to date on the perennial question of how large the human population will become.

THE DEMOGRAPHIC DIVIDE

Demographers commonly divide the world into two major regions: more developed (comprising North America, Europe, Australia, New Zealand, and Japan) and less developed (comprising the remainder). These are contested terms—sometimes affluent and poor are preferred. By this categorization, eight out of 10 people on earth currently live in less developed countries, which is why some observers argue they should collectively be known as majority world. China and India, whose status as less developed is currently a matter of debate, are the world's two largest countries, with populations estimated at 1.3 billion and 1.1 billion, respectively, in 2005. Together, they account for almost half of the developing world, and 37 percent of the planet's human population.

In 1950 about 29 percent of world population lived in more developed nations, with 21.7 percent in Europe alone. At that time, Africa's share of world population was only 8.8 percent. These proportions have since changed dramatically as countries have experienced very different birth, death, and migration rates. For example, European women had on average 1.4 children in 2005—well below replacement-level fertility. The region is experiencing negative population growth. In contrast, the average woman in Africa had 5.1 children in 2005—the highest regional rate in the world—and rates of natural increase average 2.3 percent. As a result of these disparities, Africa held 14 percent of the world's population in 2005, while Europe's share dwindled to 11.2 percent.

The differences in demographic structure between these two regions exemplify what is known as the demographic divide, resulting in the separation of demographic issues into two distinct camps with very different attitudes and policy approaches. In Africa, for example, high birth rates mean that populations are young, with some 42 percent of the total population under age 15. Most governments consider their birth rates to be too high, and they may wish to prioritize investments in family planning programs, maternal and child health, and educational opportunities for girls in order to reduce fertility. At the same time, however, these governments face rising mortality rates and declining life expectancies due to HIV/AIDS. This devastating epidemic has in many cases drastically reduced the number of adults able to care for children, and diverted scarce health funds toward HIV/AIDS treatment and prevention.

In Europe, by contrast, the population concerns are far different. Extremely low fertility rates have led some observers to talk about a birth dearth. As populations age and individuals live longer, there is also much social angst about who will care for the elderly. In many cases, governments are reluctant to deal with the thorny social issue of maintaining or increasing their current population size through immigration, and are instead creating incentives to encourage couples to have more children.

THE POPULATION-ENVIRONMENT DEBATE

Whether the growing human population is inherently good or bad for the global environment is one of the most hotly debated issues in science. On one side of the debate are those that see human population numbers, and our rapid recent growth, as the most significant cause of environmental and humanitarian crises. The most famous advocate of this view was Thomas Malthus (1766–1834), an English pastor and economist. In a famous essay first published in 1798, Malthus argued that food supplies grow more slowly than do human populations, and he predicted that without the population checks of disease, death, or delayed marriage, population growth would outstrip food supplies and lead to hunger and misery.

In 1972 a group of scientists known as the Club of Rome recast Malthus's main arguments in ecological terms. They and contemporary neo-Malthusians argue that human populations are growing faster than our ability to support ourselves from finite natural resources such as soil, water, and forestlands. They argue that we will soon exceed, if we haven't already, our limits to growth, or the earth's carrying capacity. The single most important way to prevent further environmental devastation and widespread human misery, they say, is to control the runaway population—to reduce human numbers as quickly as possible. Because they emphasize sheer numbers and densities of peoples in given areas, neo-Malthusians typically focus their attention on less developed countries, where large numbers of people, environmental degradation, and hunger often visibly coexist. To redress such problems, neo-Malthusians advocate policies that prioritize fertility reduction through family planning, enforced control on resource use, and the setting aside of biodiverse areas as off-limits to resource users.

On the other side of the debate are those that feel that the number and density of people—at the global or regional level—is not the principal factor for understanding patterns of use, management, or degradation of the natural environment. They argue that the number of people that can be supported by natural resources depends very much on how humans choose to use, trade, and govern those resources; in effect, resources may be finite, but humanity's ingenuity to find better and more efficient ways to harness and distribute those resources is not.

The Danish economist Ester Boserup (1910–99) is famous for her refutation of Malthus by showing how, throughout human history, growing numbers of people in rural areas stimulated the invention and adoption of more labor-intensive farming methods that allowed for higher yields. In other words, human populations have typically adapted their farming techniques to accommodate their growing populations. The academic Julian Simon (1932–98) also argued that people could be the solution to resource scarcity and environmental problems because of our ability to innovate ways to better use resources.

Recent field studies have also called into question neo-Malthusian explanations for such environmental problems as deforestation, soil erosion, desertification, and overfishing. Researchers repeatedly find very little direct evidence that such processes are the direct result of the number or density of local resource users. Rather, they show that these problems typically arise under specific political, historical, and economic circumstances. They find, for example, that when local users have a long-term stake in the management decisions affecting resources, then forests, wildlife, and biodiversity in general can thrive even at very high human densities.

Most significantly, critics of neo-Malthusian views argue that simple cause-and-effect models of overpopulation and environmental degradation ignore the profound interconnections between people, resources, and capital in the globalized world. They point out, for example, that the colonization of some countries by others has left a legacy of marginalization and inequitable resource distribution whereby peasants starve on tiny plots of marginal land while vast tracts of rich soil are controlled by multinational companies and devoted to the cultivation of export-oriented luxury foods such as coffee. This example shows that there are complex historical reasons for hunger and resource degradation that are largely unrelated to a country's population-to-resource ratio.

AN EMERGING CONSENSUS

Over the past decade or so, the consensus is emerging that human population numbers on their own are insufficient for understanding the human impact on the global biosphere. The equation I = PAT was proposed by ecologist Paul Ehrlich to reflect the fact that human environmental Impact was the product of Population, Affluence (usually measured as income per capita), and the Technologies used to meet everyday needs. Thus the impact of a few wealthy people living in amenities-rich urban luxury would have the same impact as many more people eking out a rural living with their own labor. But the equation still suffers from the misconception that specific environmental impacts are the direct product of characteristics of the local population.

The crisis of global warming helps frame these issues more holistically, and to focus particularly on the consumption side of the population-environment issue. For example, the United States comprises less than five percent of the world's population, but is currently estimated to contribute some 33 percent of human-produced greenhouse gases into the earth's atmosphere. Yet global warming—like most environmental problems—is not inevitable. There are technologies and skills to greatly reduce the reliance on fossil fuels. But economic momentum, political inaction, and everyday consumption choices have to date prevented many from meaningfully addressing this crisis. Doing so in a serious way means making tough choices about where to live (high density cities or sprawling subdivisions), what to eat (locally grown food or exotic imports), the types of technologies to choose (solar panels or coal-fired power plants), where to take vacations, and what clothes to buy.

To reflect the need to more closely examine the role of consumption in environmental problems, the New York–based Population Reference Bureau (which publishes an annual report compiling data on all countries' population trends), has now included information on countries' energy use per capita, as measured by kilograms of oil equivalent. By this metric, the average person in developing nations uses only 20 percent of what the average person in more developed nations does. Put another way: with 80 percent of the world's population, the residents of less developed countries used, collectively, only 44 percent of the energy consumed annually.

SEE ALSO: Birth Control; Birth Rate; Death Rate; Fertility Behavior; Fertility Rate; Malthus, Thomas; Malthusianism.

BIBLIOGRAPHY. Charles Mann, "How Many Is Too Many?" *Atlantic Monthly* (February 1993); G.L. Peters and R.P. Larkin, *Population Geography* (Kendall/Hunt, 2002); Population Reference Bureau, www.prb.org (cited October 2006); United Nations Population Division, www.unpopulation.org (cited October 2006).

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Portugal

PORTUGAL IS A European country located on the Iberian Peninsula in the southwestern part of the continent. Portugal has a land area of 35,672 square miles (92,391 square kilometers), including the Atlantic island groups of the Azores and Madeira, and an estimated population of 10.6 million people in 2006. The country may be divided into five main physiographic units that form a succession of hilly terrains and depressions occupied by the large Iberian rivers such as the Douro, the Tagus, and the Guadiana. The climate is cool and rainy in the northern mountains and turns progressively warmer and drier toward the south, with near arid conditions in the Algarve region.

Air pollution is becoming an important issue in cities such as Porto and Lisbon where European Union (EU) standards for air particulates and tropospheric ozone are frequently surpassed. In Porto, for instance, people suffering from chronic obstructive pulmonary diseases (which has been linked to concentrations of particulates in the atmosphere) rank second in number in Europe after London. Traffic and fossil fuel burning (fossil fuels with high sulfur content are still relatively important in the country) are the main causes. In July 2000, the European Court ruled against Portugal for not having passed legislation dealing with 99 hazardous substances and for not having established temporal targets for their reduction. Moreover, acid rain has contributed to the defoliation of part of Portugal's extensive forest cover.

Portugal has also received repeated calls from the EU to curb water pollution. In 1999 and 2000 the country was not complying with the Drinking Water Directive regarding concentrations of fecal and total coli bacteria forms. The European Commission decided to take Portugal to the European Court for failing to declare a sufficient number of protected zones under the Nitrates Directive and thus prevent groundwater pollution, especially in the irrigated agricultural areas of Setúbal and the Algarve.

Soil degradation is one of the most important environmental problems of Portugal, especially when linked to forest fires. In 2002 almost 30 percent of the land was under cultivation, but a substantial part presents diminishing fertility as a result of erosion. In 2000 forests covered more than 40 percent of the total land area. Because of agricultural abandonment, forest areas are growing (140,850 acres [57,000 hectares] of net gain between 1990 and 2000). Portugal exports timber and is the world's largest producer of cork (67 percent of the world total), mostly extracted from the vast forests of the Alentejo. In 2003, about five percent of the land was subject to environmental protection.

Garcia de Orta

Garcia de Orta (1501 or 1502–68) was a Portuguese Jewish physician who detailed cures for tropical diseases. During the 16th century many Portuguese sailors were journeying in the tropics, and some were succumbing to tropical diseases, often bringing back diseases to Portugal. Garcia de Orta, the grandson of Jews who fled persecution in Spain, practiced medicine and was a professor at the University of Lisbon in 1530. He became the chief physician in the fleet of Martin Afonso de Sousa in 1534 when the new viceroy sailed for India. Living in Goa, de Orta became well-acquainted with many diseases and their local cures.

In Goa, Garcia de Orta cultivated a botanical garden full of spices and other medicinal plants. He corresponded with others regarding tropical treatments and published a book on tropical medicine in Goa in 1563. He was the first recorded person to conduct an autopsy in India, and performed an autopsy on a cholera victim, becoming the first European to describe cholera, among other diseases.

In 1543 Garcia de Orta married a relative who had converted to Christianity, but the marriage was troubled. Six years later de Orta managed to have his mother and two aunts sent to Goa after their arrest and persecution for being Jews. Garcia de Orta died in 1568, apparently without having been denounced himself. His sister was burned at the stake for her Jewish beliefs in the following year, and in 1580 de Orta was posthumously convicted of being a Jewish heretic and his body was exhumed and burned—a sad end for someone who contributed so much to medical science.

In 2003 forest fires affected more than 1.05 million acres (425,000 hectares), or five percent of the total land area of the country, during a series of fires that were the worst in Europe in 50 years. Portugal declared the whole country a disaster zone and received monetary aid from the Solidarity Fund of the EU. Despite governmental measures implemented to avoid large fires, the summers of 2004 and 2005 were again tragic. In 2005, during the worst drought experienced by the country in more than 50 years, some 320,000 acres (130,000 hectares) burned and 13 people died in fires in the center of the country.

Coastal urbanization for tourist development, especially in the Algarve, has also raised considerable concern. In this case, one of the more pressing issues is water availability. In 1998 the construction of the Alqueva Dam on the Guadiana River began. Once completed (in 2025), it will have created the largest artificial lake in Europe (97 square miles [250 square kilometers]), with a total capacity of 146 million cubic feet (4.150 cubic hectometers). Though originally designed for irrigation, a growing proportion of the water will go for tourism uses, especially golf courses. The dam's environmental effects are expected to be numerous. The Alqueva Dam will not only submerge prime agroecological land but it is thought that it will also affect fisheries at the mouth of the Guadiana River.

SEE ALSO: Acid Rain; Colonialism; Dams; Deforestation; Drinking Water; Fire; Fisheries; Pollution, Air; Pollution, Water; Soil Erosion; Timber Industry; Tourism.

BIBLIOGRAPHY. S. Diez et al., *Survey of Organotin Compounds in Rivers and Coastal Environments in Portugal 1999–2000* (Elsevier Ltd., 2006); E.P.R. Goncalves, R.A.R. Boaventura, and C. Mouvet, "Sediments and Aquatic Mosses as Pollution Indicators for Heavy Metals in the Ave River Basin (Portugal)," *Science of the Total Environment* (v.114, 1992); R.A. Shakesby et al., "Wildfire Impacts on Soil-Erosion and Hydrology in Wet Mediterranean Forest, Portugal," *International Journal of Wildland Fire* (v.3/2, 1993).

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Postcolonialism

POSTCOLONIALISM (also sometimes known as postcolonial theory, or post-oriental theory) refers to the legacy of 19th century European colonial rule. The study of postcolonialism acknowledges that colonialism continues to affect former colonies many decades following their political independence. Postcolonial studies articulate the many and complicated histories through which colonialism is still being reproduced.

Contemporary academic inquiry on postcolonialism owes much to the work of Edward Said. His book *Orientalism,* one of postcolonialism theory's seminal texts, investigates and articulates the means by which colonized peoples are constructed by colonizers. Specifically, Said describes the ways in which the Western world has wrongly depicted the Orient as a strange and exotic place. Said argues that postcolonialism can only be understood by acknowledging the means that reinforce and strengthen colonialism. Specifically, he demonstrates how European arts and literature have negatively represented the Orient as "Other." The result is that the knowledge produced and consumed by Western societies reinforces the superiority of the West over other peoples and cultures.

Another important contribution to postcolonial scholarship is Paul Gilroy's *The Black Atlantic*. This work traces the movement of black people from their native countries to the Western world and how these people, often treated as commodities by the West, have fought to establish their own distinct cultural identities counter to colonizers' dominant constructions of them. Through explorations of music and other art forms, Gilroy argues that this is a process that continues, subtly and not so subtly, to this day. Gilroy's work demonstrates how black culture is not exclusively African, American, Caribbean, or European, but a complex and simultaneous mixture of them all, a Black Atlantic Culture.

After more than two decades of development, postcolonial research is now an interdisciplinary field involving scholars from English literature, history, sociology, human geography, anthropology, cultural studies, and more. Researchers tackle the problems of how the experience of colonization affects those who were colonized; how colonial powers continue to control; what remnants of colonial control remain in education, science, and technology; what forms of resistance were and are being used against colonial control; how colonial education influences the culture and identity of the colonized; how Western science changes knowledge systems in the world; the emergent forms of postcolonial identity after the departure of the colonizers; whether decolonization and a return to the precolonial past is possible or desirable; and how new forms of imperialism might be emerging and replacing colonization.

In recent years, a slight backlash has occurred with certain scholars and journalists beginning to challenge some of the assumptions in postcolonial studies, claiming that previously colonized peoples are not the powerless victims they have been made out to be. These commentators have emphasized the extent to which previously colonized countries have shaped, and continue to shape, their own destinies, sometimes through empire building of their own. Cynics would suggest, however, that the intention of these arguments is to lay a certain amount of blame on previously colonized countries for their current threats to the Western world (such as terrorism). Hence, for many, the backlash is nothing more than another form of dangerous colonial power.

Postcolonial studies have affected everyday language and led to the replacement of marginalizing terms such as *third world*. In academic study and many other engagements between former colonizers and colonies, people—particularly in the Western world—have become more aware of the need to think more carefully about the way in which they act and interact. This is a subtle, but nevertheless important, change.

THE ENVIRONMENT

Postcolonial conditions impinge on the environment in a number of ways. First, postcolonial states often have a legacy of environmental management (e.g., forestry) rooted in colonial governance systems. These may be heavy-handed, out of step with local populations, or otherwise founded on the expropriative ways of colonial tradition. Game park management in Africa and Asia is evidence of such entrenched relations. Second, postcoloniality enforces a state of production and exchange relations in which dependency persists, and peripheral locations continue to exploit primary resources in service of core areas. The flow of value and externalized environmental costs is consistent with historical patterns, even in the early 21st century.

Third, and more subtly, postcolonialism can be seen in environmental knowledge relations, where ideas, systems, and paradigms are exported to postcolonial states where local knowledge traditions, training, and articulation of environmental issues and problems is silenced through the celebration and entrenchment of "expertise."

This last problem, so emblematic of historical relationships between official and lay knowledge, has serious implications for land management, wildlife preservation, and pollution abatement where local traditions are lost amid enthusiasm for environmental modernization. However, postcolonial conditions can conversely engender dangerous romances about indigenous ecological knowledge and traditions. This way of thinking may lead to patriarchal relationships and symbolic participation, reinforcing colonial relationships while claiming concern for preserving traditional environmental knowledge and values—essentially separating East from West or North from South—with all that follows from such distinctions. For these reasons, understanding colonialism is crucial to understanding environmental conditions and problems around the world.

SEE ALSO: Colonialism; National Parks; Orientalism.

BIBLIOGRAPHY. Bill Ashcroft et al, *The Empire Writes Back: Theory and Practice in Post-Colonial Literatures,* 2nd ed. (Routledge, 2002); Deepika Bahri, "Introduction to Postcolonial Studies," www.english.emory.edu/Bahri (cited January 2007); J. Briggs and J. Sharp, "Indigenous Knowledges and Development: A Postcolonial Caution," *Third World Quarterly* (v.25/4, 2004); Paul Gilroy, *The Black Atlantic: Modernity and Double Consciousness* (Cambridge, 1992); P. Robbins, "Research Is Theft: Rigorous Inquiry in a Postcolonial World," in G. Valentine and S. Aitken, eds., *Key Perspectives in Geography: Philosophies, People, Places, and Practices* (SAGE Publications, 2006); Edward Said, *Orientalism* (Vintage, 1979); J. Wainwright, "The Geographies of Political Ecology: After Edward Said," *Environment and Planning A* (v.37/6, 2005).

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Potatoes

THE POTATO IS an edible tuber originating in highlands of South America. Growing potatoes for food value has spread across the world to the extent that it is now the world's fourth most important food crop, following maize, wheat, and rice. The vegetable (*Solanum tuberosum*) is gaining in importance globally, resulting principally from increased growth in suitable areas of India and China. Global production has doubled over the last two decades and is forecast to do so again by 2020. China has the largest crop of potatoes, with annual production of around 80.5 million tons (73 million tonnes), from a worldwide total of 356 million tons (323 million tonnes). The Russian Federation produces 39.7 million tons (36 million tonnes) per year, and the third largest producer is India, which grows an estimated 27.6 million tons (25 million tonnes). The total value of the crop amounts to around $40 billion annually.

While potatoes are found in a number of different varieties, most share the characteristic of being low in vitamins and other nutrients but comparatively high in carbohydrates, making them a good source of energy. However, potatoes are also characterized by high levels of vitamin C and protein. The combination of ease of growth with the energy value of the plant means that potatoes are particularly important to people who are poor or forced to occupy marginal agricultural land. In recognition of this importance, the United Nations has designated 2008 the International Year of the Potato.

From its origins in the Peruvian and Bolivian plateau known as Titicaca, where as many as 5,500 different varieties have been developed over the years, the potato was taken to Europe by the Spanish and adapted itself to new climates at a time when rapid population increase was fueled by such transfers of technology. This process was not inevitable, nor was it immediately successful. Concerted efforts were required to make the potato popular in, for example, France, where it took nearly two centuries before it became accepted.

When potatoes were introduced in the United States, the wide open spaces of the Midwest states made large-scale production convenient and profitable. The leader in this process was a man named

Luther Burbank, who grew new varieties in the United States in the early 19th century, in particular the Russet Burbank, which remains one of the most popular varieties in the country. The domination of the U.S. environment by human endeavor, including the establishment of large-scale damming and irrigation projects, enabled the economies of scale that now characterize the country's agriculture. The desire to grow ever more quantities of crops such as potatoes has led to the physical transformation of a great deal of the landscape and it is far from clear if the use of water resources is sustainable. This has been accompanied by significant levels of research and development investment into the business of agriculture in the customary pattern of the public sector supporting the private. Despite all of this, new diseases and pestilences are still emerging in those areas around the world in which potatoes are being grown on a large-scale for the first time.

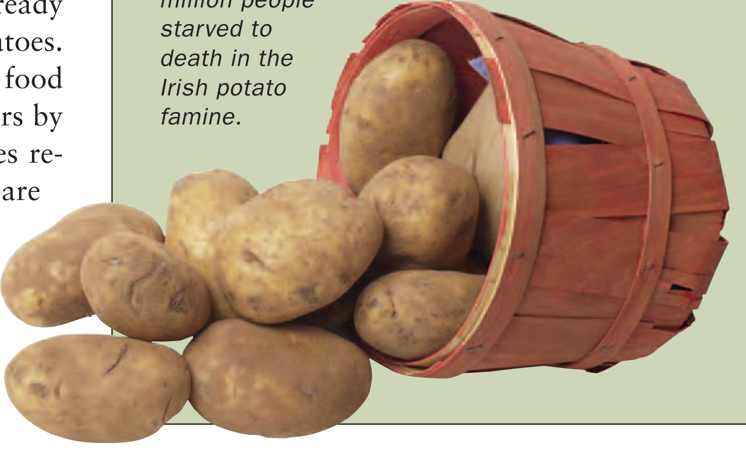
In terms of cuisine, potatoes have been found to be quite flexible in being adapted to local tastes and are prepared in many ways. Cooking is necessary because the raw potatoes contain chemical substances that can have negative health impacts. Care should also be taken about the black "eyes" that develop in potatoes and are also potentially problematic.

In the modern Western world, great quantities of potatoes are eaten in deep fried snack form, often with added salt, artificial coloring, and flavoring. These snacks are believed by some to add to obesity problems in the societies in which they have become popular. They have become part of the standard package of quick meals in leading multiple fast food chains and, for the sake of security of supply and taste, are customarily processed, powdered, and frozen, and such methods further reduce the already limited amount of vitamins within the potatoes. The move to becoming more of a processed food was stimulated among producers and marketers by declining sales led by fears of the health issues related to over-reliance on potatoes. Now there are fears in traditional rice-eating countries such as Japan that, as part of packaged fast food meals, the potato will suppress production of rice and will further contribute to the increasing obesity problem, not to mention the cultural implications. The use of potatoes in distilling vodka in the states of the former Soviet Union and neighboring areas has also contributed to excessive drunkenness as the failure of post-Communist policies has led to widespread popular discontent and despair. Again, a simple vegetable proves itself to have numerous uses into which deep meanings have become embedded to the extent that

The Irish Potato Famine

When the disease known as potato blight struck Ireland in the mid-19th century, it led to a terrible famine. A number of Western cultures had become dependent on the potato as a staple crop, and for many people in Ireland, potatoes were almost the only source of food. The reliance of Irish peasants upon the potato, which was also the principal form of animal fodder, had been intensified by the reliability of the crop, which had adapted well to high rainfall levels prevalent there. The famine was exacerbated by the refusal of British landlords to do anything to alleviate the suffering. Population levels have still not recovered from the subsequent starvation and mass emigration.

One minor consolation of the disaster was that it inspired a wave of scientific exploration aimed at determining the cause of the disease, properly known as *Phytophthora infestans*, which was identified as a fungoid infestation. This wave of research gave new momentum to the discipline of plant pathology.



More than one million people starved to death in the Irish potato famine.

it is almost impossible to separate the original item from its cultural significance.

SEE ALSO: Agriculture; Crop Plants; Ireland; Pests, Agricultural; United States, Midwest.

BIBLIOGRAPHY. Food and Agriculture Organization (FAO), "Buried Treasure: The Potato," *Spotlight* (FAO, 2006), www.fao.org (cited December 2006); Washington State Potato Commission, www.potatoes.com (cited December 2006); Larry Zuckerman, *The Potato: How the Humble Spud Rescued the Western World* (North Point Press, 1999).

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Poverty

THE RELATIONSHIP BETWEEN poverty and environmental degradation is one of the more contentious areas of sustainable development. The conventional view, often dating back to colonial attitudes, has been that the poor are to blame for environmental degradation. To a great extent this standpoint has been implicitly or explicitly supported by development agencies such as the World Bank and United Nations (UN) and the findings of key development forums, such as the UN-appointed World Commission on Environment and Development (WCED), which, in its 1987 report *Our Common Future,* brought to the fore the close causal links between environmental change and poverty:

> [M]any parts of the world are caught in a vicious downward spiral; poor people are forced to overuse environmental resources to survive from day to day, and their impoverishment of their environment further impoverishes them, making their survival ever more uncertain and difficult.

Similar assertions have been reiterated at subsequent global conferences, such as the Rio Earth Summit (1992), various UN meetings, and the Johannesburg conference of 2002.

However, this somewhat deterministic representation, that the poor degrade their environments and in that case only increased income (at the individual level) or economic growth (at the national level) can lead to more sustainable interactions between people and the environment, has a number of shortcomings. On the one hand such a simplistic poverty–environmental degradation nexus ignores or diminishes the importance of contextual factors. Subsequently this second view, that there is a complex web of factors that result in environmental degradation, of which poverty is only one of many, tends toward examining relationships around resource access (e.g., assets, land, labor, credit, markets), institutions (e.g., land tenure systems, governance) and vulnerability (e.g., seasonal versus long term networks, entitlements). These structural issues may offer a more dynamic and holistic basis of analyzing people's relationships (both poor and wealthy) with their environments as well as more constructive policy opportunities.

THE POVERTY-ENVIRONMENT NEXUS

International development agencies have paid at least some attention to relationships between poverty and the environment for a number of years. Making environmental concerns a more central concern of poverty has, in large part, been driven by the desire of the international community to meet its poverty eradication targets set in the Millennium Development Goals (MDGs). But what is the relationship between natural resources and poverty (or wealth), and what is the impact of poverty (and the poor) on the environment? Despite earlier, enduring, discourses that blamed the poor for environmental degradation and pollution, there is little evidence that such a nexus exists on any significant scale.

Consequently, third world leaders and populations often suspect that governments and environmental movements of the West are trying (through the environment-poverty-development debate) to limit the way they can exploit their own environments, keeping them permanently poor. This was a basis for conflict between developing countries and the West at both the Rio and Johannesburg sustainable development summits. Developing countries have been typically skeptical of forms of sustainable development that aim to protect the environment ahead of the pressing needs of the poor, for example through the creation of conservation parks and marine reserves. For them, poverty, underdevelopment, and global inequality (resulting from unequal terms of trade) are the most pressing problems facing the world and these have to be tackled before environmental problems can be adequately and holistically addressed.

The poverty-environment nexus therefore has a number of contentious aspects. First, there is the view that poverty alleviation is a more serious problem than environmental protection. These views are accentuated by fundamental and significant inequalities in wealth and access to resources within nation states and globally. These inequalities mean that the question of sustainability is framed quite differently for people in different parts of the world: they have contrasting needs, aspirations, resources and constraints. For someone in the West, sustainable development is about securing and preserving an environment in which to enjoy a comfortable standard of living and that can be equally enjoyed by one's descendants (intergenerational sustainability). It may also be about securing enough natural resources to offset global warming through protecting forests and large water bodies, often in developing countries (for example the Amazon basin). For someone below the poverty line in the third world, sustainable development may be about securing one's individual and cultural livelihood and meeting basic needs, and natural resources use is an important means by which to do this.

Consequently, while some argue that poverty is closely linked to environmental degradation, for others increased utilization and exploitation of natural resources, at an even greater rate than today, is the only realistic strategy for meeting current needs and for future development. Forests, agricultural lands, fisheries, wetlands, and rivers all support the livelihoods of people and communities. In fact, some 70 percent of the world's poor continue to live in rural areas and depend on their local environments for their daily survival.

Additional arguments suggest that environmental degradation causes human poverty. In other words, an environment with falling fish stocks, soil fertility, or forest cover can support fewer people. In urban areas degraded environments, primarily from unregulated industrial development and waste disposal, impact on urban communities living in marginal environments through exposure to polluted waterways, infectious and parasitic diseases, and other environmental and health hazards. Equally so these threats have as much to do with the governance of cities and the relative lack of power of the poor to demand provision of safe water, sewage and sanitation services, and access to social goods than poverty *per se*.

The poor are affected much more by environmental degradation and pollution, whether it emanates from their own communities or from the activities of others. A great amount of research has supported the observation that the poor are impacted by pollution and environmental degradation disproportionate to their contribution. Land degradation, desertification, flooding, and other hazards are more likely to impact on the poor, rather than the rich who are better serviced and often distant (or walled off in the case of cities) from degraded environments and industrialization. The poor's greater exposure to the impacts of pollution is accentuated by their geographical and social position and relative lack of influence over politics and policy. They are more likely to be exposed to environmental hazards in the workplace, the home, and in their neighborhoods. In third world cities the poor are less likely to have access to potable water, to have access to sewage and sanitation systems, and often do not have waste (both hazardous and nonhazardous) collected or disposed of safely. Even in wealthier Western cities research has shown that poorer urban citizens are more likely to live downwind of polluting industries and closer to sites of waste disposal.

POVERTY AND DEGRADATION

There is also a strong argument for a reverse connection: That poverty is not just a symptom of environmental degradation but is also a *cause*: Poor people are forced to degrade their environment because they have no other means to survive. This occurs when poor people with limited access to land or other resources are forced to overexploit such resources as they do have to the point where there is long-term damage to the environment. People may be marginalized through environmental conditions, poor soils, remoteness, difficult terrain, a hazardous environment, or socioeconomic reasons, or their livelihoods may have been disrupted or destroyed through their own activities, or the activities and decisions of others (particularly if they are less powerful vis-à-vis other social groups). This can take many forms: cultivating land every year without adequate fallow periods; overgrazing with too many stock for a given area of land; overfishing so that stocks do not naturally regenerate; and settling and using marginal lands that easily erode or lose fertility. As Robert Chambers has noted:

> Poor people in their struggle to survive are driven to doing environmental damage with long-term losses. Their herds overgraze; their shortening fallows on steep slopes and fragile soils induce erosion; their need for off-season incomes drives them to cut and sell firewood and to make and sell charcoal; they are forced to cultivate and degrade marginal and unstable land.

Such damage to the environment then leads to a situation where production falls in future years and fewer people can be supported, exacerbating the original problem of poverty. Poverty and the environment are therefore linked in a multidimensional relationship often referred to as the Poverty-Environmental Degradation Spiral. In this model poverty places unsustainable demands on local environments that lead to environmental damage resulting in resource depletion and declining productivity. Environmental degradation then serves to reinforce poverty, which leads to further environmental decline, and so on.

NATIONAL-LEVEL POVERTY

We can consider these examples at the micro-level, with what individuals or communities do when faced with poverty and falling environmental carrying capacity. Yet these processes also work on a larger scale: Nations suffer from poverty as well as individuals. Countries with massive debt burdens and crippling debt servicing costs face a similar situation to individuals with restricted access to resources. In order to extricate themselves from poverty, they use available resources heavily (for example, by milling rain forests or giving liberal mining or fishing concessions to overseas companies). At a national level poorer countries are more likely to be exporters of resources (such as timber) and sinks for the dumping of hazardous and toxic wastes from wealthier ones. This also includes the greater possibility of high-polluting industries being relocated from countries with stricter environmental standards (typically more developed nations) to states with less environmental standards or laxer regulation (typically developing countries). The environmental costs of development are then transported from wealthy to poorer regions and countries.

WEALTH AND DEGRADATION

It is important to note that poorer societies, and countries, have less of an impact on the environment that wealthier societies and states. Growth is necessary, it is suggested, in order to meet basic needs, but such growth need not be environmentally damaging. Focusing on the impact of the poor on the environment and the world's resources obfuscates the fact that the wealthy use a disproportionate amount of the world's water, energy, forestry, and food resources and, in turn, contribute the greater amount of waste that represents an ecological footprint far beyond the local scale—though research on wealth and environmental degradations across scales is less common.

In turn, promoting economic growth through exports based on monocrops as the answer to poverty and environmental degradation ignores the fact that the shift to more intensive large-scale farming (such as cotton, cocoa, and coffee) actually *increases* ecological impact and decreases benefits to poorer farmers and communities. Research has consistently shown that wealth and development has potentially greater environmental impacts than poverty and the poor.

The argument is often then made that a country's environmental wealth is plundered and impoverished to meet an immediate need and prevent (depending on whether we are discussing households or whole countries) poverty or bankruptcy. Poor or developing countries may then be unlikely to fund environmental protection, regulation, or sustainable development initiatives that inhibit the attraction of industrial relocation or even resource extraction operations. However, in both cases, the actions of the wealthy are as important as poverty as an environmental issue.

There is, consequently, a strong case for focusing on the structural causes of poverty in order to better understand and address environmental issues. This involves a more inclusive addressing of causality at a range of scales, from local to regional and global. It also involves understanding a number of processes, whether they be ecological, social, economic, cultural, or political. For example, the environmental conditions that many poor urban communities face are related to a lack of access to infrastructure, services, affordable land, healthy localities, and a lack of inclusion in urban governance, than purely income.

A SUSTAINABLE LIVELIHOODS APPROACH

A more dynamic approach to the poverty and environment debate is to focus on the factors that impact on people's livelihoods. Recently development agencies and practitioners have refocused on supporting sustainable livelihoods as a means of reducing poverty and the impact of poverty on the environment. Communities around the world are able to lead rich, dignified, and fulfilling lives when they are in charge of their natural resources.

To many of these people, and particularly those who are considered "poor" in the economic sense of the word, a fulfilling life is about much more than simply money or possessions. It is about their access to and control over natural resources and their involvement in decision-making processes about these resources.

For the Bagyeli tribe in Cameroon, for example, the creation of protected areas on their ancestral territories has infringed upon their individual and collective rights, marginalizing and impoverishing them—despite external views that see the creation of protected parks as the basis for sustainability. They believe that any poverty reduction strategy proposed by the government or by external funding organizations must include their participation, and must be based on their collective right of access to land and forest resources. As one indigenous Bagyeli person exclaimed:

> If you do not collect fruits, you cannot have soap; if you do not go fishing, you cannot eat salt; if you do not cultivate plantains to sell you cannot buy clothes. I am dirty and without clothes because I do not do anything. I have already been forbidden from entering the forest.

Among the more holistic and progressive ways to examine the poverty-development-environment nexus is the Sustainable Livelihoods Approach (SLA), which can be used for identifying where constraints or opportunities lie and for developing policy. It is a potentially useful tool for communities and policy makers alike as it views people as operating in a context of vulnerability. Within this context, they have access to certain assets or poverty reducing factors. These gain their meaning and value through the prevailing social, institutional and organizational environment. This environment also influences the livelihood strategies—ways of combining and using assets—that are open to people in pursuit of beneficial livelihood outcomes that meet their own livelihood objectives. The objective of the SLA is to *support* people's livelihoods, increasing the sustainability of people's livelihoods, as a means of eliminating poverty. This is best achieved through promoting more secure access to, and better management of, natural resources rather than excluding the poor from their sources of livelihood.

At a practical level, this means that an initiative must start with an analysis of people's livelihoods and how these have been changing over time; fully involve people and respect their views; focus on the impact of different policy and institutional arrangements on people/households and on the dimensions of poverty they define (rather than on resources or overall output *per se*); stress the importance of influencing these policies and institutional arrangements so they promote the agenda of the poor (a key step is political participation by the poor themselves); bridge gaps between the macro and micro levels, recognize the importance of macro level policy/institutions to the livelihood options available at the micro level; and work to support people to achieve their own livelihood goals.

Another key element of the structural approach is the emphasis on social equity, justice, and liberation. Just as there are basic material needs for people, there are also fundamental social needs and considerations of injustice. Unjust societies are not sustainable societies because they rest on the exploitation or subordination of one group in society by another. Therefore, sustainable development is not possible within the context of an unjust society because large elements of that society cannot survive and function. This approach, then, places stress on the removal of injustices and inequalities within societies. Dealing with these injustices and inequalities is, to the oppressed or poor concerned, their most pressing development need. Talk of sustainability is meaningless when such conditions persist. Consequently, rather than focus on the (static) argument that poverty and the poor degrade the environment, sustainable development must incorporate notions of social justice and be directed at achieving sustainable societies (in an ideal world free of injustice and major inequalities) as a precondition for environmental sustainability. Writers from a political ecology framework argue that poverty and the environment are interrelated around issues of combating poverty, inequality, and injustice. These are essential steps to achieving sustainable development. Such a strategy aims to achieve not just environmental sustainability but also the sustainability of just and equitable societies.

At its most basic level, many of the debates over the poverty-environment nexus revolve around whether human or environmental needs are given priority and whether "development," if it is defined as neo-liberal capitalism, can ever be sustainable. Effectively dealing with poverty, and addressing the causes of poverty, is fundamental to environmental sustainability. The poverty-environment nexus goes beyond a question of degradation and into issues of rights, access, entitlements, local institutions, property rights, and decision making power over the use of resources. The links between poverty and the environment are therefore likely to be context specific and most effectively examined at relevant spatial and social scales. Far from being a straightforward issue of the poor degrading the environment at unsustainable rates, a much more mutually dependent and dynamic relationship between poverty and the environment exists.

SEE ALSO: Livelihood; Movements, Environmental; National Parks; Political Ecology; Subsistence.

BIBLIOGRAPHY: Friends of the Earth International, *Nature—Poor People's Wealth: The Importance of Natural Resources in Poverty Eradication* (Friends of the Earth International, 2005); Leslie Gray and William Moseley, "A Geographical Perspective on Poverty-Environment Interactions," *The Geographical Journal* (v.171/1, 2005); David Satterthwaite, "The Links between Poverty and the Environment in Urban Areas of Africa, Asia and Latin America," *Annals, The American Academy of Political and Social Science* (v.590, 2003); World Resources Institute, *World Resources 2005: The Wealth of the Poor—Managing Ecosystems to Fight Poverty* (World Resources Institute, 2005).

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Powell, John Wesley (1834–1902)

A CHILD OF America's mid-19th century western agricultural frontier and a celebrated explorer of the Grand Canyon, John Wesley Powell devoted his remarkable career as a scientist and, for a time, powerful U.S. bureaucrat, to the expansion of scientific work in the federal government. He focused on the survey and mapping sciences of geology, geography, and ethnology (i.e., the study of American Indian language and culture). Powell was director of the U.S. Geological Survey (1881–94), founding director of the Smithsonian Institution's Bureau of Ethnology (1879–1902), and earlier, leader of the Geographical and Geological Survey of the Rocky Mountain Region (~1869–79), known as the Powell Survey. In each of these offices, Powell expanded the reach of government-supported survey, mapping, and research projects, and in doing so, sought to bring scientific knowledge to bear, both directly and indirectly, on problems of environmental and resource governance, particularly those associated with American agricultural expansion and settlement in the arid West during the late 19th century.

Though he became a keen spokesman for Washington's emerging scientific community in the 1870s and 1880s, Powell's own expertise was initially built on the success of his Colorado River expeditions and he had a limited formal scientific education. A native of central Illinois, he undertook these expeditions while still a geology professor and museum curator. That Powell piloted the voyages, despite having lost much of his right arm in the U.S. Civil War, remains an astonishing feat. But Powell's contributions to the earth sciences, including his development of general concepts of baselevel of erosion, antecedent and subsequent rivers, and runoff, were also built on skillful synthesis and analysis of observations in the West, including subsequent survey work on the Colorado Plateau in southern Utah.

Operating under the Smithsonian Institution and U.S. Department of the Interior, the Powell Survey joined three other federally sponsored surveys in the West. Some of this work Powell managed from Washington, where he garnered Congressional appropriations in support of ongoing triangulation surveys, topographical mapping, and geological and ethnological studies. Key works produced during this period include Powell's *Explorations of the Colorado River of the West and Its Tributaries* (1875), which blended geological observations with exploration narrative, the *Report on the Geology of the Eastern Portion of the Uinta Mountains* (1876), and the collaborative *Report on the Lands of the Arid Region of the United States* (1878).

In the latter volume, in which the Utah Territory served as a model for U.S. arid lands as a whole, Powell introduced a land use classification system delineating land as (potentially) irrigable, pasturage, or timber regions, based on topographical, geographical, and geological characteristics. While the book intended to "set forth the characteristics of these lands and the conditions under which they can be most profitably utilized," it insisted that these conditions were circumscribed by the limits of irrigation technology and of nature itself in the arid West.

The report called for sweeping reforms of the Homestead, Desert Land, and Timber Cultures Acts, arguing that government distribution and regulation of public lands must better reflect the physical conditions of the region. In his advocacy of more efficient land and resource usage, Powell also criticized Native American land use practices, especially the use of fire to drive game, and he called for the removal of the tribes to federal Indian reservations as a solution to the problems of resource conflict and violence between the white miners and settlers and Native Americans.

Two years after the four western surveys were consolidated into the U.S. Geological Survey (USGS) in 1879, Powell was named to direct the agency. He established goals for an ambitious national mapping program organized around the mission of a complete topographical map of the United States (in 2,600 sheets) which would provide the basis, in turn, for a comprehensive national geological map. The maps were to be widely distributed for public use.

In the late 1880s, Powell also came to direct a federal irrigation survey of U.S. public lands in the western states and territories, in the course of which he attempted to set in place a system of land use classification similar to that he had called for in his Arid Lands Report. The resulting enmity from western senators, who perceived that Powell was slowing the pace of economic development in the West, would kill the irrigation survey, and Powell's land reform plans, before they took shape.

Powell resigned from the USGS directorship in 1894, but his national mapping programs continued; he departed the survey as a pioneer of the sciences in American government and of the geo-coded world.

SEE ALSO: Grand Canyon; Maps; Native Americans; U.S. Geological Survey.

BIBLIOGRAPHY. William Morris Davis, "Biographical Memoir of John Wesley Powell, 1834–1902" *National Academy of Sciences, Biographical Memoirs* (v.III, 1915); John Wesley Powell, *Report on the Lands of the Arid Region of the United States*, W. Stegner, ed. (Belknap Press, 1962); Wallace Stegner, *Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West* (Penguin Books, 1992); Donald Worster, *A River Running West: The Life of John Wesley Powell* (Oxford University Press, 2001).

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Pragmatism

PRAGMATISM AS A school of philosophy arose in (and has remained for the most part confined to) North America in the late 19th century. Pragmatism's most well-known and influential early theorists included Charles Sanders Peirce, William James, John Dewey, and George Herbert Mead. Though not as well-known or widely appreciated internationally—or even within American academic philosophy—as many European philosophers, these "classical" American pragmatists continue to inform a diverse and evolving contemporary American pragmatism.

Perhaps most fundamentally, "all [pragmatists] agree in their rejection of foundationalist epistemology." Pragmatist anti-foundationalism should not, however, be thought to reflect an antirealism or antinaturalism. The early pragmatists, particularly Peirce and Dewey, were intensely interested in theorizing the nature of scientific inquiry—in large part for the sake of the development of the practice(s) of natural science. For pragmatists, we *must* continue our scientific investigations into the "truths" of the world; but our explanations must proceed without recourse to a priori, unchanging "laws." This emphasis on experience and *experiment* (and perhaps the near conflation of the two) "led James to call his philosophy 'radical empiricism,'" according to Kelly Parker. All explanation is the product of experience, and experience has proven that our understandings of the world are nothing if not "fallible."

The concept of "fallibilism"—originally theorized by Peirce—is also integral to pragmatism. Human beliefs are necessarily based in certain fundamental constructs. All such constructs—whether guiding natural science or social inquiry—are also necessarily fallible. We can never, in other words, assume that there is any transhistorical correctness underlying a particular concept of belief. Emphatically for pragmatists, however, this should not be construed to mean that no beliefs or constructs are correct or accurate. It is more that, as Larry Hickman puts it, "we *may* be able to get it [a belief or construct] better and better, truer and truer, but we *never* get it completely right" (emphasis added). "May" and "better" are primary qualifiers in this sentence. To anyone who would conflate the pragmatist optimism, inherent in this sentence, that "we may be able to get it…truer and truer," with the Enlightenment "project" of the accumulation of knowledge increasingly nearing absolute Truth, it could be pointed out that we only ever know that we *may* be getting it truer. So there is a point in trying, a necessity for inquiry, to be sure, but it is unverifiable—and therefore a nonissue—to argue whether the development of any particular truth is approaching Truth. To staunch antimetaphysicalists (e.g., most poststructuralists) who might quarrel that "better and better, truer and truer," still harbors an implication that there is a transhistorical end-state toward which we "think" we might be headed, the flat declaration that follows, that "we [know we] never get it completely right," should sufficiently silence this charge.

Pragmatist anti-foundationalism and empiricism are thus based in a desire to explain and understand the world, but in a less epistemologically confident manner than as practiced within predominant modes of Western science.

ENVIRONMENTAL PRAGMATISM

In 1996, Andrew Light and Eric Katz proposed a focused "*environmental* pragmatism" as a solution to a definable problem within environmental philosophy: its lack of practical influence on environmental science, activism, or policy. To remedy this perceived deficiency, they suggest that "the fruits of this philosophical enterprise should be directed toward the practical resolution of environmental problems." Of particular concern to Light and Katz was the observation that environmental philosophy remained mired in a "theoretical dogmatism," with the majority of environmental philosophers committed to the belief that only a nonanthropocentric environmental ethics "will yield a morally justifiable environmental philosophy."

Philosophical and practical opposition to the moral monism that results from dogmatic nonanthropocentrism and theories of intrinsic value in nature is probably the broadest base of common ground between the contributing authors in Light and Katz's 1996 edited collection *Environmental Pragmatism*, defining a subfield of environmental studies that has grown substantially in the decade since.

SEE ALSO: Conservation; Environmentalism; Nature, Social Construction of.

BIBLIOGRAPHY. Larry Hickman, "John Dewey's Pragmatic Naturalism," in A. Light and E. Katz, eds., *Environmental Pragmatism* (Routledge, 1996); Andrew Light and Eric Katz, eds., *Environmental Pragmatism* (Routledge, 1996); Ben Minteer, "Beyond Considerability: A Deweyan View of the Animal Rights–Environmental Ethics Debate," in Erin McKenna and Andrew Light, eds., *Animal Pragmatism: Rethinking Human-Nonhuman Relationships* (Indiana University Press, 2004); Kelly Parker, "Pragmatism and Environmental Thought," in A. Light and E. Katz, eds., *Environmental Pragmatism* (Routledge, 1996); J.S. Robert, "Wild Ontology: Elaborating Environmental Pragmatism," *Ethics and the Environment,* (v.5, 2000).

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Prairie

PRAIRIE IS A type of grassland that is characterized by the presence of grasses without many trees and a generally low altitude with few hills or other uplands. The prairie tends to promote the lifestyle of herders or nomads and has in more recent years become home to large-scale and often intensive agriculture which may have required the resettling of indigenous people away from their traditional lands.

Although it is possible to categorize the pampas of Argentina or the steppes of Central Asia as prairie, the term is more usually applied (particularly in the United States) to the rolling grassland that covers more than two million square miles of the central United States and extends into parts of Canada. These lands have become almost mythologized in the American psyche for their role in opening up the west of the continent and as remote, rural agricultural areas.

It is believed that French explorers of what is now the central United States labeled the high plains regions of states such as Kansas, Oklahoma, and the Dakotas, as well as the mid-plains to the east, ranging from Texas to Manitoba in Canada, as prairie or meadow. Almost the entirety of this vast area of land has now been transformed to become farmland, either through dryland techniques or, more recently, by drawing upon the below-ground water resources of the Ogallala Aquifer. The nature of the topography lends itself to economies of scale and scope in agriculture. This was accentuated by the allocation of land as a very cheap resource to settler families. Consequently, the transformation of the land into cattle or crop growing territory has been conducted on a large and uniform scale. This form of agriculture has enabled farmers to provide large amounts of produce of comparatively even quality and low cost. This has had significant impact upon the ability of farmers to feed a growing population and also to export food.

One of the main problems threatening the sustainability of existing living practices in North American prairie regions is the provision of water resources. The depletion of the Ogallala Aquifer and existing above-ground water resources, together with continuing increase in demand for water and the changes being wrought by global climate change, mean that most agricultural and residential practices will have to change significantly.

Since the 1970s the U.S. government has been encouraging and legislating for changes in the high plains regions, in particular, to try to mitigate excessive strain on water resources. This has included changes in agricultural practice and in patterns of urban residential planning. However, these changes as presently manifested are likely to prove insufficient. New regulatory structures and licensing systems might prove to be effective in the short and medium term through trading of water rights and diversion of resources. As climate change leads to alterations in the regular pattern of seasons, changes in demand for power and water will stretch existing preparations for supply and demand management of these goods.

Wildlife supported by prairie regions has been considerably reduced in terms of variety and number as agriculture has spread across the land and transformed it. This makes nature reservations of great importance in maintaining existing stocks and offering the opportunity to rebuild depleted stocks of at least some species. Maintaining reservations against the pressures for commercial development will require strong and well-policed regulation allied with a high level of political will.

SEE ALSO: Dryland Farming; Grasslands; Livestock; Ogallala Aquifer; Water Demand.

BIBLIOGRAPHY. Dennis S. Nordin and Roy V. Scott, *From Prairie Farmer to Entrepreneur: The Transformation of Midwestern Agriculture* (Indiana University Press, 2005); David R. Percy, "Responding to Water Scarcity in Western Canada," *Texas Law Review* (v.83/7, June 2005); Candace Savage, *Prairie: A Natural History* (Greystone Books, 2004); J.E. Weaver, *Prairie Plants and Their Environment: A Fifty Year Study in the Midwest*, reprint ed. (University of Nebraska Press, 1991).

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Precautionary Principle

THE PRECAUTIONARY PRINCIPLE is a response to uncertainties over potentially harmful impacts to humans and the environment. The precautionary principle can be described in two ways. First, it specifies that it is better to avoid a set of actions if they contain potential serious or irreversible negative outcomes. In a more active form, taking a precautionary approach may necessitate action to avoid the potential negative consequences of delay or inaction.

A precautionary approach is used to manage potentially harmful actions (e.g., illegal hunting), processes (e.g., nuclear proliferation), products (e.g., asbestos) and technologies (e.g., genetically modified organisms). The precautionary principle can be implemented to secure personal well-being in the face of external threats or may be applied altruistically in order to safeguard resources and prevent potential harm to others, including future generations. It is this condition—the difficult task of projecting risks and benefits into the future in order to make informed decisions today—that often draws the ire of antiprecautionary advocates.

The precise origins of the precautionary principle are difficult to pin down, especially in light of the principle's contemporary widespread appeal and seemingly rational "look before you leap" logic (although there are strong counter-sentiments to be addressed below). The term can be traced to the German implementation of the foresight principle, or *Vorsorgeprinzip*, in environmental law during the 1970s. The 1982 World Charter for Nature was one of the first international endorsements of the precautionary principle. In 1992, Article 130r of the Maastricht Treaty noted that newly formed European Union (EU) environmental policies would be "based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay."

Managing complex health and environmental affairs in the face of scientific uncertainties has rendered the precautionary principle a common governance axiom. In this context, the precautionary principle suggests that anticipatory action to prevent possible negative outcomes on human health and the environment is worthwhile despite a lack of clear evidence on the risks or the benefits of alternative measures. This is different from "burden of proof" protocols guiding many environmental management decisions where "business as usual" tactics often persist unless there is clear evidence supporting an alternative development path. In the face of scientific uncertainty over potential harms, a "better safe than sorry" approach is usually established by those following precautionary principles.

Precautionary decisions in the policy arena are oftentimes supported by a cost–benefit analysis to measure the risks and rewards of action in monetary, social, and ecological terms. Under this analysis, nonmitigating and mitigating action costs, opportunity costs (or the cost of lost opportunities as a result of a particular chosen course of action), and the option value of putting off action to a later date are all assessed in an effort to find the most efficient path forward.

In the modern-day policy making climate, the decision to apply precautionary principles cannot be reduced merely to an objective debate over the scientific certainty of future events. Instead, decisions involving the management of environmental resources and the well-being of future generations are heavily influenced by politics. Not only is scientific evidence interpreted differently by various interest groups, it is also produced in various capacities to support political ends.

Two notable examples illustrate the use of the precautionary principle. The Montreal and Kyoto Protocols, though different in eventual outcomes, have become widely accepted through the application of precautionary principles. Both the Montreal Protocol, which bans the production of ozone depleting substances, and the Kyoto Protocol, which reduces levels of greenhouse gas emissions, concern themselves with environmental systems that influence a global array of individuals and communities. While the Montreal Protocol is ratified by the major economic powers and exhibits widespread adherence, the Kyoto Protocol lacks the same level of commitment from developed nations, most notably the United States. Nevertheless, the commitment by nations to sign and in some cases ratify these international treaties—especially in the face of significant uncertainties over the accuracy of complex, long-term climate and upper-level atmospheric models—points to the tractability of the precautionary principle in the global policy arena.

Other international protocols, such as the Río Declaration on Environment and Development, signal, at least rhetorically, a commitment to precautionary global environmental governance. Principle 15 of the 1992 Río Declaration specifically states:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Though the precautionary principle has garnered much support over the past 15 years, a number of criticisms remain. The most vocal concerns come from antiprotectionists, supporters of technological innovation, and libertarians advocating personal freedom. Free trade advocates such as the World Trade Organization (WTO) argue that definitive proof should be required before potential health and environmental hazards precipitate the formation of barriers to trade.

One example is the WTO's position that the EU's six-year moratorium on genetically modified (GM) food imports from the United States is illegal. The EU ban, premised on the uncertain health effects of GM foods, was finally lifted in 2004 under pressure from the WTO to eliminate protectionist economic policies.

Others argue that technological innovation is inhibited by the precautionary principle. A risk-averse society denies the potential for technological developments that could potentially help, not harm, society. In this context, these groups often refer to once controversial, now widely accepted drugs and medical procedures found in the health care industry. Others are particularly concerned with a loss of personal freedom to innovate arising under strict adherence to the precautionary principle. These critics instead follow "proactionary" principles. Coined in 2004 by Natasha Vita-More, the proactionary principle suggests that many of history's great technological achievements were not well understood at the time of their discovery.

SEE ALSO: Cost-Benefit Analysis; Intergeneration Equity; Kyoto Protocol; Montreal Protocol; Polluter Pays Concept; Rio Declaration on Environment and Development; World Trade Organization.

BIBLIOGRAPHY. Michael Crichton, *State of Fear* (HarperCollins, 2004); Indur Goklany, *The Precautionary Principle: A Critical Appraisal* (Cato Institute, 2001); Poul Harremoës, *The Precautionary Principle in the 20th Century: Late Lessons from Early Warnings* (Earthscan, 2002); Timothy O'Riordan and James Cameron, *Interpreting the Precautionary Principle* (Earthscan, 1994); Carolyn Raffensperger and Joel Tickner, *Protecting Public Health and the Environment: Implementing the Precautionary Principle* (Island Press, 1999).

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Precipitation

PRECIPITATION REFERS BOTH to the process by which particles fall from clouds to the earth below, and to those particles themselves. Owing to various chemical and physical actions, cloud droplets that would otherwise remain in the atmosphere can aggregate around an ice or liquid core until they achieve a mass that causes them to fall from the sky.

The different forms of precipitation that are possible include rain, snow, hail, and sleet. The type that forms depends on the specific weather conditions prevailing within the cloud and during the time between creation of the particle and its arrival on the ground. For example, cloud conditions may be such that ice particles form and start to fall to the ground, but the air conditions closer to the ground are sufficiently warm enough to melt the ice before it arrives. In any case, the process by which particles form and become larger is primarily the result of collisions with other cloud droplets and coalescence into larger particles. The speed with which this occurs depends upon specific local conditions, but it can take only a few minutes for the one million or so collisions to take place in favorable conditions and for precipitation to begin.

In particularly unusual climatic conditions, it is possible for a large group of small animals like frogs to be swept into the air and deposited as precipitation at a distant location. More commonly and predictably, dust or sand from desert areas can be regularly borne aloft and precipitated in other areas, as occurs with the red dust rain that derives from Xinjiang and arrives in Beijing periodically. The distance between the origin and ending of the precipitation process can lead to complex legal issues of responsibility in those cases where precipitation has, through pollution, led to damage to the environment. An example of this has been the acid rain that was produced by industrial activities in parts of Britain and then fell on Scandinavia.

The level, type, and nature of precipitation can have a significant impact upon the fertility of land on which it falls and, therefore, the ability of the land to sustain human and animal populations. The factors that can influence precipitation include the presence of ocean currents such as the Gulf Stream; the topography of mountains, basins, and depressions; wind patterns; and the distribution of banks of air in the atmosphere. These factors interact with each other in very complex ways, which makes prediction of the impact of attempts to modify weather very difficult.

The impact of future climate change is also very difficult to predict, although intensification of many existing meteorological phenomena is likely. Research suggests that human civilization can adapt to climatic changes within a comparatively narrow range but, especially when urbanization has taken place, will collapse when more extreme changes are indicated. The predictions of future climate changes, based on trends that have already been issued, would include some that exceed the narrow range of survivability of human civilization. Significant levels of resources would be required to withstand the more intense hurricanes, rainfall, and extreme forms of weather that may become more common in future.

Land areas that receive less than 250 millimeters of precipitation annually are classified as deserts, irrespective of the ground temperature. Much of the polar regions of the world are deserts, along with the very hot lands of the Sahara and the Kalahari. These lands are very dry and consequently sustain comparatively fewer forms of life than other parts of the world—and those life forms are specialized to deal with the conditions. Approximately one third of nonpolar land on the planet is classified as desert.

By contrast, some areas have very high levels of annual rainfall and this helps them support rainforests or tropical rain forests, which sustain a very diverse set of flora and fauna. These areas receive the majority of their rainfall from seasonal patterns, such as the monsoon rains that water much of south and southeast Asia. This includes various parts of India, which are the wettest places in the world, with annual rainfall exceeding 11 millimeters. The islands of Hawaii can also receive extremely high levels of precipitation because of the specific local conditions. The relatively even temperatures of oceans compared to land also tends to ensure that coastal lands receive more precipitation than falls offshore, as in the case of Ireland, which receives a great deal of the precipitation from clouds that have passed across the Atlantic Ocean.

Human activities can also have an impact upon the nature and level of precipitation. Since undergrowth and forest cover help to trap water in the ground, this leads to a cycle of greater fertility, which means that the larger plants can continue to thrive. Should those plants or trees be cut down for agricultural or commercial purposes, then the ability of the land to retain water will degenerate and this can lead to problems with flooding and mudslides and the desertification of forest land. This in turn affects the specific local weather conditions, reducing precipitation and intensifying the loss of plant life.

SEE ALSO: Acid Rain; Desert; Rainforests; Runoff.

BIBLIOGRAPHY. Tim Flannery, *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth* (Atlantic Monthly Press, 2006); Eugene Linden, *The Winds of Change: Climate, Weather, and the Destruction of Civilizations* (Simon & Schuster, 2006); H.R. Pruppacher and J.D. Klett, *Microphysics of Clouds and Precipitation* (Springer, 1996).

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Predator/Prey Relations

PREDATOR/PREY RELATIONS REFER to the population dynamics between any heterotrophic species (consumers) and the species that it feeds on. The term "predator" in this usage refers to primary consumers (herbivores) as well as secondary and tertiary consumers (carnivores, top carnivores, and omnivores). The concept is crucial to understanding species demography, trophic hierarchies, ecosystem stability, and biodiversity conservation.

The works of Lotka and Volterra during the 1920s form the basis of much subsequent work. Lotka examined the competitive interactions between species, both in terms of intertrophic competition but also with competition between species for similar resources (interference), in terms of the laws of thermodynamics, bringing the concept of energy flow and efficiency into synthesis with Darwninian competition. This was further elaborated upon by Lindemann, Elton, and MacArthur and ultimately culminated in Odum's concept of the ecosystem. The Lotka-Volterra model of predator/prey relations describes the populations of both predator and prey species as fluctuating together, with the changes to the predator population lagging behind that of its prey in time. In such a model, neither the predator nor the prey become extinct, as predator populations will decline as prey populations decline, and the resultant decline in predators allow the prey population to recover.

The actual variance in abundance of predator and prey populations is affected by specific characteristics of the predator. A predator that has a narrow range of prey species (a stenophagous predator) will have its populations fluctuate in accord with the predictions of the Lotka-Volterra model. The abundance of the prey species in such a situation exerts a greater control on the populations of the predator, and extinction of either predator or prey species is not likely.

Alternatively, a predator that consumes a wide range of prey species (a euryphagous predator), exerts greater control on the overall abundance of each species, with variable effects on biodiversity. A euryphagous predator can reduce the biodiversity of an area by eating one or more of its prey species to extinction because of its wide dietary range and the presence of other species to feed upon. A euryphagous predator can also increase the biodiversity of an area by limiting the overall abundance of each of its prey species and preventing any one of them from becoming dominant. That is, were the predator to be removed from the environment, the abundance of each prey species would be regulated by interference competition, with a greater likelihood that one or more of these species would be driven to extinction by competitive exclusion.

ECOSYSTEM STABILITY

These concepts of predator/prey relations are crucial to understanding dominant ideas of ecosystem stability. The general premise of ecosystem stability states that greater native biodiversity within an ecosystem provides stability, where stability is defined as the maintenance of a constant community structure (that is, an ecosystem is considered stable when the species composition does not change). This statement is further elaborated upon to specify that a high level of biodiversity across all trophic levels provides stability. As the number of predator and prey species increases, according to this argument, intratrophic competition increases. Predators become more efficient in and specialized to a narrower niche and hence are more likely to be stenophagous. With a greater incidence of stenophagous predators, control of overall population numbers shifts to the bottom of the trophic levels (producers), extinctions are less likely to occur, and the higher levels of efficiency mean that all environmental resources are consumed and cycled, making it more difficult for a species from outside the ecosystem to become established within it. Hence, species composition remains stable and the ecosystem is considered stable. This line of reasoning has guided conservation practice throughout the latter half of the 20th century and into the 21st.

SPECIES INVASIONS

In terms of human-environment interaction, predator/prey relations have informed knowledge of the process and management of species invasions. Some factors commonly cited as allowing for the success of an invader in a new environment relate to it often being a generalist predator, and having escaped its natural predators. Hence, some invasive species are seen to drive the extinctions of several prey species that are not adapted to predation by the predator, while the new predator has nothing to keep its own population in check and vastly expands its own numbers at the expense of the native biodiversity.

Managers have used predator/prey models in controlling invasive species, often through biotic control. Biotic control involves introducing a predator species that is stenophagous toward the targeted invasive species, with the reasoning being that this new specialized predator will keep the number of the invasive species down while not preying on the native species in the ecosystem. Nevertheless, examples exist where the biotic control species expanded its dietary range upon being introduced to a new environment, and became a pest as well.

Questions of predator/prey relations also surface in conflicts over conservation efforts, especially in relation to the reintroduction of predators into an environment. For example, during the 1930s wolves were systematically eradicated from the American West because they were seen as livestock pests; this resulted in explosions of populations of primary consumer species such as mule deer and elk. These consumers then were seen to further reduce the biodiversity of the vegetation due to over-browsing. Conservationists have encouraged the reintroduction of predators such as wolves, bears, and cougars, but these measures are often met by resistance over economic and safety concerns.

SEE ALSO: Lotka-Volterra Curve; Native Species; Wolves.

BIBLIOGRAPHY: Daniel Botkin, *Discordant Harmonies. A New Ecology for the Twenty First Century* (Oxford University Press, 1991); Charles S. Elton, *The Ecology of Invasions by Animals and Plants* (University of Chicago Press, 1958); Mark V. Lomolino, Dov F. Sax, and James H. Brown, *Foundations of Biogeography: Classic Papers with Commentary* (University of Chicago Press, 2004); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley & Sons, 2003); Leslie H. Real and James H. Brown, *Foundations of Ecology: Classic Papers with Commentary* (The University of Chicago Press, 1991).

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Prescribed Burning

PRESCRIBED BURNING, ALSO known as "controlled burning," refers to the planned use of fire in different environments for a wide range of reasons, including reduction of wildfire severity, protecting grasslands from forest incursion, and simulating prior fire regimes. Although the term was developed only in the late 20th century, the practice of prescribed burning has been applied throughout human history.

The word *prescribed* is used as these fires are set only once certain environmental parameters are achieved. In industrialized societies, the parameters are generally based on quantitative thresholds for a range of factors such as wind speed and direction, air temperature, relative humidity, and moisture content of vegetative fuels and soil. Together with attributes such as local topography, these influence fire behavior, intensity, and rate of spread. Thresholds are usually determined empirically following research into fire behavior and are established to ensure that the fire can be contained while achieving management objectives.

However, generations of experience also provide the basis for knowing where and when to burn for best results. Indigenous peoples have long employed fire for environmental management. After 40,000 years some Australian Aboriginal communities continue to use fire to achieve a range of habitat and cultural outcomes. For example, fires are set to stimulate germination of grasses that attract kangaroos and other game for hunting and to thin out trees and shrubs to ease movement and habitation. Native Americans also burned selected areas regularly to favor grass species over trees and shrubs and improve grazing for game. Other societies share long histories of using fire as a land management tool. In Europe, fire was used for centuries to clear land, improve its short-term fertility, or bring about changes in vegetation structure to suit farming or hunting objectives.

Central to understanding the environmental consequences of prescribed burning is the concept of the fire regime. This refers to the frequency, intensity, season, and fire types, natural or otherwise, that have occurred in an area over time. Species, especially flora, evolve responses to fire regimes that enable them to persist in the ecosystem in the face of fire, but their adaptive responses relate to the historical fire regime. Therefore, changes to a fire regime, including the exclusion of fire, may cause changes in the species composition of an ecosystem. Prescribed burning imposes human fire regimes on the environment, contributing to the shaping of the landscape as a cultural artifact.

In New World countries such as the United States, Canada, and Australia, colonial settlement and agriculture interrupted fire regimes and ecosystems associated with indigenous environmental management practices. Wary of the threat that wildfires represented to their lives and assets, European settlers tended to suppress fires in the landscape. Ironically, these changes often produced a more wildfire-prone environment. Shrubs and trees replaced grasslands and forest densities increased. Of course, heightened fuel levels meant that when wildfires inevitably occurred they did so with greater severity.

After World War II, research into fire behavior and its role in the environment made clear the need to include fire as an integral part of land management in order to restore or maintain historic vegetation patterns and fire regimes. This represented a paradigm shift, which, together with improvements in the technology to conduct and control prescribed burning, resulted in an increase in its use particularly in silvicultural practice to reduce wildfire risk and to manage forest estates. Its use has also increased as a means of reducing wildfire risk to urban environments. Prescribed burns conducted to reduce wildfire risks are often referred to as “hazard reduction” or “fuel reduction” burns. They are of low intensity so they may be contained; yet they are hot enough to consume the vegetative material that might otherwise become fuel during a wildfire. Hazard reduction burns need to be conducted every few years, depending on the vegetation, to keep fuel levels low.

The advent of frequent hazard reduction burning, particularly to protect urban environments at the wildland-urban interface, has led to concerns that some species that coevolved with indigenous or natural fire regimes will not survive altered fire regimes. As a result, research is now being undertaken to establish fire regimes that support both wildfire hazard reduction and biodiversity conservation, but some regard these objectives as incompatible. Prescribed burning undertaken specifically to achieve conservation objectives, such as preserving threatened ecosystems or particular species, may be referred to as “ecological burning.”

Other concerns about prescribed burning include: the potential for increased soil erosion; the risks of fires escaping containment lines; smoke pollution; and the costs of providing adequate resources to conduct and control burns. More recently attention has also focused on the implications of burning for the carbon cycle and climate change issues. These and other problems drive continuing research into the use of prescribed burning and the parameters associated with fire prescriptions. Prescribed burning remains a contentious and complex issue. Debate is characterized by uncertainty over both the effectiveness of hazard reduction burning and the ecological consequences of prescribed burning.

SEE ALSO: Biodiversity; Carbon Cycle; Colonialism; Ecosystems; Fire; Forest Management; Global Warming; Indigenous Peoples; Native Americans.

BIBLIOGRAPHY. William J. Bond and Brian W. van Wilgen, *Fire and Plants* (Chapman and Hall, 1996); John Mulvaney and Johan Kamminga, *Prehistory of Australia* (Allen and Unwin, 1999); Stephen J. Pyne, *World Fire: The Culture of Fire on Earth* (Henry Holt, 1995).

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Preservation

PRESERVATION, OR PROTECTION of ecosystems and biodiversity from injury or harm, is a form of resource management advocating the separation of humans from nature. Since the 19th century, there has been a schism in the American environmental movement over the best way to manage natural resources, with preservationists on one side and conservationists on the other. Preservationists believe that nature should be protected from the simplifying effects of human management. Conservationists believe that natural resources should be adequately used and managed by society in a utilitarian manner to achieve the highest possible benefit for the greatest number of people. The preservationist perspective believes that ecosystems and biodiversity can only be saved through nonuse, or full protection. Preservationists criticize the material aspects of the conservationist approach, arguing that they have compromised conservation values in the name of economic development.

Preservation-oriented policies raise an important corollary issue: what types of ecosystems and species warrant preservation? Most often, the answer is large wilderness areas that can support large carnivores, which are often seen as keystone species indicating overall ecosystem health. The association of wilderness with preservation adds another layer of complexity to the debate surrounding preservation; wilderness has become a highly contested concept as both social and natural scientists have demonstrated that there are no areas in the world that can be called "pristine," or free from the influence of humans. Areas once considered to be "pristine wilderness areas" are often the product of many generations of human management.

The environmental historians Roderick Nash and William Cronon have drawn attention to the need to understand the cultural and historical rationale for preserving certain landscape elements. They demonstrate that associations with the concept of wilderness have not always been positive. In early American and European history there was a strong negative association with wilderness, which drove the desire to conquer or destroy wilderness rather than preserve it. Up until the late 18th century, the most common usage of *wilderness* referred to landscapes perceived as "barren," "desolate," "savage," and "deserted." Nash draws our attention to William Bradford's first impression as he stepped off the *Mayflower* into what he saw as a "hideous and desolate wilderness." Early American pioneers struggling to make a living on the frontier saw little in wilderness worth protecting; instead, wilderness was an obstacle to survival. Wilderness was considered a chaotic and immoral wasteland and the westward progress of pioneers found satisfaction in its destruction.

By the 19th century, however, there was a growing appreciation of wilderness areas in the United States. Yellowstone National Park, established in 1872, was the world's first instance of large-scale wilderness preservation. The emergent national interest in the preservation of landscapes was supported by a variety of different arguments. The Romantic Era, as the period has come to be known, is characterized by the writings of philosopher Henry David Thoreau, who sought inspiration in the solitude of nature. Thoreau felt that the American character benefited from living in the wilderness, a belief that later inspired President Theodore Roosevelt to establish federal protection for almost 230 million acres. Numerous artists, such as Thomas Cole and Albert Bierstaadt, and writers such as James Fenimore Cooper, found their main source of inspiration in wilderness. Transcendentalists such as John Muir, the founder of the Sierra Club, saw connections between religion and nature and sought evidence of the power and goodness of God in nature. Others saw the American wilderness as an important component of the American identity, distinguishing it from Europe. In the words of Michael Nelson, an environmental ethicist, "The United States is a place where the eagle flies, the buffalo roam, and the deer and the antelope play." When making comparisons to Europe, America's natural environment was one of the few areas in which the young nation could claim superiority.

The proposed construction of the Hetch Hetchy Dam, which would provide water and electricity to the arid San Francisco region by damming portions of Yosemite Valley, became a landmark case representing the division between conservationists and preservationists. In 1907 Roosevelt supported the planned Hetch Hetchy Dam under the utilitarian argument that the dam was essential to the material development of the state and would result in the highest possible use of water resources for the growing San Francisco population. John Muir and other preservationists, refusing to accept this decision without a fight, launched an aggressive campaign, arguing that Yosemite National Park—including the valley that would be flooded by the dam—was an important "public playground." The campaign proved temporarily successful and Roosevelt retreated from his endorsement of the reservoir, although it was later approved under Woodrow Wilson's administration in 1913.

By the 1930s other preservationists adopted a more radical view, known as deep ecology, developed by the Norwegian philosopher Arne Naess. In contrast to utilitarian argument, deep ecologists adopt an ethical argument to support preservation of biodiversity: all nature has an intrinsic worth, apart from its benefits to humankind. This view affects the preservationist-conservationist debate by shifting the perspective from anthropocentrism—the belief that man is the center of the universe—to biocentrism, in which mankind has a place equal to all other elements of the natural world.

BIODIVERSITY

Regardless of the philosophical underpinnings that motivate the preservationist approach to separating man from nature, preservation it is not always successful in its primary goal, protecting biodiversity. The growing evidence that humans have had a role in producing supposed "wilderness" areas raises the important question: What happens to the wilderness landscapes when people are removed? An understanding of the role that Native Americans had in shaping the ecosystem that now comprises much of Yosemite Valley in California provides a clue to this question. Ethnoecologist Kat Anderson and anthropologist Michael Moratta have demonstrated that for Native Americans in the Sierra Nevada region, "fire was the most important management tool employed to clear brush, maintain grasslands and meadows, improve browse for deer, enhance production of basketry and cordage material, [and] modify the understory species composition in the forest." Given this knowledge, it is not surprising that the preservation policies in place at Yosemite National Park have resulted in a decline in biodiversity; forest succession, historically kept in check by Native Americans, has begun to overtake the meadowlands. The landscape in Yosemite Valley that American explorers sought to preserve was in part shaped by the management techniques of the Native American residents they expelled.

POPULATION DISPLACEMENT

It is not only the role of people in shaping the landscape that is overlooked by preservationist policies, but also the human and environmental rights of people who are displaced in the name of preservation of natural resources. A critical part of the history of both Yellowstone and Yosemite National Parks, often overshadowed by the magnificence of the landscape, is the fact that the eviction of Native Americans was a prerequisite to establishing the park.

Author Rebecca Solnit points to the fact that the naming of the principal landmarks in Yosemite was the result of the Indian War of 1851, in which Lafayette Bunnell and a battalion of about 200 men captured the Native American inhabitants and marched them to a reservation in the flatlands of San Joaquin Valley. For Solnit, this process of naming the landscape after the very people who were forcibly evicted is a bizarre mixture of romanticizing Native Americans while simultaneously annihilating their culture and settlements from the region. Just as the wilderness areas of United States could only be romanticized once they were "conquered," the "savage" civilizations of the Native Americans could only be romanticized once they were extirpated.

For over a century, Yellowstone National Park became the model by which parks were established around the world. The American ideal of linking landscape, nature, and a national identity was replicated in nearly every country. The global movement to preserve landscapes and biodiversity was largely led by a group of wealthy, elite Europeans and Americans who saw themselves as gentlemen hunters-naturalists. Roderick Neumann, in his exploration of the political purpose that national parks played in colonial Africa, shows that Kruger National Park, established in 1926 in the Southern African Republic, played a significant role in formation of collective (white) national identity. He also persuasively shows that the very idea of wilderness protection in Arusha National Park in Tanzania was a European colonial construct, enforced at the expense of local livelihoods, that simultaneously strengthened the political power of the colonial administration. The preservationist model of conservation, as it is applied in much of Africa, not only evicts local people from their homelands, but also impoverishes them as the local elite invariably claim the profits from the tourism and safari hunting industries. Given this, it is not surprising that local residents resent protected areas and work to undermine the goals of preservation by continuing their reliance on protected areas for their livelihoods.

In other parts of the world, the separation of man from nature in the name of preservation has failed to garner the support it has in America. Ramachandra Guha has gone as far as to call the most extreme elements of the American wilderness preservation model a "frankly imperialist manifesto." Guha and other scholars such as Vandana Shiva and Juan Martinez-Alier argue that wilderness and people should be allowed to coexist in a coherent whole; the separation of man from nature is an artificial dichotomy. They question who gave the conservation movement the moral authority to determine which areas need protection and which people need to be relocated to achieve protection.

ENVIRONMENTAL JUSTICE

In the 1980s wilderness preservation policies received a new critique from within the United States from the environmental justice movement. Environmental justice advocates seek to broaden the environmentalists' perspective to include urban, work, and home environments, and the mitigation of hazardous resources. The goal of this group is to make environmental concerns more meaningful to a wider range of people living in varied environments, not just those who can visit remote national parks for pleasure. By drawing attention to the fact that many urban poor may never visit a national park, the American environmental justice movement emphasizes that the benefits of the traditional conservation agenda are not shared equally. This movement is creating a potential bridge to people in the developing world who feel that they have been unfairly burdened by the creation of protected areas.

ALTERNATIVE MODELS

While the preservationist model of conservation has undoubtedly protected valuable and unique ecosystems and species in the United States, many conservation advocates recognize the poor fit between the American preservationist model and conservation goals of other countries. Consequently, many alternative models of conservation have been developed. These include extractive reserves, joint forest management, community-based conservation management, and integrated conservation and development projects. All of these alternatives promote benefit sharing in an effort to compensate local people for the resources they have given up by distributing income, employment, and other benefits from tourism. There is a growing awareness that conservation does not happen in a social vacuum, and that the preservationist's model of conservation has a limited ability to protect biodiversity. Social and natural scientists are increasingly working together to rethink the traditional preservationist, or "Yellowstone model" of conservation with alternatives that capture a more holistic understanding of mankind's place in nature.

SEE ALSO: Colonialism; Conservation; Livelihood; Muir, John; National Parks; Roosevelt, Theodore Administration; Wilderness.

BIBLIOGRAPHY. Jian Agyeman, Robert Bullard, and Bob Evans, *Just Sustainability: Development in an Unequal*

World (Earthscan, 2003); Kat Anderson and Michael Moratta, "Native American Land-Use Practices and Ecological Impacts," *Sierra Nevada Ecosystem Project: Final Report to Congress, Vol.II, Assessment and Scientific Basis for Management Options* (University of California, 1996); William Cronon, "The Trouble with Wilderness," in William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (W.W. Norton & Co., 1996); Ramachandra Guha, "The Authoritarian Biologist and the Arrogance of Anti-Humanism: Wildlife Conservation in the Third World," *The Ecologist* (v.27, 1997); Ramachandra Guha and Juan Martinez-Alier, *Varieties of Environmentalism: Essays North and South* (Earthscan Publications, 1997); Roderick Nash, *Wilderness and the American Mind* (Yale University Press, 2001); Michael Nelson, "An Amalgamation of Wilderness Preservation Arguments," in Andrew Light and Holmes Rolston, eds., *Environmental Ethics* (Blackwell Publishing, 2003); Roderick Neumann, *Making Political Ecology* (Hodder Arnold, 2003); Rebecca Solnit, "Indian-White Conflicts over Yosemite," in Carolyn Merchant, ed., *Green Versus Gold: Sources in California's Environmental History* (Island Press, 1998).

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Primates

PRIMATES ARE A group of animals that include human beings. All primates are mammals. There are about 180 species that are members of the primate class. Besides humans, primates include great apes or gorillas, chimpanzees, bonobos, orangutans, gibbons, lemurs, aye-ayes, and macaques. Primates are classified into two main groups. The Anthropoid family includes human beings, apes, and monkeys. The other primates are in the Prosimian family. It includes aye-ayes, galagos, lemurs, lorises, pottos, and tarsiers. There are other species that have been included as prosimians, such as tree shrews, but not all scientists accept this classification.

Primates' similarities to humans have made them a frequent subject for the study of human diseases. The rhesus monkeys (*Macaca mulatta*), of which there are three subspecies, were used in experiments in the 1930s and 1940s. The rhesus antigens in the blood of rhesus monkeys enabled researchers to identify blood groups in humans.

Beginning in 1948, monkeys were sent in rockets into space to study the physiological effects of weightlessness. Rhesus monkeys and chimpanzees were used in a number of space experiments. For example, in 1959 a rhesus monkey named Able was sent on a Jupiter Rocket on a bioflight. He was trained to tap a switch when a red light flashed, to collect data on performance. In 1961 a chimpanzee, Ham, was closely monitored for cardiovascular responses during a Mercury flight. In 1985 small primates were also studied for the effects of space travel during a 13-day voyage aboard the space shuttle Discovery.

Since most primates live in social groups, researchers have investigated their behavior, communications techniques, and organizational patterns. Insights gathered about their behavior have contributed to understanding human behavior. Researchers have found that some primates use tools, and, in the case of chimpanzees, wage war. Jane Goodall studied chimpanzees for many years in the Gombe Stream Game Reserve in Tanganyika (now Tanzania). She observed that chimpanzees are not strict vegetarians. They eat meat for a period and then return to a vegetarian diet for other periods. In order to get meat they will sometimes engage in chimpanzee cannibalism. Dian Fossey, (1932–85), an American ethnologist, studied the highland gorillas for some years, but was killed protecting these great primates.

In contrast, some prosimians live as individuals rather than in groups. Bonobos (*Pan paniscus*), such as Kanzi, at the Language Research Center in Atlanta, Georgia, have been able to communicate with humans to a limited degree using a keyboard and symbols. The study contributed to the educational theory that children who are taught to sign can communicate before they can speak.

Fully half of all primate species are threatened with extinction. The main threats come from humans: The destruction of forest habitat and the hunting of primates as pests, as stock for zoos, for pets, and for meat have reduced the numbers of most primates. The hunting of primates for food—the bush meat trade—is a serious threat. Gorillas, chimpanzees, and bonobos in central Africa are especially vulnerable to commercial hunters, who may engage in the illegal or unregulated slaughter of many wild animals. The price of great ape meat is high because many Africans believe that they draw strength from the meat. The hunting of apes kills more than the total amount currently held in zoos.

SEE ALSO: Animal Rights; Fossey, Dian; Goodall, Jane; Lab Animals; Primatology; Space Program (U.S.).

BIBLIOGRAPHY. Simon Bearder et al., *Primates in Perspective* (Oxford University Press, 2004); John Russell Napier, *The Natural History of the Primates* (MIT Press, 1985); Dale Peterson, *Eating Apes* (University of California Press, 2003).

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Primatology

PRIMATOLOGY IS THE study of primates: Placental mammals of the order Primates best known as apes. Humans are also considered primates but are usually not studied as part of primatology. The discipline is fragmented insofar as primatologists may be found working within a number of different fields and disciplines (e.g., anthropology and zoology) and with a variety of methodologies. It is controversial, since extrapolating lessons about human behavior and communities from other primates is often considered problematic, and because much of the history of primatology has been marked by theories heavily influenced by their social and political contexts.

Primates include two main families, which are the Prosimians and the Anthropoids. The Prosimians include the tarsiers, lorises, and lemurs and are jointly commonly referred to as the lower primates. The Anthropoids are the higher primates and include humans, monkeys, and apes, including chimpanzees, orangutans, and gorillas. The intensely complex forms of behavior and social systems established by the higher primates make them fascinating creatures for study, and they help in understanding many of the bases of human society. Primatology studies the anthropology, biology, psychology, and evolutionary history of primates. Commonality between primate and human forms of behavior has been revealed by this method. The higher primates, in particular, demonstrate forms of behavior such as adultery, diplomacy, apology, and deception that had previously been considered to be uniquely human and to have moral implications.

Studies of chimpanzees have shown the degree to which language is used by primates; this has helped indicate the ways in which thinking has developed within animals. The structure of chimpanzee societies, for example, depends upon the number of animals involved within the group. Chimpanzees

The Sangeh Monkeys

The Sangeh Monkey Forest on the Indonesian Island of Bali is home to a large population of monkeys who are the self-appointed guardians of the Hindu temple of Pura Bukit Sari.

According to local legend, during the Ramayana, when Rama was attacking Ravana, the demon god, the former was helped by Hanuman, king of the monkeys. Hanuman, along with thousands of monkeys, tried to crush Ravana by squeezing him between the two halves of Mount Meru. In that encounter a part of the mountain, along with a large number of monkeys, was flung toward the island of Bali. It crashed into the forest, with many of the monkeys surviving and establishing a large colony. A temple, nestled within a grove of sacred nutmeg trees, was built at Sangeh during the 17th century.

Today the resident monkeys are regarded as sacred and are a major tourist attraction, despite their ferocity. Locals carry sticks to beat them off, as they jump on people, snatch food, and like to steal cameras and jewelry. While they once survived off offerings left at the temple by devotees, they now do much better with the thousands of tourists who visit each month bearing peanuts and other food.

can recognize other members of the group and will have social relations with them. However, should the group—the "monkeysphere"—become too big, it takes too long and too much effort to identify and contextualize all the other members and the society becomes inefficient. In such a case, the group will divide into two smaller groups that represent more efficient societies.

Additional research has focused on the ways in which chimpanzees and human babies learn and develop, and this has indicated considerable levels of similarity in these processes. However, the controversial nature of some findings has inspired criticism of primatology. Some previous examples of research may no longer be considered valid because of the atypical conditions in which the primates were kept and treated.

It is possible to distinguish between Western and Japanese schools of primatology. The former tends toward an objective, quantitative, and scientific approach to the subject, while the latter, as represented most notably by Kinji Imanishi, has more of a subjective and interpretive approach. Japanese primatologists approach their subjects as creatures with whom to establish a relationship that is a form of partnership and that leads to greater levels of mutual understanding. The Western primatologist is more likely to attempt to maintain independence from the creatures and to try to describe and analyze it in isolation from the human relationship.

SEE ALSO: Animals; Chimpanzees; Fossey, Dian; Goodall, Jane; Primates.

BIBLIOGRAPHY. Geoffrey H. Bourne, *The Gentle Giants: The Gorilla Story* (Putnam, 1975); D. Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (Routledge, 1989); Kinji Imanishi, *A Japanese View of Nature: The World of Living Things* (RoutledgeCurzon, 2002); William H. Kimbel and Lawrence B. Martin, eds., *Species, Species Concepts, and Primate Evolution* (Springer, 2002); Callum F. Ross and Richard F. Kay, eds., *Anthropoid Origins: New Visions* (Springer, 2004).

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Prior Appropriation

PRIOR APPROPRIATION IS a legal doctrine for assigning water rights based upon the rule "first in time, first in right." It was first developed in Colorado and is known as the Colorado Doctrine, or officially as the Prior Appropriation System. The doctrine is a system of water allocation for controlling who uses how much water, the kinds of uses allowed, and when the waters may be used. The doctrine of prior appropriation is quite different from the law on riparian water rights originally developed in England and imported into the American colonies. The law on riparian water rights has historically been easy to apply in the water-abundant eastern United States where contention over a plentiful resource has, until fairly recently, been uncommon. However, in the water-scarce west, water wars have occurred that were both physical and legal.

The water referred to under the doctrine of prior appropriation is surface water, that is, water that naturally occurs in the open atmosphere. Surface water includes rivers, streams, lakes, reservoirs, ponds, impoundments, seas, and estuaries. The term *surface water* also includes all springs, wells, and other collectors. Water coming from surface runoff includes precipitation, snowmelt, and even water from irrigation that is in excess of the amount that can percolate into the soil, and is as a consequence held in a small depression.

Claimants to water under the doctrine of prior appropriation include senior appropriators and junior appropriators. Senior appropriators are the owners of water rights that were acquired prior to other right holders on the same stream. Junior appropriators are claimants who acquired water rights after the rights of others on the same stream. Riparian access, which is ownership of land adjacent to a stream, does not give a right to its water. Rather, the historical appropriation of water for a beneficial purpose is what creates prior appropriation.

Water in the doctrine of prior appropriation rejects the idea that anyone may own the water in a stream. Rather, the water must be used for a beneficial purpose such as irrigation or watering livestock. Beneficial use is applied broadly in the doctrine of prior appropriation. It includes using water for homes, cities, agriculture, industry, stock watering, recreation, wildlife, power generation, and mining. Recent expansions of the meaning of *beneficial* have included dust-settling control and snow making. Historically, courts in western states have rejected very few uses of water as unbeneficial. One use not accepted as beneficial has been holding water for ecological uses. The fact that wildlife or a natural body of water needs water retained has not impressed the courts. However, a few courts have begun in recent years to rethink the meaning of *beneficial* and to apply it to ecological needs.

Under the doctrine of prior application, each water right has an annual quantity and drawing date assigned to it. Every year, the senior appropriators may draw out of the water source their full allotment of water. Since water is scarce, it is usually assumed that the water is available for allocation. Then, the next water right, which is the next earliest, may use the full application. In times of drought, the full application may not be used because the water is simply unavailable. In dry years, junior applicants may receive no water at all, although the senior applicant gets the full amount. Water rights may be sold. If they are sold, then the prior appropriation date travels with the sale. Also, only the amount of water historically used can be transferred with the sale. The application of prior appropriation to water used across state lines or across international boundaries often falls under federal jurisdiction.

Water rights under the doctrine of prior appropriation may also be mortgaged or encumbered as if they were rights to real property. In addition, the water does not have to be used on the land on which it originates nor on the land upon which the right is based. If a water right is not used for some beneficial purpose for a period of time, it may be forfeited under the doctrine of abandonment. The lapsing of water rights is rare. The details of the doctrine of prior appropriation vary from state to state. California uses a combination of both prior appropriation and the older common law riparian water rights. The doctrine is important in regions like much of the western United States, where water is a scarce resource. However, as the competition for water in states east of the Mississippi River has increased, the doctrine is beginning to influence water polices.

SEE ALSO: Riparian Areas; Riparian Rights; Water; Water Law.

BIBLIOGRAPHY. David H. Getches, *Water Law in a Nutshell* (West Group, 1997); Joshua Getzler, *History of Water Rights at Common Law* (Oxford, 2004); Norman K. Johnson, *The Doctrine of Prior Appropriation and the Changing West* (Western States Water Council, 1987); Larry O. Putt, *Evaluation of Prior Appropriation in Mississippi* (Mississippi State University, 1976); Richard W. Sadler and Richard C. Roberts, *Weber River Basin: A Study of Grass Roots Democracy in Water Development* (Utah State University Press, 1993); Samuel C. Wiel, *Water Rights in the Western States: The Law of Prior Appropriation of Water* (Bancroft-Whitney, 1911).

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Prisoner's Dilemma (PD)

THE PRISONER'S DILEMMA (PD) is a concept from game theory that posits a tension between the benefits of cooperation versus noncooperation. In its narrative form, it proposes that two prisoners, both suspects of a crime, are held by the police in separate rooms for interrogation and pressed for either a confession or an accusation against the other prisoner. If both mutually accuse one another, both will serve a moderate sentence. If one accuses the other, who remains silent, the accused serves a lengthy sentence and the accuser goes free. If both remain silent, both serve minimal sentences. Clearly for both players, the best outcome is to remain silent. The temptation to accuse the other prisoner, however, and so gain the best individual outcome, tends to lead to a choice to mutually accuse one another, thus leading to a worst outcome for both.

This perplexing puzzle has long been applied to a great number of real-life problems, including scenarios involving the use of nuclear weapons between two countries. During the early 1980s theorists such as Robert Axelrod began to apply the PD toward understanding the Tragedy of the Commons and the evolution of cooperation. While the Tragedy of the Commons provides a useful model for explaining why overexploitation of community-held resources might occur, it does not shed light on how communities might profitably control the use of the commons, which they have historically done.

The PD is a formal mathematical game model that represents results of an interaction with different payoffs and therefore takes into account the rewards and punishment for different actions. The two-person version of the game is as follows:

1. If both players cooperate, they both receive the same reward payoff (R);
2. If both players defect, they both receive the same punishment payoff (P);
3. If one player defects and the other cooperates, the cooperator gets the sucker's payoff (S) and the defector gets the temptation to defect payoff (T);
4. The temptation to defect must be larger than the reward for mutual cooperation, which must be larger than the punishment for mutual defection, which in turn must be larger than the sucker's payoff (T>R>P>S);
5. The reward for mutual cooperation must be larger than the sucker's payoff plus the temptation to defect payoff divided by two (R>(S+T)/2), so that the benefit to both over several turns is larger than if they would have mutually cooperated.

The best strategy for both players collectively is to cooperate with each other. The individual's best strategy is the temptation to defect for the higher payoff (see Figure 1). Therefore, a dilemma is created with an individual having to make a choice between defection (cheating), which is the best individual strategy (e.g., in Figure 1, the individual would gain 5 points), and cooperation, which yields the higher combined reward for both players (e.g., in Figure 1, the scores would total 6 points).

		Player B	
		Cooperate	Defect
Player A	Cooperate	R = 3	S = 0
	Defect	T = 5	P = 1

Figure 1: Prisoner's Dilemma Payoff Matrix

However, the simplicity of this game becomes more complex as varieties of the game add "real world" rules to the game. In response to this, Axelrod applied the PD toward the explanation of cooperation within groups, which has influenced anthropological research of the Tragedy of the Commons. For example, Axelrod used the following rules in his analysis of iterated (repeated) PD games:

1. Players cannot enforce other players' strategies or commit themselves to a particular strategy;
2. The only history of past actions known to each player is their own history with the specific player, not actions with other players;
3. A player cannot refuse to play or prevent another player from an interaction;
4. A player cannot change the payoffs of another player.

Using these rules, Axelrod tested which strategy would succeed in playing this game by soliciting strategies from game theorists, scientists, and interested individuals. After each turn of the game, the ones with a higher total score would advance and the ones with the lower total would fall back. He found that tit-for-tat (TFT, or cooperating on the first interaction and then doing whatever the other player did on the previous move) resulted in the highest overall score in the tournament. Following Axelrod, other studies using different payoff matrices have found that TFT was not the best overall strategy, but contrite TFT (same as TFT, but if the other player defects, this strategy only defects once before cooperating again) is more stable. In other studies, another strategy was more successful than TFT, namely Pavlov, which continues the previous strategy if the player wins (rewarding cooperation), changing strategy upon losing (punishing defection).

SEE ALSO: Externalities; Game Theory; Nash Equilibrium; Tragedy of the Commons.

BIBLIOGRAPHY. Robert Axelrod, *The Evolution of Cooperation* (BasicBooks, 1984); Robert Axelrod and William Hamilton, "The Evolution of Cooperation," *Science* (v.211, 1981); Robert Boyd, "Mistakes Allow Evolutionary Stability in the Repeated Prisoner's Dilemma Game," *Journal of Theoretical Biology* (v.136, 1989); William Poundstone, *Prisoner's Dilemma* (Random House, 1992); Anatol Rapoport, ed., *Game Theory as a Theory of Conflict Resolution* (Reidel, 1974); Eric

Alden Smith and Bruce Winterhalder, *Evolutionary Ecology and Human Behavior* (Aldine De Gruyter, 1992).

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Pristine Myth

THE PRISTINE MYTH may have begun with Christopher Columbus upon his return to Spain after his first voyage. The lifestyle of the natives in the Caribbean region had made it seem like the original paradise to him. As reports of the discoveries in what was eventually seen as the New World filtered across Europe, there arose the idea that the New World was pristine, unlike the Europe that was close at hand. It became a favorite device of social criticism to hold aloft the pristine or innocent natives there as a mirror exposing the faults of Europeans. This same method of social criticism has been practiced in America and elsewhere in the New World.

The reality is that while undeveloped by European standards, the New World as known to Columbus or as later described by Charles Darwin and others was not pristine. It had been modified to a degree by the Native Americans. When the first people came to the Americas, probably 30,000 or more years ago, the continents were indeed pristine. However, by the end of the last Ice Age many species had disappeared. The megafauna of mastodons, saber-toothed tigers, camels, horses, the dire wolf, and other animals vanished. It is now suspected that either hunting or changes in the environment wrought by fires or other means killed off these animals. There is probably no way to know what species of plants may have been lost.

As a consequence, while it is tempting to see the great forests of North America as pristine when the first colonists arrived at Jamestown, or in Canada, the reality is that the Native Americans had already made significant changes to the environment. What these changes were may never be fully known. For decades it has been taught in American schools that when the colonists arrived they found an untouched wilderness; it was a Garden of Eden that was soon spoiled by the settlers. Teaching this way "mirrors" bad practices from good environmental practices.

There is now a growing body of evidence that suggests that the modifications made in the Western Hemisphere in the pre-Columbian era were significant. Some have conjectured that the Amazon rain forest is an artifact of human effort. Increasing numbers of archeologists, anthropologists, geographers, and others are now viewing the Native Americans as less than ecologically pure hunters and farmers.

The pristine myth is important to many environmental groups because their agenda is to restore wilderness areas to an original pristine condition. It allows them to argue that the environment began pristine, was spoiled, and should now be restored.

SEE ALSO: Colonialism; Conservation; National Parks; Preservation; Wilderness.

BIBLIOGRAPHY. Michael P. Branch, *Reading the Roots: American Nature Writing Before Walden* (University of Georgia Press, 2004); Susan Kollin, *Nature's State: Imagining Alaska as the Last Frontier* (University of North Carolina Press, 2001); Thomas R. Vale, ed., *Fire, Native Peoples, and the Natural Landscape* (Island Press, 2002).

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Private Property

PROPERTY RIGHTS DETERMINE who is entitled to use and dispose of resources, both natural and man-made. Private property is a form of property ownership in which an individual, company, or corporation enjoys the associated rights. It thus differs from common property (where a group of people enjoys those rights jointly), state property (where the sovereign ruler or nation is the presumed owner, with the state managing the property), and open access (in which case no property rights have been established).

The nature of private property varies depending on which rights have been conferred upon resource owners by social institutions such as the state or

While logging may be profitable within the lifetime of a private landowner, replanting that forest would not pay off.

commonly recognized customs. The "bundle of rights" included consists of varying combinations of the rights to use, sell, rent, lease, destroy, give away, and pass on the property as an inheritance, and to exclude others from its enjoyment. These rights may or may not involve reciprocal obligations or duties on the part of the property owner (for example, ownership of water may be contingent on its "beneficial use").

The *de jure* property rights may not always be recognized by others, and thus there is usually a cost associated with the defense of property rights. These costs are especially high if the difficulties of excluding others from the enjoyment of that property are great or if there is little social acceptance of this particular kind of property. For example, intellectual property rights in seed varieties and their propagation can be difficult to defend while enjoying little popular acceptance; the development of hybrid varieties that do not breed true and of "terminator" genes that prevent the reproduction of seeds are attempts to make private property rights more easily defendable.

Some resources, such as air to breathe, are generally regarded as nonexcludable: others could not possibly be prevented from using them. Other resources may be nonexcludable for social or technological rather than physical reasons; for example, where communal grazing rights are the norm, an individual's claim to private property rights to grazing land would not be respected. A resource may also be nonexcludable for reasons of cost, for example, if the costs of fencing land exceed its benefits to the property holder. Hence, private property rights can only emerge where excludability is possible in practice as well as theory.

PERCEIVED BENEFITS

The question of whether private property is desirable is a different matter. From a mainstream economic point of view, private property should be established whenever possible, in order to maximize economic efficiency. The basic argument is that most production involves an investment by the producer to obtain resources and manage them so that they will remain productive in future. If the owner of a resource does not capture all the benefits of that investment, he or she is likely to invest less than is optimal for sustained, maximum production. Hence, for example, a farmer should own his or her land in order to ensure that he or she will invest in protecting soil fertility, building irrigation infrastructure, buying machinery, and so on for the long term. Only long-term security of tenure is thought to encourage this kind of ecologically as well as economically sustainable farming.

On the basis of similar arguments, private property rights have been introduced as a way of minimizing the costs of achieving air pollution standards. In this case, a government authority decides the overall amount of pollution that will be allowed within an area, and then provides tradable pollution permits to polluting industries located there. Tradability of the permits ensures that companies that can cheaply reduce their emissions will sell their permits in order to cut costs; while those companies that cannot easily reduce their emissions will buy permits. This ensures that environmental targets are achieved at minimum cost.

It must be remembered, however, that the government still has to set overall pollution limits and enforce compliance. Thus, although pollution permits are treated as a kind of private property, the protection of air quality remains a function of the state, that is, a form of state property.

DRAWBACKS

The promised benefits of private property rights are not always assured, however. For example, private property in land allows the owner to rent out that land. If tenants are forced to pay excessive rents and can be evicted arbitrarily, they are left without the resources or the incentives to make long-term investments. Meanwhile, the landowners may be more interested in extracting high rent payments from the tenants than in the long-term development potential of the land. In such cases, there will be very little investment in long-term productivity of the land. This problem may be remedied at least partially by land reform that assigns "land to the tiller," and that also provides farmers with the resources they need in order to successfully make a living on the land (as has been done, for example, in South Korea, Taiwan, and the Indian state of Kerala).

Even if tenancy relations create no perverse incentives, land uses that are profitable within the lifetime of an owner may be unsustainable over longer time periods. For example, the intensive use of agrochemicals on highly nutrient-demanding cash crops for export may promise to be profitable in the owner's lifetime but lead to longer-term land degradation as well as off-site ecological impacts (called externalities by economists). The exploitation of minerals may cause extensive ecological impacts both on and off site but still be profitable to the owner. Logging of timber may be highly remunerative to a landowner, but replanting the forest in order to reestablish trees that take many decades to reach maturity will not pay off within the present owner's lifetime. The option to sell the land may exacerbate a short-term orientation. For example, logging companies in Southeast Asia, where tropical rain forests are being cut down at a very rapid rate, often sell deforested land to companies interested in establishing oil palm plantations. Although oil palm plantations may be sustainable in the sense of being able to persist a long time, such land use change does lead to the loss of natural forest cover and associated biodiversity. Some of these issues can at least theoretically be addressed by creating property rights in the resources affected by externalities, for example, by establishing property rights in clean water. However, ecological impacts that are expected to occur only in the future cannot be mitigated in this way; instead, government regulations may be necessary.

Many critics of private property rights also point out problems of inequity. Following Pierre-Joseph Proudhon's tenet that "all property is theft," they have pointed out the injustices in the original creation of private property, integral to the process that Karl Marx called "primitive accumulation." Examples include the expropriation of colonized peoples around the world, enclosures of common property in England and elsewhere, and the privatization of state assets in post-Soviet Russia and eastern Europe. Injustices may persist for an indefinite period of time after the original property rights have been established. For example, the Portuguese colonial practice of assigning huge landholdings to a few individuals in order to lay claim to large territories in Brazil laid the foundations for the present situation in which impoverished people suffer from land scarcity even while population density is low and many landowners do not utilize all of their land. Brazil's Landless Workers Movement (MST) denies the legitimacy of private property that is unused while others have no land at all and occupies unused land in order to force the government to carry out constitutional provisions that call for the redistribution of such land. Extreme inequity in land ownership as found in Brazil may lead to serious ecological impacts in which wealthy landowners use resources wastefully, while marginalized people are forced to eke out a living on unproductive land in unsustainable ways or to migrate into urban shantytowns that lack basic sewage, water supply, and garbage collection facilities.

Environmental protection may also require that some resources be removed from the market altogether, or be made into state property of some kind. For example, the preservation of extensive ecosystems may require the creation of a national park owned by the state. If that land was owned by many separate private landholders, a few might wish to preserve natural habitat, but these areas would usually be small and fragmentary and therefore insufficient for species preservation. In some cases, it may be possible for the state or a private foundation (e.g., a land conservancy) to buy easements, whereby private landowners forfeit some of their land-use rights (for example, to drain wetlands). If such rights are taken away by legislative action ("takings"), many private property advocates resist because they see this as an abridgement of their property rights (e.g., the Wise Use Movement in the United States). Without the abridgement of private property in some form, however, it is unlikely that many areas of high biodiversity and landscape value will be preserved.

INTELLECTUAL PROPERTY

Intellectual property rights, and especially patents, are a particularly controversial form of private property. Patents violate free-market doctrine in that they provide temporary monopolies in the supply of goods involving innovative technologies. These monopolies can be made quasi-permanent by continual minor innovations that serve primarily to extend the period of patent protection rather than to improve the marketed commodity.

The rationale for providing temporary monopolies (not a necessary feature of private property) is to provide an incentive for companies to engage in costly research. However, patents are based on the assumption that an individual or company is solely responsible for the innovation. In fact, often many people were involved in order to create an innovative product, though it can be very difficult to identify each person's contribution. For example, when drug companies utilize the knowledge of indigenous people about medicinal herbs, the common knowledge of a large group of people going back many generations is appropriated, usually with very little compensation. These people may even be prevented from marketing products that they have produced for many years (e.g., the company W.R. Grace attempted to prevent Indian manufacturers of products from the neem tree from selling their products on the Indian market).

Some activists demand methods of repaying communities (and not just individuals) in such cases; more radical proposals call for the reversal of laws passed in the 1980s that first allowed the patenting of life forms. Environmental concerns associated with patenting of genetically engineered organisms relate to the potential dangers of introducing completely new organisms into ecosystems with unpredictable effects, and encouraging more pesticide-intensive forms of agriculture (e.g., via crops resistant to pesticides).

Ultimately, no single form of property can successfully address all possible social, economic, and environmental conditions. Which form of property is favored in any particular instance also depends on how much value people place on total production or efficiency, on social equity, and on environmental protection. All existing societies exhibit a diversity of property regimes; the challenge is to devise effective solutions that satisfy diverse interest groups and provide for ecological sustainability as well.

SEE ALSO: Capitalism; Colonialism; Communism; Conservation Easements; Enclosure; Equity; Externalities; Genetic Patents and Seeds; Genetically Modified Organisms; Indigenous Peoples; Intergenerational Equity; Justice; Land Trusts; Markets; Marx, Karl; Neem; Permits, Tradable; Privatization; Property Rights; Public Land Management; Socialism; Wise Use Movement.

BIBLIOGRAPHY. Terry L. Anderson and Fred S. McChesney, *Property Rights: Cooperation, Conflict, and Law* (Princeton University Press, 2003); Peter Dauvergne, *Loggers and Degradation in the Asia-Pacific: Corporations and Environmental Management* (Cambridge University Press, 2001); Ramachandra Guha and Juan Martinez-Alier, *Varieties of Environmentalism: Essays North and South* (Earthscan, 1997); Jack R. Kloppenburg and Michael J. Balick, "Property Rights and Genetic Resources: A Framework for Analysis," in Michael J. Balick, Elaine Elisabetsky, and Sarah A. Laird, eds., *Medicinal Resources of the Tropical Forest: Biodiversity and Its Importance to Human Health* (Columbia University Press, 1996); Bruce A. Larson, ed., *Property Rights and Environmental Problems* (Ashgate, 2003); Roy Prosterman, Mary Temple, and Timothy Hanstad, *Agrarian Reform and Grassroots Development: Ten Case Studies* (Lynne Rienner Publishers, 1990); Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World* (Penguin Putnam, 1998); Vandana Shiva and Radha Holla-Bhar, "Piracy by Patent: The Case of the Neem Tree," in Jerry Mander and Edward Goldsmith, eds., *The Case against the Global Economy: And for a Turn toward the Local* (Sierra Club Books, 1996); Angus L. Wright and Wendy Wolford, *To Inherit the Earth: The*

Landless Movement and the Struggle for a New Brazil (Food First Books, 2003).

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Privatization

PRIVATIZATION IS THE conversion of state or common property, or of an open-access resource, into private property. The privatization of a common property resource is also often referred to as *enclosure*. Privatization is justified on economic efficiency grounds, with claims that it ensures that owners or investors devote their full attention to enhancing the productivity of the privatized resources because they reap the full returns of their efforts. In addition, it is claimed that private property ensures that the costs of any environmental damage must be borne by the property owner, thus ensuring that such damage is minimized. Critics of privatization, however, insist that it usually serves only to enrich a small elite by handing them a resource formerly owned by all the people in common, without leading to any environmental benefits.

It is impossible to make accurate generalizations about the environmental impacts of all forms of privatization, because private property is suited for some but not all purposes, and, like all forms of property, depends on supporting institutions (e.g., relevant laws and their enforcement). Furthermore, property cannot so easily be classified as "public" or "private," because many kinds of property involve overlapping rights or entitlements—the "bundle of rights" that constitutes property may be unbundled during privatization, with only some of those rights being transferred to private property holders. The result is then some form of "recombinant," or "fuzzy," property in the words of David Stark and of Katherine Verdery (both of whom study eastern European privatizations). Detailed study is needed on such privatizations in order to understand the environmental outcomes. In addition, even if privatization is an appropriate goal, actual outcomes depend on whether it is handled in a transparent manner untainted by corruption. Finally, particularly in the post-Communist context, many social and economic changes occurred at once (including democratization, economic collapse, and in some cases recovery) that can make it difficult to determine which environmental changes are due to privatization rather than other causes.

In some instances, the new property regime is clearly not appropriate for environmental preservation, social equity, or even the creation of a free market. This consideration applies most often to "natural monopolies," such as the provision of water and sewerage services, the construction and maintenance of railway lines (though not necessarily the services of rail transport on the rail network), roads, and electric power grids (though not the production of electric power). In such cases, market competition is either greatly constrained or absent, and poorly conceived privatization efforts can easily lead to negative results. For example, privatization of British rail services was followed by some highly publicized accidents, high prices, and inconvenient connections and ticketing arrangements between lines operated by different companies. Such problems push consumers to prefer car or bus transport over more environmentally friendly trains. To correct these problems, renewed state involvement in the rail system was found to be necessary.

Networks constructed on the basis of private initiative tend to focus only on the most profitable places (sometimes called "cherry-picking"); if the goal is universal provision, this may be insufficient. For example, in 19th-century Britain, private piped water supplies only brought potable water to about 10 percent of the urban population, which not only meant poor living conditions for the other 90 percent, but also greater risk of disease outbreaks (e.g., cholera). In response, piped water supplies were made a municipal responsibility, later centralized in 10 regional water authorities. However, in the late 1980s, continuing concerns about river water quality and the reluctance of the national government under Margaret Thatcher to make necessary investments in water treatment led to a policy of privatization. Since it was recognized that regional monopolies would likely engage in monopolistic practices, price caps were imposed on water charges, while environmental regulations were strongly enforced. The result was improved water quality in rivers, lakes, and beaches, but underinvestment in some aspects of water provision (e.g., in preventing leakage of water) and high returns for shareholders. These were so high, and the water charges increased so much, that the public protested and the subsequent Labour government tightened price controls. This public reregulation has been so extensive that the private water companies actually resemble public services, and some of them have even applied to change their status to nonprofit ventures owned by some or all of their customers.

Privatization of water supplies has also occurred elsewhere in the world, often with far more problematic results. In the Bolivian city of Cochabamba, a privatization program in 2000 turned over the system to a subsidiary of the Bechtel corporation. In contrast to the British case, where the water itself was still regarded as public property, this privatization even extended to rainwater as soon as it fell on the ground within city limits, turning people who collected rainwater in their own cisterns into thieves. A high rate of return was guaranteed to the water company, in part by tying water rates to the value of the U.S. dollar. A massive protest movement declared that the vital resource of water was everybody's property, and forced the reversal of water privatization within half a year. The renewed municipal water company was reformed to ensure direct accountability to customer representatives. More successful water privatization schemes do exist (for example, in La Paz, Bolivia), but include much more stringent regulation of private water companies.

In other cases, privatization is much more likely to lead to environmentally favorable outcomes because a private property regime is in principle well adapted to the resource use in question. This includes the privatization of state-owned or communal agricultural farms in China after 1978, and in eastern Europe and the former Soviet Union after 1989. Privatization in these cases offered the opportunity to reverse some of the environmental damage created by decision making and price setting by distant bureaucrats with little appreciation of local environmental or social conditions (e.g., as analyzed by James Scott). The actual outcomes varied tremendously, however, depending on how the process of privatization was handled. For example, in a study of three villages in China's Henan province, Muldavin found that two villages created corporate institutions to take over indivisible communal facilities (for example, small enterprises processing agricultural commodities), with each member holding a share.

The land, however, was distributed among individual property holders. One of these villages achieved positive environmental outcomes by pursuing a diversified "ecological" agriculture with strong investment in irrigation and biogas facilities, though fertilizer use was perhaps excessively high. The other "corporate" village pursued a high-input agriculture plus industrialization, thus increasing environmental impacts. A third village was completely decollectivized, meaning that indivisible agroindustrial assets were appropriated by a few individuals. Irrigation facilities declined, many farmers ended up with excessively small holdings and overexploited their soils, while others applied excessive amounts of fertilizers to compensate for the lack of irrigation. This study demonstrates how important the process of privatization is in determining outcomes, and that it is essential to build up new institutions to make the new property regime viable.

In the former Soviet Union and eastern Europe, outcomes of privatization of agricultural land have also been very diverse. Where land holdings after privatization were small and fragmented, access to markets was poor after the centralized marketing facilities were dismantled, or the elimination of price controls led to drastically increased prices for agricultural inputs, farmers reverted to more subsistence-oriented production methods, involving small-scale diversified family farms minimizing the use of agricultural chemicals (e.g., in large parts of Bulgaria, Romania, and Poland). On the other hand, where access to markets was good, and where state or collective farms remained as large undivided units (e.g., as joint stock companies), they typically invested in more intensive or specialized farming, while shedding some of their labor force and increasing economic efficiency (e.g., much of Eastern Germany).

An instructive historical example illustrating the importance of the process of privatization occurred in 19th-century Alpujarra (in Spain) and Lucania (in Italy), as described by McNeill in *Land, Property,* *and the Environment* (2002). Although some of the old and complex property regimes in land, water, trees, and animals had been highly inequitable, they did ensure that radical changes in land use required the support of diverse interest groups with overlapping rights, preserving ecologically sustainable land uses. Privatization was marred by widespread nepotism, allowing a few new owners to take over vast acreages. They were able to quickly accumulate windfall profits from the sale of timber, with little concern for the eroding hillsides left behind. Many of the deforested lands were put to the plow in spite of their unsuitability for agricultural purposes, increasing erosion problems. This kind of behavior is often referred to as "asset stripping."

On a much larger scale, asset stripping has occurred in the wake of privatization of large state enterprises in the former Soviet Union and some of the eastern European countries. These activities may have much more important social and economic than environmental consequences, however. Some forms of deindustrialization that happened as a result may be regarded as environmentally beneficial (e.g., reduced greenhouse gas emissions), but others may not (e.g., leaking oil pipelines, abandoned industrial sites contaminated by chemicals).

Those industries that privatize and continue to operate are expected to work more efficiently, that is, minimizing the consumption of scarce (i.e., expensive) natural resources. This can lead to investments in order to become more energy efficient, for example. However, where clean air, water, and soils are treated as if they were expendable (that is, there is no effective regulation of pollution), there is no incentive for private enterprise to take any more care to avoid pollution than the state enterprises that preceded them. Where privatization has stimulated rapid industrial growth (as in China), the result is therefore a significant increase in environmental pollution. This once again shows that it is vital that privatization be accompanied by effective institutions (in this case, appropriate regulations), and that it may be counterproductive if such institutions do not exist.

SEE ALSO: Capitalism; Collective Agriculture; Communism; Enclosure; Markets; Private Property; Property Rights; Socialism.

BIBLIOGRAPHY. Karen Bakker, *An Uncooperative Commodity: Privatizing Water in England and Wales* (Oxford University Press, 2003); Michael Burawoy and Katherine Verdery, eds., *Uncertain Transition: Ethnographies of Change in the Postsocialist World* (Rowman and Littlefield, 1999); Barbara Cellarius, *In the Land of Orpheus: Rural Livelihoods and Nature Conservation in Postsocialist Bulgaria* (University of Wisconsin Press, 2004); Richard Edmonds, ed., *Managing the Chinese Environment* (Oxford University Press, 2000); Joshua Muldavin, "The Paradoxes of Environmental Policy and Resource Management in Reform-Era China," *Economic Geography* (v.76.3, 2000); Oscar Olivera, in collaboration with Tom Lewis, *Cochabamba!: Water War in Bolivia* (South End Press, 2004); John F. Richards, ed., *Land, Property, and the Environment* (Institute for Contemporary Studies Press, 2002); James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (Yale University Press, 1998); Thomas Sikor and Dara O'Rourke, "Economic and Environmental Dynamics of Reform in Vietnam," *Asian Survey* (v.36/6, 1996); Katherine Verdery and Caroline Humphrey, eds., *Property in Question: Value Transformation in the Global Economy* (Berg, 2004); Ingolf Vogeler, "State Hegemony in Transforming Rural Landscapes of Eastern Germany: 1945–94," *Annals of the Association of American Geographers* (v.86/3, 1996); Ernst von Weizsäcker, Marianne Beisheim, Oran Young, and Matthias Finger, eds., *Limits to Privatization: How to Avoid Too Much of a Good Thing: A Report to the Club of Rome* (Earthscan, 2005).

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Production, Conditions of

THE CONDITIONS OF production in agriculture are the environmental factors that affect plant or animal growth. The conditions of production in industry are a form of socioeconomic organization that can lead to the real or apparent exploitation of local labor.

The conditions of production in agriculture are variables that affect yield and are often impossible to control, unlike conditions in industry that can be controlled. In many poor countries of the world, especially in the Southern Hemisphere, weather patterns or disease greatly affect the growing of crops. These and other conditions of production often lead to the loss of crops and independence when farmers have to mortgage their land or farm animals to local money lenders at usurious interest rates.

Historically, scholars have viewed small scale production units in third world countries as inherently efficient because they are the product of many years of hard work by many generations of a single family. It has been widely accepted that these small operations are at their peak of efficiency because all possible opportunities for production efficiency have already been attempted in generations gone by. However, recent studies indicate something more complex, if not the opposite.

Moreover, the growth of global agricultural corporations that can increase production efficiency through economies of scale, access to higher yielding seeds, and cheaper fertilizer are presenting small operations with external challenges to production efficiency and economic survival. Along with that economic challenge is the fact that studies have shown that small plot holders in third world countries do not exercise cooperative actions among themselves to control the spread of weeds and insects, which large scale operations can do with their access to insecticides and herbicides.

The conditions of production in agriculture have been the subject of intense study in the industrially advanced countries. This has led to studies of the growth rates for chickens, hogs, and beef cattle raised for consumption of meat. The feeding of the growing billions of people on the earth is pushing farmers to be ever more productive. For example, studies of dairy cattle have shown that there are optimum ages for productive activity for delivering calves and for producing milk, after which productivity goes into decline. To optimize the production of a dairy operation requires the removal of members of the herd on a regular basis once they reach the declining level of productiveness.

The conditions of production in industry are those natural conditions that affect production such as the weather. However, the organization of production can also greatly affect productivity. Adam Smith, in the beginning of *The Wealth of Nations*, the seminal economic work of capitalism, described the increased productivity of a pin factory that was gained through the division of labor in the manufacturing process. Near the same time that Smith wrote about the enclosure movement, the growing Industrial Revolution in England led to the development of the factory system. This way of organizing production virtually replaced the home cottage industry system. It forced large numbers of people into cities and into working for low wages in factories where the factors of production were rigorously controlled.

Today, with slavery virtually abolished globally, the use of exploitative labor occurs most often agriculturally on plantations and industrially in what are called "sweat shops." In these instances, conditions of production are controlled externally and workers produce goods for lower wages than they would be paid in industrially advanced countries. In some cases the laborers are children.

In the growing agroindustries of the world, the production of living organisms includes not only traditional livestock or traditional food crops, but also the growth of traditionally cultivated insects such as silk worms or worms for fish feed. The production of living organisms includes the industrial production of microscopic organisms such as viruses for the manufacture of medicines and the production of bacteria for use in eating sludge and cleaning up oil spills.

SEE ALSO: Agriculture (including Agricultural Revolution); Enclosure; Environmental Protection Agency (EPA); Industrial Revolution; Industry.

BIBLIOGRAPHY. Takatoshi Ito and Andrew K. Rose, eds., *Growth and Productivity in East Asia* (University of Chicago, 2004); Andrew K. Rose, E.G. Gregorich, and Martin R. Carter, *Soil Quality for Crop Production and Ecosystem Health* (Elsevier Science & Technology Books, 1997); David Sadler, *The Global Region: Production, State Policies and Uneven Development* (Elsevier Science & Technology Books, 1992).

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Production of Nature

THE PRODUCTION OF Nature perspective examines the material transformation of nature by human societies, insisting that labor rests at the heart of the social relation with nature. It rejects the notion that nature is external to human societies, but rather stresses the role that human societies have in giving shape to nature through the activities of production, consumption, and the social relations governing these activities—especially under advanced capitalism. By rejecting a dualistic view of society versus nature, it provides an alternative to visualize and understand the relationship between society and nature.

Central to the approach is the idea that the labor process is a social act that transforms both humans and nature, and thereby dissolves the intellectual dualism between nature and society. Building on the work of Karl Marx, it looks to labor—or more generally, production—as a process involving both people and nature, in which people initiate and manage the material interactions with nature resulting in finished goods and infrastructure. Production takes place in nature and involves changes in the form of matter using both human labor and natural forces. People work in nature as a kind of natural force, using muscle, machines, and knowledge to shape nature according to human desires. Production includes far more than an individual's fabrication of an object. It encompasses imaginative work, economic and cultural creation, collective endeavors, and also consumption. As people shape the external world through production, moreover, they also transform their own nature and their own societies.

The Production of Nature does not imply that every atom in an endangered species, cloned sheep, genetically modified salmon, or university building is literally created by people. Instead, the view holds that people's actions affect the location and protected status of the wild animal, the process that led to the birth of the clone, the gene-splicing technology and patents of the salmon, and the location, style, materials, and social purposes of the university building. To differing degrees, all seemingly natural systems have a social framing and context while all seemingly social systems have a natural substrate, much modified by historic processes of producing nature. Meanwhile, environmental problems such as global warming, desertification, and mercury poisoning show that the materiality of produced nature can have unexpected and damaging consequences.

Under capitalism, the process of buying materials, transforming them with added labor, and selling them at a profit is central to the production of nature. Sometimes nature seems to pose certain barriers, however, to this cycle. Seeds, for example, were long a self-reproducing good. Unlike tractors, they were at one time difficult for capitalist firms to own, produce, and sell. In the past 100 years, however, science broke down the barriers to capitalist ownership of seeds through the selective breeding of hybrid, high-yielding varieties and the creation of a legal framework of patents to such seeds. More recently, biotechnology and patent law has extended to the modification and patenting of entire organisms with novel combinations of characteristics. The Production of Nature approach shows how these processes are driven by the dynamics of capitalism, which have promoted narrow and short-term interests at the expense of the precautionary principle, social considerations, or any interest in cultural or biological diversity.

The Production of Nature approach contrasts with more common views that conceptualize nature as separate and external to society. Proponents argue that this is a false abstraction because it is impossible to know nature as external to social structures, belief systems, and social values. There is no pristine, prehuman nature, and the view that nature is external to society is a false ideology usually mobilized to justify social oppression and/or short-sighted environmental domination. In contrast to dualistic views of nature and society, the Production of Nature moves environmental debates beyond the rhetoric of either protecting nature or dominating it. In particular, Production of Nature proponents reject a back-to-nature attitude in environmental debates. It is impossible to stop producing nature, but it is possible to produce nature (and society) along more socially and ecologically progressive lines.

At one extreme, a Marxist politics of nature accepts the proven and potential benefits of scientific and technical transformations of nature and recognizes that nature and society are tightly woven together. In contrast with approaches that advocate better nature management, or a hands-off nature protection, it seeks a revolutionary transformation of capitalism in favor of an economic system that is not driven by the narrow drive to accumulate profits. It advocates a social system in which science and technology is uncoupled from capitalist imperatives in order to serve more socially and environmentally progressive ends.

A more reformist interpretation, in contrast, contributes to debates about genetically modified organisms in agriculture by identifying the corporate control of biotechnology research and development and by promoting a stronger role for publicly-funded, democratically accountable universities in the research development of biotechnology, including more careful assessments of the long-term implications for human health and agro-ecosystem functions.

For critics, the Production of Nature approach overemphasizes production at the expense of cultural processes that also socialize nature, and in which productive processes are always embedded. They also point out that the approach shows much greater interest in how capitalism produces nature and much less in how produced nature affects capitalism; it does not encompass the agency of nature. Furthermore, it portrays nature as nothing more than a means to human happiness, and seems to silence a consideration of nature and natural processes in their own right.

SEE ALSO: Marx, Karl; Second Contradiction of Capital.

BIBLIOGRAPHY. N. Castree, "Marxism, Capitalism, and the Production of Nature," in N. Castree and B. Braun, eds., *Social Nature: Theory, Practice, and Politics* (Blackwell, 2001); N. Smith, "Nature at the Millenium: Production and Re-Enchantment," in B. Braun and N. Castree, eds., *Remaking Reality* (Routledge, 1998); N. Smith and P. O'Keefe, "Geography, Marx and the Concept of Nature," *Antipode* (v.12, 1989).

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Progressive Party

PROGRESSIVE PARTY IS the name of a number of political parties in the United States and in several countries around the world. Progressive parties are or have been "left of center" parties. They are usually statists, because they advocate actively using the power of government in all manner of public policy areas including ecology. Theodore Roosevelt, who is generally viewed as a Progressive though he initially entered the White House as a Republican, became the president of the United States on September 14, 1901, following the assassination of President William McKinley (1843–1901). He was elected to his own term as president in 1904. In 1912, Roosevelt made another bid for the presidency and created the "Bull Moose Party," or the United States Progressive Party. The nickname "Bull Moose Party" came from Roosevelt's answer to questions about his health and his stamina for creating a new political party—he replied that he was as healthy as a "bull moose."

Important environmental planks in the platform of the United States Progressive Party of 1912 were promotion of country life and conservation. The promotion of country life was a pledge to promote prosperity in rural areas and improvements in rural life. The conservation plank of the platform proposed a policy of conservation that applied to forests, oil, and other natural resources. Conservation would govern development and use of natural resources in a manner that was not destructive.

Homesteading would still be encouraged, but most natural resources still in government hands, either state or federal, were to remain in public hands so that they could be wisely conserved and used for the general welfare. Moreover, it would be a policy in which the government would gain mining fees or lumber profits for the benefit of the people, and not for the benefit of commercial enterprises. The nation's water supply would be effectively nationalized with regular payments to be made to the government for the exercise of water rights by private companies. A similar arrangement was to be made for leases of public lands for grazing rights. Finally, the platform includes the statement that those natural resources necessary for the national welfare should be owned or controlled by the nation. The presidential election of 1912 was a disappointment for the Progressives. They vastly out-polled the Republican Party in popular votes and Electoral College votes; however, they lost the election to the Democratic Party's candidate Woodrow Wilson. By the election of 1916, the Progressive Party had disappeared, but it reemerged in subsequent elections.

In 1924 Robert Marion La Follette, Sr. (1855–1925) organized the Progressive Party so that he could run for president. The party's platform called for public ownership of water power, public control and conservation of all natural resources including coal, mineral ores, oil, and timber lands so that these could be responsibly used for the common good. It carried Wisconsin and disappeared after the election. Henry Wallace was the presidential candidate in 1948 on the Progressive Party ticket. Its platform was in the main written by extreme leftists. Beyond asserting that all natural resources belonged to the people, it had little to say about conservation or the environment. The Progressive Party of Canada was based in Manitoba. It flourished in the 1920s and 1930s, but soon lost public support. It was linked with the United Farmers Parties in several other Canadian provinces.

Several American states have had, or still have, progressive parties. In 1988 Eugene McCarthy established the Minnesota Progressive Party so that he could run for president of the United States. He and the party fared poorly at the polls. The Vermont Progressive Party is a state-level party that promotes left-of-center ideas. The party's stand on environmental issues includes opposition to unregulated development, preservation of the rural environment of Vermont, and pollution prevention. The Progressive Party of Washington State considers itself to be a revival of the original Bull Moose Party of 1912. Organized in 2003, it supports conservation, a search for alternate fuels and energy, small farms and businesses, and respect for the earth. The Progressive Party of Missouri is similar. The New Zealand Progressive Party held some offices in the government in 2006, and is active in conservation and environmental issues. Its achievements include efforts to save the kiwi bird, increasing fishing reserves, and the establishment of preserved or dedicated-use public lands. Other small progressive parties exist around the world.

SEE ALSO: Movements, Environmental; Policy, Environmental; Roosevelt (Theodore) Administration.

BIBLIOGRAPHY. James Leonard Bates, *The Origins of Teapot Dome: Progressive Parties and Petroleum, 1909–1921* (University of Illinois Press, 1963); Roger T. Johnson, *Robert M. LaFollette, Jr. and the Decline of the Progressive Party in Wisconsin* (Archon Books, 1970); Robert C. Pachlke, *Environmentalism and the Future of Progressive Politics* (Yale University Press, 1989); David Stradling, ed., *Conservation in the Progressive Era: Classic Texts* (University of Washington Press, 2004).

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Property Rights

PROPERTY RIGHTS DETERMINE who is entitled to use and dispose of resources, both natural and man-made. They profoundly affect the decisions people make regarding the use of resources, and hence the magnitude of human impacts on the environment.

Property rights entitle one or more people to use a resource (usufruct), to exclude others from its use, to transfer ownership to someone else (e.g., by sale, inheritance, or gift), or to allow someone else to use the property temporarily (e.g., for rent). Property rights may also allow the owner to destroy the property. These rights are conferred by social institutions (e.g., by government) and are subject to renegotiation. Hence, property rights consist of "bundles of rights" that vary in time and place.

The environmental implications of property rights depend on the kind of property as well as on the type of resource, and the uses that people make of that resource. Important kinds of property include open access (no one owns the resource), common property (owned by a defined group of people), state property (owned by the state), and private property (owned by an individual, or a corporation treated as a legal person). Important characteristics of the resource include whether it is renewable or not, whether it requires human effort to maintain its quantity or quality, and whether it is "excludable" or not. An excludable resource is one from which all others can be excluded; for example, land is an excludable resource but the atmosphere is not. Important characteristics of resource uses are whether they are liable to degrade or deplete the resource. For example, logging can deplete a forest and degrade its soils and is thus a "rivalrous" resource use, while breathing the air or walking on a sidewalk is nonrivalrous. Some resource uses improve the resource, for example, the utilization of knowledge typically adds to the existing knowledge base of society, and nobody loses knowledge when somebody learns.

OPEN ACCESS

An open access regime is appropriate if the main resource uses are nonrivalrous, especially if little or no human effort is required in order to maintain that resource (for example, air to breathe or sunlight). Patent rights (a kind of private property) are intended to provide economic incentives to create new technical knowledge, even though that knowledge is nonrivalrous. Hence, many patents are controversial, especially if they are extended to living things such as genetically modified organisms (GMOs) or are used to appropriate knowledge that was previously in the public domain, that is, open access.

Open access can also be appropriate in the case of rivalrous resource uses, if those resource uses are kept within limits by other factors. For example, at a time when the human population was much lower than it is now, market incentives to overfish were limited and industrial fishing methods had not yet been developed, and it was therefore safe to leave most oceanic fisheries under an open access regime. However, once such limits are removed, there may be a competitive rush to exploit a resource before others do, leading to Garret Hardin's Tragedy of the Commons (which would be better termed a "tragedy of open access"). Nowadays, open access is not an environmentally sustainable option for most rivalrous resource uses.

COMMON PROPERTY

Common property regimes are especially suited to nonexcludable resources that are being used in rivalrous ways. The costs of trying to impose private property in such cases are enormous, and can lead to serious inequities. For example, if the water in a large aquifer with slow rates of replenishment (such as the Ogallala Aquifer in the United States) is treated as private property, the aquifer as a whole is treated as an open access resource, encouraging landowners to appropriate as much water as possible before it is tapped by their neighbors. Conservationist users of the water lose out because the groundwater table under their own land declines as a result of others' use of that water. In such cases, some form of common property in the aquifer needs to be established in order to provide the incentives required for sustainable rates of use.

Common property may also be established in man-made assets that require a common effort to maintain. For example, irrigation structures that serve numerous farmers may best be maintained as common property in order to ensure that both upstream and downstream farmers devote similar amounts of labor and capital to maintaining the structures and reap similar benefits. If such common ownership institutions decline, the resource will be degraded.

Finally, common property may also be established in excludable resources that can be managed as private property, for the sake of social objectives such as equity. For example, most nomadic herders did not have private property in grazing lands until private property regimes were forced upon them. Common property in grazing lands allows the flexible management of livestock, taking them wherever forage is seasonally available in an unpredictable environment, while assuring that everybody's herds are likely to survive. Private property in ranching land in semiarid areas is only feasible if land holdings are large, and may thus require the exclusion of large numbers of people from land ownership (as happened in Spain, the Americas, Australia, and southern Africa).

In order to perform well, common property requires effective management institutions that are able to formulate rules of resource use acceptable by the great majority of members, that effectively involve members in decision making, and that are able to enforce rules reliably.

STATE PROPERTY

States claim property in resources they find particularly important, such as unclaimed land, forests, and coastal waters. State property also usually includes man-made infrastructures that cannot be effectively managed as private property, such as the road network. In theory, these resources are to be managed for the public good; for example, state-owned forests are supposed to serve multiple uses including timber harvesting, watershed protection, wildlife conservation, and recreation.

Private management of such forests may lead to environmentally unsustainable outcomes, because the time horizons of individual owners may be limited to their own lifetimes, encouraging the destruction of resources that take centuries to replenish. However, the time horizons of governments may also be short, particularly if government officials are corruptible by major resource users. For state property to deliver on its promises, a high degree of democratic accountability must be assured. Otherwise, this property form, which *de jure* is a form of common property, *de facto* becomes a form of open access or private property.

PRIVATE PROPERTY

Private property is most appropriate in the case of excludable resources used in rivalrous ways, such as land used for crop agriculture. In theory, the landowner suffers the full impact of any destructive uses of his property, which is sufficient incentive to use that land in an environmentally sustainable way. However, this form of property by no means guarantees positive environmental outcomes even in situations to which it is best suited.

SEE ALSO: Equity; Game Theory; Genetically Modified Organisms; Intergeneration Equity; Overfishing; Private Property; Privatization; Tragedy of the Commons.

BIBLIOGRAPHY. Terry L. Anderson and Fred S. McChesney, *Property Rights: Cooperation, Conflict, and Law* (Princeton University Press, 2003); David Bollier, *Silent Theft: The Private Plunder of Our Common Wealth* (Routledge, 2003); David Feeny, Fikret Berkes, Bonnie J. McKay, and James M. Acheson, "The Tragedy of the Commons: Twenty-Two Years Later," *Human Ecology* (v.18/1, 1990); Susan S. Hanna, "Property Rights, People, and the Environment," in Robert Costanza, Olman Segura, and Juan Martinez-Alier, eds., *Getting Down to Earth: Practical Applications of Ecological Economics* (Island Press, 1996); Bruce A. Larson, ed., *Property Rights and Environmental Problems* (Ashgate, 2003); John F. Richards, ed., *Land, Property, and the Environment* (Institute for Contemporary Studies Press, 2002).

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Protected Areas

PROTECTED AREAS COME in many forms with many purposes. They may be tens of thousands of square miles in size, or less than a couple of acres (10,000 square meters). They may be strictly protected with no visitors allowed, or they may be multiple use areas that protect wildlife. They may also allow extensive recreation, or they may be complex, long-settled landscapes with historic, scenic, and cultural values. The global diversity of protected areas is one of their strengths. Few would deny protected areas a strong place in conservation and environmental management. But there is debate over which kinds of protected areas are best, and how they should be planned and managed.

HISTORY

The earliest protected areas were probably local, often communally and informally designated sites consisting of areas that had cultural, spiritual, or subsistence value. Similar areas remain in the traditions and practices of many peoples around the world today. For centuries there were also areas protected for the maintenance of specific resources, usually for societal elites, e.g., the game, timber, or furbearer reserves established in many parts of Europe and Asia over the last 1,000 years and more.

The modern history of protected areas is usually seen as beginning in the early to mid-19th century with the development of major urban parks in cities such as London, New York, and Montreal. They were seen as benefiting urban populations, fostering social improvement and public health.

These areas served as places to exercise and take in the fresh air as well as backdrops for cultural events. By the mid-19th century, the public called for areas to be set aside to serve as large parks that would protect scenic and natural wonders such as Niagara Falls, Yosemite, Yellowstone, and Banff. In the 1860–80s, the United States, Canada, and Australia would become some of the first countries to establish state or national provincial parks. The parks were not only a way to enjoy the outdoors but were great opportunities for tourism. The timing was just right as the newly completed railroads provided tourists a way to reach these destinations.

The late 19th and early 20th centuries also saw the first wildlife and migratory bird sanctuaries, which were often tied to early conservation efforts and then later to the Canada/U.S. International Migratory Bird Convention of 1916. It was a time of national and state park growth as well as the beginning of wildlife research and a strengthened conservation focus for many protected areas. This emphasis was picked up again after World War II and the postwar growth period of the 1950s. North American–style parks were created in a few places in the early 20th century, notably in many parts of south and east Africa. But it was not until the post–World War II era—when European colonies gained independence and the influence of the environmental movement grew—that they became a global phenomenon. Beginning in the late 1960s, most national parks were strongly protectionist of biodiversity and exclusionary of people.

SPECIAL TYPES

Other types of protected areas have also developed since the 1960s, paralleling the growth in environmental and other preservation movements, including historical and cultural movements. Most national and subnational jurisdictions have protected area systems that preserve historic resources. Some have special protected areas for indigenous people and their traditional cultures, e.g., Brazil and Australia. Many European nations have protected areas that include human populations and their traditional activities, scenery, and wildlife, sometimes called *working landscapes*. Examples include many British national parks, U.S. coastlines, and Canadian rivers. Other areas, such as the Russian *zakazniks*, are focused on sustaining particular resources and their traditional uses, e.g., furbearers, trees, or reeds. Still other areas aim to offer strict protection of important features and resources, such as ecological reserves in Canada or *zapovedniks* in Russia.

Protected areas can also include marine areas. In the 1930s, the first designated marine areas were located in the Caribbean. Beginning in the 1960s, more marine areas were designated as protected areas, including Australia's famous Great Barrier Reef Marine Park. It is only in the last 10 years or so that the campaign for marine protected areas has achieved a higher profile. Marine protected areas, however, still lag far behind terrestrial protected areas in numbers and area. This is due to a range of factors from lack of knowledge and public profile, to the almost universal opposition of fishing interests to strict (no-take) protections, or even more moderate ones.

ORGANIZATIONS AND PROGRAMS

International designations have been created to recognize especially significant existing protected areas around the world, such as the United Nations Educational, Scientific and Cultural Organization's (UNESCO) cultural and natural world heritage sites. The UNESCO Man and the Biosphere reserve system seeks to develop a global network of core protected areas with buffer and transition zones that allow local traditional activities to continue alongside conservation, research, and tourism. The Ramsar Convention on Wetlands recognizes globally significant wetlands already protected by national and other governments.

A study of protected areas cannot overlook the ones that are privately owned and managed. These areas may serve many purposes but usually entail a mix of conservation, recreation, and resource production. They may be owned by major nongovernmental organizations (NGOs), such as the North American Nature Conservancy, local land trusts, individuals, and corporations. In some countries such as Costa Rica and Australia, governmental programs exist to recognize and assist protected areas.

PLANNING AND MANAGEMENT

The planning and management of protected areas continue to face many challenges. The term *protected areas* connotes different meanings in different places, and there is confusion as to which areas are protected. The World Conservation Monitoring Center in Cambridge, England, seeks to track global protected areas, and uses a standard set of categories developed by the World Conservation Union's (IUCN) World Commission on Protected Areas. This typology comprises six categories and is under review. It has been much discussed recently, in part due to its relative emphasis on government-owned, strictly protected areas along the national and state/provincial park model.

Another challenge to protected areas in the last 20 years is the decline of governmental funding in the management of these areas, which has resulted in the privatization of management and services. This puts pressure on revenue generation, which often leads to increased fees for entry and participation in educational activities. This raises issues of equity in terms of who can access the protected areas and how many derive educational benefit from visiting. Another critical challenge of great complexity is how global environmental change will affect the ecosystems, wildlife, recreational resources, and peoples that protected areas have been established to protect.

COOPERATIVE MANAGEMENT

Possibly the critical challenge for protected areas globally, including in developed countries, is expanding protected areas to facilitate protected area systems that form networks and are ecologically connected, while also not harming the livelihoods of local people—whether hunter-gatherers or commercial ranchers. In many parts of the world, interest is growing in working landscape models and others that involve and provide benefits for local people, such as integrated conservation and development projects. Cooperative management and tourism development with local indigenous peoples, such as those in the Canadian North and Costa Rica, are increasingly common. The future of protected areas as global tools for biodiversity conservation may well depend on whether they can also become agents for local development and capacity building, and also be flexible enough to function in various cultural, economic, and political contexts.

SEE ALSO: Great Barrier Reef; National Parks; Yosemite National Park; Yellowstone National Park.

BIBLIOGRAPHY. S.R. Brechin et al., eds., *Contested Nature: Promoting International Biodiversity with Social Justice in the Twenty-First Century* (SUNY Press, 2003); R. Bushell and P.F.J. Eagles, *Tourism and Protected Areas: Benefits Beyond Boundaries* (CABI Publishing, 2006); Karen R. Jones and John Wills, *The Invention of the Park: Recreational Landscapes from the Garden of Eden to Disney's Magic Kingdom* (Polity Press, 2005); Michael Lockwood, Graeme Worboys, and Ashish Kothari, *Managing Protected Areas: A Global Guide* (Earthscan, 2006); Sue Stolton and Nigel Dudley, *Partnerships for Protection: New Strategies for Planning and Management for Protected Areas* (Earthscan, 1999); United Nations Environment Programme World Conservation Monitoring Center World Database on Protected Areas, www.unep-wcmc.org (cited December 2006); World Conservation Union (IUCN) World Commission on Protected Areas, www.iucn.org (cited December 2006).

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Proteins

PROTEINS ARE COMPLEX organic compounds consisting mainly of amino acids joined together by peptide bonds in long chains. These are comparatively large and complicated molecules and their full functions have not been completely established. Proteins are essential to the central chemical processes of life and are of great nutritional value. They are specific to different species and also vary according to different organs and locations within a particular living creature. The functions of proteins range from structural support, forming part of the immune response, and as the catalysis of chemical reactions. One of the most important is hemoglobin, which helps the blood to carry oxygen throughout the body. Proteins were first identified in the 19th century and their name derives from the Greek for "of the first place."

The configuration of different amino acids and their ordering determine the nature and structure of individual proteins. Hydrogen bonding, hydrophobic and electrostatic forces, and van der Waals forces are all involved in the structuring of protein molecules. Some molecules consist of two or more peptide chains and others are covalently conjugated with carbohydrate molecules. These latter are known as glycoproteins. Varieties of glycoproteins are influential in determining the blood type that people have. The lack of proteins leads to a variety of diseases. An example is sickle cell anemia, which results from the substitution of one protein for another very similar one in the hemoglobin.

Proteins are converted into energy by creatures through chemical decomposition (digestion) and are used in cell repair and growth, and energy. Historically, mankind has used animals as an important source of protein, although some nonanimal proteins supplement this, depending on the availability of alternative foods and cultural factors. Dairy products, cereals, and legumes are important nonanimal sources of protein. However, while animal proteins are complete in that they contain all necessary amino acids for human sustenance, nonanimal proteins are incomplete and must be eaten in suitable combination. For good health, approximately one gram of protein should be eaten per one kilogram of weight per day. The Kjeldahl method is used to identify the exact protein value of different types of food. A diet balancing different types of nutrient and chemical purposes is recommended.

In recent years, researchers have taken the first steps to creating artificial proteins through chemical methods, using computer-aided design techniques to visualize the structure. Such artificial proteins may be used, it is hoped, for specific medical techniques that are not currently possible. They also open up the possibility of the enhancement of organic material, notably human beings. Such augmentation raises a number of ethical concerns. Growing proteins in laboratory conditions would also represent a new source of food, which would have particular applications in environments in which natural animal and nonanimal proteins would not flourish, such as in space.

SEE ALSO: Animals; Chemical Additives (in Foods); Food; Food Webs (or Food Chain).

BIBLIOGRAPHY. D.M. Barbano, J.M. Lynch, and J.R. Fleming, "Direct and Indirect Determination of True Protein Content of Milk by Kjeldahl Analysis: Collaborative Study," *Journal of Association of Official Analytical Chemists* (v.74, 1991); Oliver Gresch and Hans-Guenter Bruenker, "Efficient Small-Scale Production of Proteins," *Biopharm International* (February, 2006); David Whitford, *Proteins: Structure and Functions* (John Wiley & Sons, 2005).

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Public Land Management

PUBLIC LANDS ARE those lands formally owned by the modern state and subject to the management authority of local, state, or federal/national institutions. In the United States, this status sets them apart from private property and commons-based regimes of land tenure in which individuals or nongovernmental stakeholder groups effectively determine the access, use, and management of land-based resources. Questions of setting and implementing public land management priorities, therefore, are inextricably linked to modern state politics and capitalist economic development.

There are two key seams in public land management debates. First, in terms of management outcomes, debates center on the extent to which lands should be managed for the purposes of environmental preservation, human recreation, or economic development. The second seam addresses questions of governance, such as how and to what extent citizens or interest groups should have a voice in public land management decisions, how those with livelihood, cultural, or other preexisting claims to the land should be integrated into the management process, and whether or not local residents or governments still have a unique or necessary role to play in the crafting or the implementation of public land management plans.

This last point underscores the broad issue of jurisdictional versus ecological demarcations of public land boundaries. If managing lands on an ecosystem level is required to achieve ecological restoration goals, to what extent do current public land boundaries align with the appropriate boundaries, and if they do not, how might diverse jurisdictional forms be meaningfully integrated?

The institutional structures within which most public land management agencies operate are rooted in the progressive-era politics of the late 19th and early 20th centuries. They were a response to ecological and socioeconomic crises resulting from a century of relatively unfettered industrial development of lands and resources. According to early proponent Gifford Pinchot, progressive conservation stood first and foremost for development, but sought to replace short-term profit motives with rational scientific decision making. By retaining lands in the public domain and managing them with college-educated, disinterested technocrats, the resources could be developed in the most efficient manner and in so doing, best serve the public interest.

While the ideals of scientific management underpin all state and federal management agencies, in practice, they are applied sporadically. Economic development as an explicit priority is perhaps best reflected in the timber production, mining, and livestock grazing programs that dominated the management of national forests and Bureau of Land Management (BLM) lands for much of the 20th century. In 1960 the multiple use mandate was introduced, in which recreation and ecological preservation became equal priorities, though critics note that this led to little actual change. Nonetheless, the decade signaled the emergence of competing constituencies and values that began to challenge the dominance of resource extraction activities.

The passage of environmental protection laws such as the 1969 National Environmental Policy Act and the 1973 Endangered Species Act forced federal agencies to bring noncommodity species and ecological health issues more directly into land management plans and protocols. The general decline in timber production on national forests in the 1990s is demonstrative of this broadening of management priorities (in addition to overlogging in preceding decades, and historical fire suppression policies). However, recent laws, such as the 2003 Healthy Forests Restoration Act, may be tipping the balance back toward timber production in the name of wildfire prevention.

RECREATION VERSUS PRESERVATION

Recreational development and environmental preservation figure more prominently in national parks, wildlife refuges, and wilderness areas. In 1872 Yellowstone became the first national park withheld from settlement as a public pleasuring ground. Congressional approval for the park hinged on the argument that it was unsuitable for settlement or resource extraction development. The creation of other national parks followed a similar logic. Despite the lack of traditional resource development, the burgeoning potential of these lands as hubs for tourism and recreation led to industrial support for the passage of the 1916 National Park Service Act. This act established the national park service and delineated the dual mandate for the management of national parks: "to conserve the scenery and the natural and historic objects and wildlife therein, and to provide for the enjoyment of the same and in such manner and by such means as will leave them unimpaired for the enjoyment of future

Promotion of park recreation helped lead to ongoing tension between recreation and ecological preservation.

generations." The promotion of visitation and recreation helped build a constituency in support of the national park system, but modifications such as roads, campgrounds, hotels, and restaurants, and the visitors posed a challenge to ecological preservation efforts. In recent decades, debates over the use of snowmobiles and other forms of mechanized transportation represent the legacy of these early managerial contradictions. Questions over the idea of increasing entrance fees have also been raised, as park visitation and maintenance costs have continually outpaced agency budgets.

WILDLIFE REFUGES

The tension between recreation and ecological preservation is also found in wildlife refuges. Managed by the U.S. Fish and Wildlife Service, priorities include the preservation and restoration of endangered species and migratory bird populations, the preservation of biodiversity within the refuges, and educational outreach. Historically, most support for the refuges derived from recreational hunting and fishing interest groups. However, these management goals are complicated by competing allowable land uses, which may include livestock grazing, motorized recreational activity, logging, or mining. The most famous example of these tensions in recent years is the debate over oil drilling in the Alaska National Wildlife Refuge.

WILDERNESS AREAS

The management of wilderness areas offers the closest approximation to an environmental preservation priority achieved through a hands-off management strategy. They are administered by various public land agencies, but in all cases prohibit resource extraction, the use of motorized or mechanized forms of transportation, and the construction of any permanent human-made structures. However, like the early national parks, most wilderness areas are located in high elevation areas devoid of economic development potential.

Management challenges include overuse by visitors, controlling invasive species and diseases, and attempting to coordinate management programs on lands that border wilderness areas, where land uses and permitted management actions may lead to unintended outcomes.

NEW APPROACHES

In the 1990s two new approaches to public land management emerged. First, ecosystem management addresses public land management, whether resource development, recreation, or ecological restoration, in a holistic, system-based manner. This entails looking at entire ecosystems in crafting management programs. For example, efforts to restore endangered species populations, such as the bison and timber wolves in Yellowstone National Park, meant coordinating efforts beyond the boundaries of the park, following the historic range of these species. It also means considering the impacts of management activities on all aspects of the ecological system. Because of the incongruence of agency jurisdictions and ecological boundaries, this often means coordinating management between different federal and state agencies, and increasingly, with local governments and private property owners.

The second new approach, collaborative resource management, refers to efforts to integrate diverse interests into the information gathering, decision making, and implementation processes of public land management. Some efforts are organized around large-scale ecosystems, such as the Greater Yellowstone Ecosystem or the Great Lakes. Many more efforts focus on watershed scale management programs. In sum, each of these newer approaches to public land management represent challenges to progressive era assumptions of state or federal scientific authority as new voices and institutions become integrated into the governance of public lands. They also reflect new ways in which economic, recreational, and ecological management priorities are being reworked within the context of public land use in the United States.

SEE ALSO: Bureau of Land Management; Conservation; National Parks; National Parks Service (U.S.); Pinchot, Gifford; Progressive Party; Yellowstone National Park.

BIBLIOGRAPHY. R.W. Behan, *Plundered Promise: Capitalism, Politics, and the Fate of the Federal Lands* (Island Press, 2001); Marion Clawson, *The Federal Lands*

Revisited (Resources for the Future, 1983); H.J. Cortner and M.A. Moore, *The Politics of Ecosystem Management* (Island Press, 1999); M.P. Dombeck, C.A. Wood, and J.E. Williams, *From Conquest to Conservation* (Island Press, 2003); Gifford Pinchot, *The Fight for Conservation* (Harcourt Brace, 1910); Charles Wilkinson, *Crossing the Next Meridian: Land, Water, and the Future of the West* (Island Press, 1992); Dylan Zaslowsky and T.H. Watkins, *These American Lands* (Island Press, 1994).

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Public-Private Partnerships

PUBLIC-PRIVATE PARTNERSHIPS ARE commonly cited by governments, business, the press and academics as constructive, and even "cure-all," mechanisms for development in many spheres. Public-private partnerships have risen to the forefront of development processes as the global shift toward governance has gathered momentum. As stakeholders in development have come to recognize that they are interdependent and as the search for new solutions to contemporary problems has expanded beyond the use of traditional mechanisms of government, public-private partnerships have become increasingly popular in both the developed and developing world.

Although varying definitions abound, public-private partnerships are collaborations across the public and private sectors that are seen by the respective parties as facilitating greater gains than could be achieved by working separately or in conflict. They are further considered as a tool or instrument of development, enabling governments to carry out their role in a context of governance, which increasingly requires a role for many players in decision making, development, and service delivery.

Public-private partnerships can form through various motivations, such as access to capital or expertise, lack of capacity to deliver services effectively, the possibility of cost savings in a competitive service delivery environment, or as responses to shifts in government policy. These partnerships should be understood as reflections of the institutional culture and local context through which they emerge. The purpose of a partnership can be to achieve a onetime goal, perhaps a particular economic development, or they can be established to effect ongoing broader development goals, such as urban renewal, shared service delivery, or the improvement of urban economic competitiveness. Where ongoing change is the goal, these networks can form strong and lasting alliances, such as those of growth coalitions and urban regimes.

Typically, public-private partnerships have been used to assist a state's infrastructure delivery programs. These partnerships are especially needed to help governments to overcome backlogs in delivery of services and infrastructure such as water and electricity provision or where local governments outsource service delivery to the private sector in an attempt to ensure greater cost effectiveness or efficiency. Furthermore, public-private partnerships for tourism are increasingly advocated as a means of local economic development, especially where state conservation areas are released for use by the commercial sector or for use as a commercial entity. In countries such as South Africa, recent focus on public-private partnerships has extended to health care provision with public and private-sector health services working in shared locations and with the private sector under contract to run government health facilities.

Regardless of the specific details of the partnership, all partnerships are formed with a view to enabling partners to share both the risks and the rewards of their collective venture and usually entail a specified and formal agreement between parties, denoting the nature of all roles and responsibilities and the nature of shared costs, risks, and benefits. Some important measures of a successful partnership are appropriate and sound leadership, good communication within the partnership and with other stakeholders (perhaps those affected by the activities of the partnership), well-defined roles within the partnership, meeting of partnership goals and shared benefits of the partnership outcomes.

Although public-private partnerships are widely lauded mechanisms for both service delivery and development, questions remain about the power relations within partnerships and the overall impact of the specific outcomes of partnership activities.

The configuration of these partnership networks creates variability in how partners exercise power and determines whether decision-making processes are led by the public or private sectors, although it is commonly held that the public partner will usually carry the greater set of costs and risks within a partnership.

It is also worth questioning whether private-sector involvement in service delivery and development may result in the sidelining of issues such as accountability to the public, social equity, and justice. This is true in property development partnerships, in the course of which the local community may be sidelined as private-sector goals become central and as the state's role simultaneously becomes that of developer and regulator, or in service delivery partnerships where the rights of the poor to water and electricity may be compromised by the market-driven systems of the private sector. Furthermore there are sometimes concerns that the private sector may use a partnership to exercise undue leverage over the allocation of public funds, especially into projects for their own gain.

SEE ALSO: Developed ("First") World; Development; Equity; Justice; Underdeveloped ("Third") World.

BIBLIOGRAPHY. Alan Harding, Stuart Wilks-Heeg, and Mary Hutchins, "Business, Government and the Business of Urban Governance," *Urban Studies* (v.37, 2000); Stephen P. Mullin, "Public-Private Partnerships and State and Local Economic Development: Leveraging Private Investment," *Reviews of Economic Development Literature and Practice* (16, 2002); Gerry Stoker, "Public Private Partnerships in Urban Governance," in J. Pierre, ed., *Partnerships in Urban Governance: European and American Experience* (St. Martin's Press, 1998).

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Public Trust Doctrine

PUBLIC TRUST DOCTRINE is a series of beliefs and codified laws that consider certain natural resources community property, to be used by all citizens. Since the time of Roman law under Emperor Justinian, common resources were protected. In the *Institutes of Justinian*, the law states "The things which are naturally everybody's are air, flowing water, the sea and the seashore." Furthermore, Roman law treated navigable waterways and the uses of these bodies of water differently than nonnavigable waterways. In essence, according to Ingram and Oggins, "Roman law sought to preserve the use of navigable waterways for public benefit."

Many societies have attempted to balance the role of the natural rights of all. Evidence of this can be found in the Chinese water law of 249–07 B.C.E., in the traditional customs from Nigeria, in the Islamic water law, from the laws of medieval Spain and France, and in the traditions of North American Native Americans. The first of such laws to be codified in North America were written by the Spanish in *Las siete partidas del sabio rey don Alfonso* from the *Recopilacion de leyes de los reynos de las Indias*, according to Ingram and Oggins. However, many scholars such as Slade believe that these rights, reserved for citizens, as they are expressed in Western culture, have become a part of the traditional values that resulted from the Saxon invasion of England during 450 C.E., and were maintained after the Norman conquest of 1066.

The English tradition was reaffirmed on the North American continent when the Magna Carta, the "Great Charter," which has influenced the development of constitutional law, was originally issued in 1215 C.E. The Magna Carta grants certain rights to the people, which in turn limit some of the power of the king. Particular rights guaranteed by the Magna Carta enlarged the rights of the people's public interest in navigable waters, public lands, and resources within the context of the English notion of *Jus publicum*, or public rights of use. The public rights of use were interpreted from the medieval period to the present day to mean those resources held in public trust by the English Crown for the good and benefit of all people. This interpretation of the Magna Carta is the most direct source of law that has served as inspiration and the foundation of the traditional American public trust doctrine, according to Wilkinson.

The earliest documentation of the application of the public trust doctrine in the United States was in

1821 when a New Jersey court ruled that the state could not convey into private property the ownership of public lands. It held that the natural resource (the waterways) vested in the trust of a sovereign state is not for the state's use, but rather for the use of its citizens for "passing and re-passing, navigation, fishing, fowling, sustenance, and all the other uses of its waters and products…" (*Arnold vs. Mundy* 6N.J.L.1, 1821). The state can act in a manner that improves the general navigation and navigability of the waterways by building locks, dams, or bridges, but it cannot take actions that deny the public of their common right to the use of natural resources, according to Stevens.

The *Arnold vs. Mundy* decision, in fact, served as the foundation of American environmental laws. The ruling implied the use of the interpretation of the public trust doctrine as conceived during the medieval period. This ruling recognized the state's role in serving as a guardian of the public's interest so that no one truly owns the publicly held resources. The public's interest is omnipresent. Present-day uses of the understanding of the public trust doctrine have been extended to include recreational use of lakes and beaches [*National Audubon Society vs. Superior Court* (Mono Lake), 658 P2d 709, Cal. 1983], wildlife preserves (*Owsickek vs. Alaska Licensing and Control Board* 763 P2d 488, 493, Alaska 1988), and the air (*Save Ourselves, Inc. vs. Louisiana Environmental Control Commission*, 452 So. 2d 1152, 1154, La. 1984). In all the aforementioned cases, the public trust doctrine has been used to assert that the fundamental underpinning of the public trust doctrine—as presented in Roman law and later extended to include roads and harbors—recognized certain natural resources and ecological systems held in trust by the state for the public's access and use as inherently public because of their unique characteristics.

SEE ALSO: Common Law; Common Property Theory; Tragedy of the Commons.

BIBLIOGRAPHY. H. Ingram and C.R. Oggins, "The Public Trust Doctrine and Community Values in Water," *National Resources Journal* (v.32/3, 1992); David Slade, "The Public Trust Doctrine: A Gift from a Roman Emperor," *Coastliner Newsletter of the USEPA* (v.7/4, 1997); J. Stevens, "Applying the Public Trust Doctrine to River Protections: California Water Plan Update," www.waterplan.water.ca.gov (2005); C. Wilkinson, "The Headwaters of the Public Trust: Some Thoughts on the Sources and Scope of the Traditional Doctrine," *Environmental Law* (v.19, 1989).

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Puerto Rico

THE ISLAND OF Puerto Rico is a U.S. Commonwealth in the Caribbean. When Christopher Columbus landed in 1493 on his second voyage to the Americas, he found a population of approximately 50,000 Taino-Arawak Indians. Spanish colonization began in 1508. Native peoples were enslaved, forced to extract gold or work on plantations, and devastated by disease, violence, and maltreatment. Subsequently, African slaves supplied labor for the island's sugar plantations from 1513 until slavery was outlawed in 1873. Sugar continued to dominate the island's economy until the 1940s.

The island was under Spanish control until it was ceded to the United States in 1898. After a period of U.S. military occupation, the Foraker Law in 1900 established a civilian government. The island was minimally developed until the 1950s when "Operation Bootstrap" tax incentives were given to companies that transferred to the island, encouraging transition from agriculture to industrial development. Migrants were drawn to urban centers by wage employment and pushed out of rural areas by difficult economic times. The island has depended on food imports ever since. Industrial development has also led to increases in water pollution. However, as a result of rural to urban migration, Puerto Rico also experienced spontaneous reforestation. The island is the site of extensive U.S. Forest Service research on tropical forest ecology.

Rapid economic growth on the island in the early 1990s is attributed largely to additional corporate tax incentives. Manufacturing facilities for large pharmaceutical companies were established in this period. President Bill Clinton began a 10-year phase out of these tax breaks starting in 1995, as they were seen as detrimental to industry in the south of the continental United States. However, companies were also enticed by Puerto Rico's educated, bilingual workers, who are paid lower wages than on the mainland. Many pharmaceutical companies expect to remain on the island even under its new tax laws.

Although Puerto Ricans have been U.S. citizens since 1917 and freely enter the mainland, they cannot vote in presidential elections. More than 50 percent of Puerto Ricans currently live on the mainland and many send remittances home. Puerto Rican pride can be likened to nationalism, regardless of the political status of their homeland. The island's resident commissioner in the House of Representatives has voting power in committees, but not on the floor of Congress. While in recent plebiscites there has been majority support for maintaining commonwealth status, an almost equal portion of Puerto Rican society desires statehood. Transition to statehood would likely require significant investment to bring the island on par with the other states. While less than 5 percent of Puerto Ricans voted in recent referendums to support independence, there was widespread condemnation of the 2005 assassination by federal agents of an island dissident who supported autonomy.

Vieques, a small island to the east of Puerto Rico and under its administration, was used for U.S. military maneuvers from the end of World War II until 2003. Frequent practice bombing just miles away from the local population of nearly 10,000 has led to public health problems, such as psychological trauma and high cancer rates. Portions of Vieques have been listed as a Superfund site because of hazardous military substances left in the soil, including depleted uranium, heavy metals, and pesticides.

There are plans to expand Puerto Rico's tourism. Visitors are attracted to the island's forests and beaches; cave exploration in karst landscapes is also popular. San Juan is the largest city and most active port. The urban center has high crime rates, even when compared to Los Angeles or New York. Puerto Rico's location between Colombia and the United States places it in a drug trafficking corridor. It has been a preferred U.S. entry point for illicit substances as subsequent domestic inspections are less rigorous than those from abroad. In recent years the U.S. Drug Enforcement Agency has been aggressive in combating Puerto Rican drug trade, but there has been public concern over a related erosion of human rights on the island.

SEE ALSO: Colonialism; Indigenous Peoples; Industrialization; Pollution, Water; Sugar; Superfund Sites; Tourism; Urbanization; War on Drugs.

BIBLIOGRAPHY. William J. Baumol and Edward N. Wolff, "Catching Up in the Postwar Period: Puerto Rico as the Fifth 'Tiger'?" *World Development* (v.24/5, 1996); James L. Dietz, *Puerto Rico: Negotiating Development and Change* (Lynne Rienner, 2003); Pedro A. Malavet, *America's Colony: The Political and Cultural Conflict between the United States and Puerto Rico* (New York University Press, 2004); Carlos Márquez, "The State of Puerto Rico," *Caribbean Business* (January 26, 2006); "Puerto Rico: FBI Kills Machetero Leader," *NACLA Report on the Americas* (November/December 2005).

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Pulp and Paper Industry

PULP IS THE fibrous material found in paper. While pulp can be made from diverse materials such as cloth rags, hemp, and straw, tree pulp remains the most popular. Trees of small diameters, tree limbs or crowns, or waste from lumber manufacturing are often pulped. Recovered wastepaper has gained importance in recent years. Electronic substitution for print materials has led to some reduction in paper demand, although new product lines also emerge for pulp. For example, fluff pulp is used in baby diapers and other highly absorbent products.

During wood pulping cellulose is separated from lignin, a natural polymer, which bonds the cellulose fibers together to create structure in trees. Mechanical, chemical, or chemi-thermomechanical pulping processes are most often used. The process chosen depends on the final product or paper grade that is desired and the input material. Hardwoods may

Pulp mills are often located adjacent to water bodies; their toxic by-products may bioaccumulate in nearby fish.

be too dense for mechanical pulping. Softwoods are preferred for paper due to their long, slender fibers, which provide strength in paper products. Virgin pulp is often mixed with mill residues, such as saw chips or sawdust.

Pulping produces significant chemical and biological waste. Breaking down wood chips through grinding requires significant energy input. Some comes from fossil fuels, although mills can burn by-products to produce a portion of the energy required for processing. Chemicals, such as sulfite and sulfate (kraft), can dissolve lignin in heated "digesters," but a variety of hazardous air pollutants are released. The recovery of the chemicals to be reused is usually viewed favorably, yet it generates additional emissions. Chemical pulping also produces tons of solid waste, made up of lignin and wood fibers, for every ton of pulp created.

If white paper is desired, bleaching occurs. Vents from bleaching tanks emit air pollutants. Nonchlorinated bleaching agents are available, but they are less popular. Highly toxic elemental chlorine has been phased out in most mills and replaced with chlorine dioxide, but bleaching processes still generate a large volume of liquid waste with toxic chemicals such as dioxins, furans, and chlorinated organics. Some of these pollutants pass though treatment plants and are discharged into water supplies. Mills are often located adjacent to water bodies given their high utilization of water.

There is technical capacity to build efficient mills that have no liquid discharge and recycle their chemical input, but they are expensive. Traditional mills release large quantities of by-products such as volatile organic compounds, particulate matter, and carcinogens. Bioaccumulation of absorbable organic halides often occurs in nearby fish populations. Environmental standards are often based on fish mortality during brief exposure to wastewater. Environmental advocacy groups argue that such tests are insufficient because they do not look at extended exposure over time or the potential for compounded results after mixing occurs with other toxins in the surrounding ecosystem.

The pulp industry is very capital intensive. Current economic returns are poor when compared to a decade ago. Dozens of mills in North America and Western Europe have shut down since 2000. Consolidations of plants owned by the same company, as well as merging between pulp giants, have become common. However, the world's largest pulp and paper companies are still found in the United States, Finland, and Japan.

While the global pulp and paper industry has traditionally been monopolized by a limited number of multinational corporations, a major capacity surge has initiated from the Southern Hemisphere. A global transition is occurring because of the ability to produce pulp quickly and at lower costs in places like South America and Asia. Furthermore, as many different types of manufacturing are transferred to developing countries, commercial packaging needs for products such as labels and containerboard lead to further restructuring of the paper industry.

In spite of improvements since the mid-1990s there is still limited use of and demand for recycled paper. Recycled paper products need to be collected in a separate waste stream to be attractive for resale. Paper companies are also looking for ways to bring down costs in postconsumer collection. The production of paper from postconsumer waste does create some environmental contamination during deinking (or pulp laundering) and reprocessing, but studies have found that overall energy requirements, production of greenhouse gases, solid waste, and particulates are less in 100 percent recycled paper than in 100 percent virgin paper. There are global environmental campaigns pressuring companies to increase postconsumer pulp in paper products, and for consumers to purchase recycled products.

SEE ALSO: Dioxins; Green Production and Industry; Industrial Ecology; Pollution, Air; Pollution, Water; Recycling; Waste, Solid.

BIBLIOGRAPHY. Datamonitor, *Global Paper and Forest Products* (May 2005); Emily McNair, *Following the Paper Trail: Overcoming Market Barriers to Environmentally Preferable Paper* (Aurora Institute, 2003); "Pulp Market Braces for Latin American Capacity Surge," *Pulp and Paper* (v.75/7, 2005); J. Rennel and S. Dillén, "Pulp and Paper: Wood Sources," in *Encyclopedia of Materials: Science and Technology* (Elsevier Science, 2001); U.S. Environmental Protection Agency, "Fact Sheet: The Pulp and Paper Industry, the Pulping Process, and Pollutant Releases to the Environment" (November 1997).

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Qatar

THE STATE OF Qatar has been ruled by the Al Thani family since the mid-19th century. During a bloodless coup in 1995, the current amir overthrew his father and began using petroleum revenues for the benefit of the state. Under the amir's guidance, Qatar's per capita income rose to $26,100, making this Middle Eastern nation the 35th-richest nation in the world. With long-standing border disputes with Bahrain and Saudi Arabia finally resolved, Qatar began the 21st century with an increasing standard of living for the population of 885,359 people. The United Nations Development Programme Human Development Reports rank Qatar 40th in the world in this area.

Except for a 60-mile border shared with Saudi Arabia, Qatar is completely surrounded by the Persian Gulf, resulting in a coastline of 563 kilometers. Like many Middle Eastern nations, Qatar's land area is comprised mostly of flat, barren desert where a haze often fills the air. Both dust and sand storms are common. Mild, pleasant winters are followed by extremely hot, humid summers.

With almost no fresh water resources and less than two percent of the land area arable, Qatar's agricultural sector is almost nonexistent, providing less than one percent of the Gross Domestic Product (GDP). The entire population of Qatar has access to safe drinking water because of the extensive system of sophisticated desalination facilities. Government initiatives also provide complete access to improved sanitation.

Other than petroleum and natural gas, which dominate the Qatari economy and provide more than 60 percent of the GDP, 85 percent of export earnings, and 70 percent of government revenues, Qatar's only natural resource is fish from the Persian Gulf. Approximately 81 percent of Qatar's workforce is involved in industries, including crude oil production and refining, ammonia, fertilizers, petrochemicals, steel reinforcing bars, cement, and commercial ship repair.

Because of the heavy emphasis on industry, some 92 percent of the population live in urban areas. Carbon dioxide emissions rose from 57.2 per capita metric tons in 1980 to 63.1 per capita metric tons in 2003. Qatar produces 0.2 percent of the world's supply of carbon dioxide emissions.

Less than 1 percent of the land area of Qatar is forested. Increased urbanization and the loss of forests place Qatari animal and plant life at serious risk, along with more than 150 species of fish and marine life. In addition to concern over these vulnerable habitats, environmentalists have expressed dismay about damaged mangrove regions and coral reefs. To improve agricultural production, foreign plant life was introduced into Qatar, unintentionally bringing disease-causing insects and weeds and fungal, nematode, and viral pathogens. Efforts to meet the resulting health crisis caused by the introduction of these new pathogens led to the overuse of harmful pesticides that further damaged the environment.

With the goal of reversing trends harmful to the environment, the government established the Supreme Council for the Environment and Natural Sanctuaries and in 2000 began passing a series of environmental laws. Protected areas were subsequently set aside to promote biodiversity and habitat. The council was also assigned the task of fighting desertification and was given the authority to close farms and businesses that were not in compliance with environmental laws. Hunting was banned outside of the hunting season from September to May. Other efforts were directed at banning the entry of hazardous waste into Qatar and constructing specialized treatment centers to store existing waste materials.

Qatar is a participating party in the following international environmental agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Coral Reefs; Desertification; Drinking Water; Habitat Protection; Invasive Species; Natural Gas; Petroleum; Urbanization.

BIBLIOGRAPHY. Central Intelligence Agency, "Qatar," *The World Factbook,* www.cia.gov (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Qatari Embassy, Washington, D.C., "Welcome to Qatar," www.qatarembassy.net (cited May 2006); Supreme Council for the Environment and Natural Sanctuaries, www.qatarenv.org/english (cited May 2006); United Nations Development Programme, "Human Development Report: Qatar," hdr.undp.org (cited May 2006); World Bank, "Qatar," *Little Green Data Book,* lnweb18.worldbank.org (cited May 2006).

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Quality of Life

THE CONCEPT OF quality of life includes multiple related ideas such as well-being, level of living, standard of living, and livability. Many commentators use the terms interchangeably. Quality of life refers to the overall nature of an individual or group's lived environmental experience—specifically, the satisfaction of desires associated with human needs and wants. Material and existential dimensions of life-worlds constitute the satisfaction of desires (such as having possessions and being happy). Well-being, on the other hand, refers to a general state of wellness, whereas level of living entails an economic and social assessment of the "actual degree of satisfaction of the needs and wants of a person or … group," and standard of living refers to the material and social aspirations of a population. Livability denotes the degree to which a place meets the requirements of human inhabitation.

A range of disciplines are concerned with quality of life, including sociology, geography, economics, planning, psychology, and public health. This is because quality of life, either a positive or negative, is framed by multiple axes of difference including gender, age, race, disability, income, education, residential location, and personal hygiene. The metrics for assessing quality of life thus exhibit substantial variation. Nonetheless, many measures are interrelated. Poverty, for example, configures life chances and thus life quality in very specific ways, including access to education and housing, exposure to pollution, exposure to violent crime, nutritional content of food, purity of water, and overall physical and mental health.

Quality of life is typically assessed through a wide variety of measures and indicators. These indicators vary across time, space, scale, and political spectrums. They include economic indicators such as income, Gross Domestic Product (GDP), and employment levels; social indicators such as nutrition, physical health, and healthcare facilities, prevalence of injuries or disease in a population, mental health, security or freedom from crime, freedom from discrimination, freedom of cultural expression, literacy and education, personal mobility, and leisure; political indicators such as democratic inclusiveness; human rights; physical or institutional indicators such as level of urbanization, urban service provision, and standards of housing; and environmental indicators such as freedom from pollution and access to open space.

The first attempts at assessing and reporting quality of life occurred in the United States in the early 20th century, when the Chicago School of Urban Social Ecology began to investigate the living conditions of urban migrants. In the 1940s, the United States developed formal procedures for assessing the quality of farm life in the Midwest. However, indices were largely economic and based upon material possessions and services associated with national affluence and progress (such as farms being connected to the electric grid). In the 1950s, measures of economic performance (such as GDP) were codified by many nation-states, since economic progress was associated with the ability to provide food, clothing, shelter, employment, education, physical mobility, and leisure.

By the 1960s, social indicators, or composite measures of welfare, were being formalized by organizations such as the Organisation for Economic Co-operation and Development and the United Nations. This was partly in response to the recognition that increases in material affluence produced by economic growth were often accompanied by unforeseen negative impacts such as environmental pollution or concentrated poverty. The real advances here were related to the ability of various agencies to report changes over time, to disaggregate data by scale and geographic location, and the connection of indicators with policy objectives. Multiple constructs and techniques emerged during this period, but three gained wide currency: economic indicators, psychological measures, and spatial indicators.

In the 1970s and 1980s, greater attention was paid to the spatial expression of quality of life, resulting in the urban social atlas movement, in which government agencies, often in conjunction with spatial analysts, published atlases of urban regions which reported territorial indicators (such as levels of education or unemployment by geographic location). From the late 1980s, psychologists have added subjective assessments of quality of life to the toolbox of measures, recognizing that quality of life is not something that is external to the individual, and that the same life conditions can be perceived differently by different people.

Most recently, some public health scholars and urban planners have begun to elucidate the interconnections between built environment, level of physical activity, and quality of life. Similarly, environmental economists have begun to quantify the ways that quality of life is dependent upon access to nature's services.

SEE ALSO: Needs and Wants; Social Ecology; Sociology; Urban Planning; Urban Sprawl.

BIBLIOGRAPHY. U. Hannerz, *Exploring the City: Inquiries Toward an Urban Anthropology* (Columbia University Press, 1980); R. Kaplan, "The Nature of the View from Home: Psychological Benefits," *Environment and Behavior* (v.33/4, 2001); C.L.M. Keyes, "Subjective Well-Being in Mental Health and Human Development Research Worldwide: An Introduction," *Social Indicators Research* (v.77, 2006); P.L. Knox, *Social Well-Being: A Spatial Perspective* (Oxford University Press, 1975); P.L. Knox, "Territorial Social Indicators and Area Profiles," *Town Planning Review* (v.41/9, 1978); F.E. Kuo, "Coping with Poverty: Impacts of Environment and Attention in the Inner City," *Environment and Behavior* (v.33/1, 2001); M.J. Sirgy et al., "The Quality-of-Life (QOL) Research Movement: Past, Present and Future," *Social Indicators Research* (v.76, 2006); I. Van Kamp et al., "Urban Environmental Quality and Human Well-Being: Towards a Conceptual Framework and Demarcation of Concepts: A Literature Study," *Landscape and Urban Planning* (v.65, 2003); A.W. Vemuri and R. Costanza, "The Role of Human, Social, Built and Natural Capital in Explaining Life Satisfaction at the Country Level: Toward a National Well-Being Index (NWI)," *Ecological Economics* (v.58, 2006).

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Quinine

QUININE, AN ALKALOID derived from cinchona used in the treatment of malaria, has been put to many uses over time, including as an insecticide and insect repellent, contraceptive, anesthetic, antiseptic, muscle relaxant, and fever reducer. Quinine is best known to many as the bitter flavoring used in tonic water, which gives drinks such as gin and tonics their characteristic taste; ironically, liquid extract of cinchona bark, from which quinine is purified, is administered as a cure for drunkenness.

Native to the Andes Mountains of South America, cinchona belongs to the plant family Rubiacaea. The genus *Cinchona* includes several other laurel-like evergreen trees and shrubs, which grow to about 49.2 feet (15 meters) tall. However, only *Cinchona officinalis*, *C. calisaya*, and *C. pubescens*—also known as *C. succirubra*—contain useful levels of quinine in their bark.

Peruvian Indians had long used infusions or powdered mixtures of cinchona to relieve fever and muscle soreness. By 1640, cinchona bark had been introduced to Europe as a cure for malaria, and was widely sold by 1677, when cinchona was formally entered into the British Pharmacopoeia. The identity of the species from which cinchona was harvested remained unknown to science until 1737; not until 1820 was quinine isolated from the bark. In 1944, chemical synthesis of quinine was finally accomplished, but refinement from natural sources is still the most economical method of quinine production.

In the mid-1800s the immense commercial potential of the cinchona market led Dutch and British interests to pirate cinchona seeds out of Peru and set up plantations in Java, Ceylon (Sri Lanka), and India. In fact, through the liberal ingestion of quinine-infused tonic water, British colonial authorities were able to govern India and Sri Lanka without high mortality due to malaria. By 1918, the Dutch cinchona plantations dominated the world quinine market. However, the Japanese occupation of Java in 1942 cut off the world's supply of quinine, which led the Allies to return to South American sources of quinine. Seeds from British plantations in India were used to once again set up plantations in South America, the plant's native environment.

Quinine and cinchona illustrate a common theme in the area of biological commodities. Raw, powdered cinchona bark was used as a medicine in South America and Europe for centuries, but upon the isolation of quinine from the bark, cinchona made the transition from valuable plant to patentable drug source. Peru and Bolivia, which were home to the first known stocks of cinchona trees and from which cinchona was smuggled, did not share in the bounties garnered from the South Asian quinine plantations.

Although quinine is still produced in South America, much of the world market is still supplied by South Asia and Africa. South American countries are unable to successfully compete in the world drug market even when the resources are indigenous to their countries. All too often, this is a pattern replicated in developing nations worldwide: Valuable commodities are patented by multinational corporations, with no benefits flowing back to the communities that originally developed their uses.

SEE ALSO: Bioprospecting; Colonialism; Drugs; Malaria; Native Species.

BIBLIOGRAPHY. "Cinchona Cultivation in India," *Current Science* (v.84/8, 2003); M. Grieve, "A Modern Herbal," www.botanical.com (cited November 2006); L. Taylor, *The Healing Power of Rainforest Herbs* (Square One Publishers, 2005).

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Race

RACE IS A problematic social classification that classifies different groups of people by particular physical attributes. Skin color is the most common identifier of racial difference. Some researchers, especially in the areas of genetics and educational psychology, continue to assert the scientific meaning and biological sources of racial differences; increasingly, however most scholars agree that racial categories cannot be thought of as biological in origin. Thus, rather than being given in nature, race must instead be recognized as a social construction, meaning that distinct human races have no real biological basis, but instead reflect subjective discriminations by individuals and societies. Though imaginary, therefore, race has very real consequences for people's lives. Race and racism are products of both social organization and cultural representation, rather than the result of innate characteristics and hereditary factors.

The theory of racialization has been crafted to understand the social and historical process by which racial categories are created, inhabited, transformed, and destroyed. Racial formation is linked to the evolution of hegemony, and the way in which society is organized and ruled. In other words, race is a political categorization scheme that maintains the prevailing distribution of power and privilege in a society. Despite the continuous temptation to think of race as an essence—as something fixed, concrete, and objective—the reality is that if changes occur in social, economic, and political life, racial categories can also be manipulated, altered, and transformed. "Whiteness" in the United States is the quintessential example of how racial categories shift as a result of changing circumstances and the reconfiguration of the dominant social hierarchy. In the late 19th and early 20th centuries, the Irish, Southern Europeans, and Jews were classified as "nonwhite" by the Anglo-Saxon majority. With the end of World War II, however, the American racial order was reconfigured as the color line was drawn around, rather within, Europe. Thus, the category of "white" expanded, while the category of "nonwhite" took on new meaning.

Racialization is both a macro-level social process, as well as a micro-level experience of everyday actions, claims, and struggles. Dominant groups exercise much power and privilege over minority groups as the racialized "Other." The historical experiences of Asian Indians and Chinese in the United States, for instance, demonstrate the power of racialization in creating and sustaining racial categories and racial hierarchies during a particular historical period. When they first arrived on American shores in the mid-19th century, Asian Indian and Chinese labor migrants encountered both *de facto* (practice) and *de jure* (law) racial discrimination. The combination of social tensions and economic competition provoked much hatred toward both Asian groups. Exclusionary national immigration and naturalization laws and restrictive state legislation on marriage, landholding, and voting—including anti-miscegenation laws and anti-alien land laws—reflected this prejudice. These discriminatory regulations were combined with prohibitive social practices to ensure that Asian Indians and Chinese would be cast as racialized minorities in American society well into the 20th century. Classified as "nonwhites," both groups were barred from becoming naturalized U.S. citizens and both groups experienced continuous socioeconomic inequity. The exclusionary era resulted in declining Asian Indian and Chinese immigration and population, extreme sex ratio imbalances, limited occupational choices, and forced spatial segregation in isolated communities.

The spatial dimension of the racialization process—also known as the ways in which the spatial segregation of different racial groups into separate communities and territories both produces and reflects specific racial ideologies—is a growing topic of concern among scholars. In other words, many are beginning to recognize that racialization cannot be understood apart from the spaces within which the process takes place. Racial identities are not only socially constructed but also spatially constituted. Thus, new questions have emerged around the issue of race, particularly in regards to: (1) the forms of racism and racial inequality that operate through geographical patterns, processes, and ideas; and (2) the ways in which racial boundaries (both material and ideological) become struggles of both territory and positionality with society. Restricting access to and through space is one of the most consistent ways to limit the economic and political rights of "nonwhite" groups. Through spatial control (in schools, housing, public facilities, and transportation), "first class" citizens are separated from "lesser" groups. At the same time, saying that one is from a certain place provides others inside and outside of that place with information about the person's status and identity. All of these processes reinforce and maintain racial categories in place.

Thus, the human landscape can be read as a landscape of exclusion, whereby weaker groups in society are forced to live in less desirable environments. The result is a highly segregated environment, where race intersects with class to create a fragmented landscape. Suburbs, enclaves, and ghettos become concrete spaces around which racial boundaries are inhabited, naturalized, and reinforced.

ENVIRONMENTAL RACISM

One manifestation of the ways in which space and race intersect is when spatial segregation results in disproportionately higher numbers of people of color being subjected to environmental and health risks when compared with other groups. It is a fact that neighborhoods with higher proportions of "nonwhites" are most likely to be downhill, downwind, and downstream from major sources of environmental contamination. At the same time, these neighborhoods are considerably more likely to be located close to hazardous waste treatment sites and/or dumping centers.

This form of exclusion, known as environmental racism or environmental injustice, occurs through both overt and subtle methods. Obvious methods include the deliberate targeting of communities of color for toxic waste disposal and the purposeful siting of polluting industries in or adjacent to the poorest communities, as well as zoning ordinances that force dumps and industries to be built in particular locations. But more invisible methods are also at work here, particularly when "white" privilege systematically, though unconsciously, creates particular spatial boundaries and spatial codes of exclusion. These codes allow "whites" to distance themselves from industrial pollution and toxic waste dumps, and consequently, from "nonwhites" as well. Certainly, most "whites" do not necessarily intend to hurt or discriminate against people of color, but because they are unaware of the privileges they receive simply from being "white," and because they gain so many benefits from their "whiteness," they inevitably do. It is precisely because so few "whites" are conscious that their actions, without malicious intent, may undermine the well-being of "nonwhites" that "white" privilege, along with its spatial manifestations, is so powerful and pervasive.

Certainly, race and racial categorization affects societies deeply and in multiple ways that are not always easily identified, separated, and catalogued. Part of the task of understanding the influence of race is to try to identify and tease apart the many influences of this categorization, while remaining conscious of the ways in which this classification scheme is constantly transforming. In this way, we can begin to understand race as an entrenched axis of inequality and as a central determinant in perpetuating inequity in society.

SEE ALSO: Developed ("First") World; Environmental Racism; Ethics; Indigenous Peoples; Justice; Movements, Environmental; Underdeveloped ("Third") World.

BIBLIOGRAPHY. Peter Jackson, ed., *Race and Racism: Essays in Social Geography* (Allen & Unwin, 1987); Katherine McKittrick, *Demonic Grounds: Black Women and the Cartographies of Struggle* (University of Minnesota Press, 2006); Michael Omi and Howard Winant, *Racial Formation in the United States From the 1960s to the 1990s,* 2nd ed. (Routledge, 2004); Paula S. Rothernberg, ed., *Race, Class, and Gender in the United States* (Worth Publishers, 2004); Ronald Takaki, *Strangers from a Different Shore: A History of Asian Americans,* rev. ed. (Back Bay Press, 1998).

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Race-to-the-Bottom Hypothesis

THE RACE-TO-THE-BOTTOM IS a critique offered by those opposed to what they view as "corporate led" economic globalization. The central argument is that as capital is able to move more freely across national borders, states will be forced to compete for needed capital investment by lowering legal standards that infringe upon profitability such as environmental regulations and worker safety protections. Since states are forced to compete against one another in order to create a more business-friendly economic environment, each will seek to lower its standards below their competitors, thus setting off a downward spiral of weaker and weaker standards.

The race-to-the-bottom hypothesis gained prominence in the early 1990s as critics on the left analyzed the global implications of the rise of neoliberal policy, an economic policy approach that favors free market functioning and opposes most state intervention in economic activity. Up to the 1980s, Keynesianism was the dominant ideological basis for economic policy in the United States and in much of the industrialized world. Keynesian economic policy called for an active role for the state in managing the macro-economy and addressing certain social needs. Under President Ronald Reagan in the United States and Prime Minister Margaret Thatcher in Britain, the neo-liberal ideology of economic theorists such as Milton Friedman was embraced and used as a basis to shape economic policy. From this perspective, free market processes are most effective for generating wealth, which trickles down, thus benefiting everyone, including the poor. Government intervention in market processes through regulation and taxation are thought to undermine the optimal functioning of the capitalist system. Big business tended to support these conservative leaders and sought to benefit from neo-liberal policies.

During this time international economic institutions such as the International Monetary Fund and the World Bank were used to impose neo-liberal programs on less developed nations that were dependent on aid and in need of foreign investment. The General Agreement on Tariffs and Trade (later the World Trade Organization) was used as a means to eliminate taxes on imported goods and to reduce domestic regulations that impeded international trade and investment.

It was in this context that critics argued that private capital gained even greater power to influence state policy and that this influence would result in a global "race to the bottom" in terms of environmental standards, wages, workplace regulations and other social welfare policies. Given the private control of resources inherent to capitalist economies, citizens who do not own capital are always in need of private investment to provide the jobs and income necessary for survival. Democratic mechanisms can be used to impose restrictions on capital for the sake of the social good, and employers and investors are likely to concede to these restrictions only if it is necessary in order to market their goods to that population. But if investors and employers are able to easily relocate outside of that state in order to avoid those restrictions, and if they face no additional penalty to import their goods for sale to the domestic market, then they have an incentive to relocate where regulations are less restrictive.

According to the race-to-the-bottom hypothesis, citizens within each of the states competing for capital investment will be forced to lower their standards or see investment decline and their economy suffer. For this reason critics of corporate-led globalization call for "social clauses" to be included in trade agreements. This "fair trade" approach would restrict imports from nations that do not adhere to given standards in terms of environmental protection, child labor, minimum wages, and so on. It is believed that this would create upward pressure on standards globally as nations seek to meet the criteria necessary for them to join in international trade.

There is conflicting evidence regarding the race-to-the-bottom hypothesis. Some scholars point to evidence such as wage stagnation in the United States as proof of the effect of downward wage pressure resulting from capital mobility. The movement of the apparel industry from the United States to Mexico and then to China is also seen as evidence of capital's search for lower wages and weaker standards. Yet others argue that regulatory standards are best understood as a product of domestic political considerations. Some even suggest that openness to trade can influence norms in nations with weak standards, thus creating improvement in practices and the strengthening of regulations.

SEE ALSO: Developed ("First") World; General Agreement on Tariffs and Trade; Globalization; Markets; Trade, Fair; Trade, Free; Underdeveloped ("Third") World; World Trade Organization.

BIBLIOGRAPHY. Scott J. Basinger and Mark Hallerberg, "Remodeling the Competition for Capital: How Domestic Politics Erases the Race to the Bottom," *American Political Science Review* (v.98/2, May 2004); Jeremy Brecher and Tim Costello, *Global Village or Global Pillage,* 2nd ed. (South End Press, 1998); Gareth Porter, "Trade Competition and Pollution Standards: 'Race to the Bottom' or 'Stuck at the Bottom'?" *Journal of Environment and Development* (v.8/2, June 1999); Aseem Prakash and Matthew Potoski, "Racing to the Bottom? Trade, Environmental Governance, and ISO 14001," *American Journal of Political Science* (v.50/2, April 2006); Alan Tonelson, *Race to the Bottom: Why a Worldwide Worker Surplus and Uncontrolled Free Trade Are Sinking American Living Standards* (Westview Press, 2000); David Wheeler, "Racing to the Bottom? Foreign Investment and Air Pollution in Developing Countries," *Journal of Environment and Development* (v.10/3, September 2001); Neal D. Woods, "Interstate Competition and Environmental Regulation: A Test of the Race-to-the-Bottom Thesis," *Social Science Quarterly* (87/1, March 2006).

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Radioactivity

RADIOACTIVITY IS THE process by which chemical elements decay from unstable to stable states by emitting sub-atomic particles and/or energy from molecules over a period of time ranging from infinitesimal fractions of a second to thousands of millions of years. Many elements exist in different isotopes, which are variant forms of molecular structure within elements of the same number and position on the periodic table of elements. Some isotopes undergo radioactive decay from an unstable isotope to a stable isotope. The process of emitting particles and energies can make radioactivity harmful to life since these emissions can be toxic or stimulate harmful growths or mutations in living cells.

The worst peacetime incident involving the release of radioactive material occurred in Ukraine in 1986, when part of the Chernobyl nuclear reactor station suffered explosions and fires resulting from human error. The radioactive material released into the atmosphere was spread over a wide area by wind and led to the contamination of forests and land for many miles around. Thousands of people were killed as a result of the initial explosion, but many more were injured from poisoning and genetic mutation resulting from proximity to the radioactive material. The atomic bombs exploded by the U.S. military over the Japanese cities of Nagasaki and Hiroshima toward the end of World War II still produce genetic mutations and illnesses 60 years and more after the event.

In the case of radioactive decay, the "parent" isotope decomposes into a "daughter" isotope. Understanding the rate at which these forms of decay take place can yield very important information about the ages of astronomical objects and the nature and age of the universe itself. The decay takes two forms, known as alpha and beta. In alpha decay, the molecule emits a helium ion and reduces its mass accordingly. In beta decay, a series of different but related processes occurs which are characterized by the absence of a discrete change in energy and mass level. Wolfgang Pauli and Enrico Fermi studied these processes and such observations were instrumental in identifying the neutrino. However, the major figure involved in the early understanding of radioactivity was Marie Curie, with her husband Pierre and colleague Henri Becquerel, whose work is remembered by the use of her name as a form of measurement, as well as the awarding of two Nobel science prizes. Extensive exposure to radioactive substances ended Marie Curie's life.

A significant proportion of radioactivity around the world takes place according to "natural" processes—that is, through the decay of substances that are found in the earth's crust and have been present since a very early period of the history of the earth. Radioactive elements in nature are known as radionuclides, and more than 60 of these are known to exist. This presence may have resulted from the processes of planet formation, or may have been brought about by interaction with cosmic rays in the many years subsequently. Perhaps the most significant of these is radon, which is a gas that is part of the decay of a chain of elements beginning with uranium-238 and passing through radium-226 and ultimately ending with daughter nuclides of radon that include alpha-particle releasing substances such as polonium-210. Radon is present in many parts of the world and its radioactive decay can cause cancers and bone diseases that may be lethal to human and animal life.

States with residential areas close to deposits of radon have been required to consider the extent to which they are responsible for re-settling people elsewhere and perhaps compensating them when their housing belongs to the public sector. Similar arguments exist with the case of asbestos, which has also affected people in homes that may be part of the public sector. Radiation from sources such as x-ray examinations has also been revealed to have negative health impacts, especially when individuals are subject to them on a sustained and repeated basis. Understanding of the dangers of radioactivity has stimulated the creation of measures to prevent disease creation in humans, including the use of lead shielding protective suits and the invention of the Geiger-meter, which is able to monitor the presence of alpha particles and some other forms of dangerous radiation.

The very slow rate at which radioactivity disperses means that nuclear power plants and machines that use nuclear reactions remain potentially dangerous for extended periods of time. In some cases, it may be possible to reprocess the nuclear material into stable isotopes. However, it is more common that the nuclear material cannot be reprocessed and must be kept in as secure a location as can be managed, perhaps for hundreds or thousands of years. This leads many people to doubt the wisdom of employing a technology that creates waste with very high future costs and risks that have yet to be properly assessed. While safety has improved considerably since the Chernobyl and Three Mile Island incidents, there remain real threats of deterioration of the conditions in which the material is kept, or that a determined criminal or terrorist may obtain radioactive material for nefarious purposes.

SEE ALSO: Chernobyl Accident; Nuclear Power; Nuclear Weapons; Three Mile Island Accident; Waste, Nuclear; Yucca Mountain.

BIBLIOGRAPHY. Eve Curie, *Madame Curie: A Biography*, trans. by Vincent Sheean (Da Capo Press, 2001); Charles P. Enz, *No Time to be Brief: A Scientific Biography of Wolfgang Pauli* (Oxford University Press, 2002);

Michael F. L'Annunziata, *Handbook of Radioactivity Analysis* (Academic Press, 2003); Emilio Segre, *Enrico Fermi, Physicist* (University of Chicago Press, 1995); Francis Song, "Currently Indisposed: Managing Radioactive Waste," *Harvard International Review* (v.25/2, 2003); Richard Tykva and Dieter Berg, eds., *Man-Made and Natural Radioactivity in Environmental Pollution and Radiochronology* (Springer, 2004).

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Rain Forests

RAIN FORESTS HAVE a continual abundance of rain with year-round growth. Most rain forests are tropical, but a few, such as the forest of the U.S. Pacific northwest, are temperate. Rain forests hold some of the largest trees on earth. Temperate rain forest trees often grow well over 200 feet (61 meters) in height. These rain forests occur in temperate zones where local conditions facilitate high amounts of rainfall, usually 80–120 inches or 2,000–3,000 millimeters per year. They are often near ocean breezes that deliver large quantities of moisture. Many are located on coastal mountain ranges where moisture from the ocean keeps them cool, even in the hottest months of summers, and mild in the winter.

Temperate rain forests occur in seven regions of the globe. In North America, they occur along the Pacific Coast that stretches from northern California to Kodiak Island in Alaska. In South America, they occur in the Valdivian and Magellanic temperate rain forests. The Calchian rain forests are located in the southeastern Black Sea area on the northern coast of Turkey and in Georgia. The Tasmanian temperate rain forests are in New Zealand. There is a small area of rain forest in southwestern Japan. Logging destroyed most of the temperate rain forests in northwestern Europe. Temperate rain forests may be coniferous, broadleaf, or mixed. The temperate coniferous forests of the Pacific Coast of North America include the famous giant coastal redwood trees (sequoias), Douglas fir trees, and sitka pines.

Tropical rain forests occur in the tropical zone, which lies between 1,600 miles north or south of the equator (23.5 degrees north at the Tropic of Cancer and 23.5 degrees south at the Tropic of Capricorn). Tropical rain forests occupy vast areas of South America, Central America, central Africa, and southern Asia, including the islands of the South Pacific and Indian Oceans. Tropical rain forests have an enormous biodiversity.

The trees in tropical forests also grow to 200 feet (61 meters), or more. The crowns of the trees touch each other, forming a high forest canopy that blocks much of the sunlight hitting the forest. Lower down, a second or even third canopy of trees grows. The image of a tropical rain forest as a jungle is incorrect. The canopy blocks most of the sunlight so only a few plants grow at the base of the trees. Jungles usually occur along rivers, or in areas where sunlight has been able to penetrate to lower levels on the forest floor. Tropical forests remain green, warm, and wet all year; the rain and the shade also keep temperatures on the forest floor remain relatively constant. Most of the time the temperature does not rise much above 90 degrees F (32 degrees C) or fall much below 68 degrees F (20 degrees C). Because there are no seasons in tropical rain forests, each species of plant has its own season for flowering and fruiting.

Sunlight in equatorial regions strikes from directly above. Tropical rain forests are areas where there is a constant barrage of equatorial sunlight that allows for more abundant manufacture of chlorophyll from photosynthesis. A continuous supply of food is available in tropical rain forests, while in temperate zones seasonal changes regulate the food supply. The tropical forest canopy contains an enormous variety of fauna and flora. Many canopy plants are epiphytes (air plants that grow on the branches of the trees). Enormous vines also grow on trees, sometimes killing the tree. Scientists have estimated that from one half to two-thirds of all the plant species in the world are found in tropical rain forests. These forests provide shelter and food for a still unknown number of animals, reptiles, and birds that feed on a profusion of insects, fruits, and plants. Fig trees, of which there are over 1,000 kinds in tropical rain forests, are one of the "keystone" species. Because tropical fig trees bear fruit several times a year, they provide food for a wide variety of animals, birds, and insects. Because the animals that eat figs are often the prey of other animals, the figs sustain populations that provide prey to carnivores.

Competition for sunlight has led to interesting adaptations. For example, strangler figs like India's banyan tree begin as an epiphyte plant in the notch of a tree but then send out roots that work their way down the trunk of the host tree. After the root reaches the ground, it penetrates the soil and grows rapidly. The roots then spread around the host tree, strangling it. At the same time, the crown of the strangler fig puts out thicker and more abundant leaves than does its host. This growth soon blocks the sunlight coming to the host tree, and eventually the strangler fig kills its host.

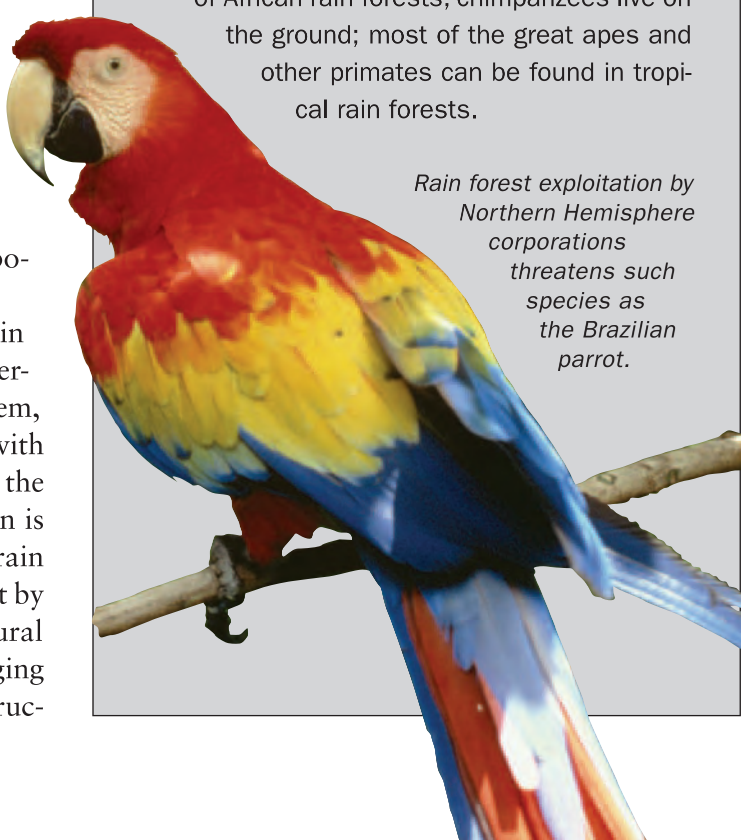
Plants growing in tropical rain forests include an enormous variety of flowers, ferns, mosses, orchids, bromeliads, vines, and fruiting trees. Hummingbirds and sunbirds feed off of the nectar produced by the canopy flowers. Heterotrophs are plants that do not need much light and can live on the forest floor. The parasitic plant *Rafflesia arnoldi* has the world's largest flower and produces a scent similar to rotting meat in order to attract pollinating insects.

Bugs—insects, spiders, bees, butterflies, moths, mosquitoes, and termites—are abundant. Many avoid predators with camouflage: The walking stick and the horned leafhopper disguise themselves to blend into their habitat. In addition to an enormous number of species of ants, in some jungles army ants move across the jungle floor, devouring everything in their path. Among the many animals of the rain forest, there are numerous poisonous insects and reptiles. Besides poisonous snakes, there are poisonous frogs such as the arrow frog. Many poisonous animals and insects use bright colors to warn potential predators away.

Until recently, humans were uncommon in tropical rain forests. In South and Central America, scattered bands of Indians have lived in them, practicing a form of swidden agriculture along with hunting and gathering. In Africa, Pygmies live in the forest. However, the world's growing population is pressing into and clearing large areas of tropical rain forests. The tropical rain forests are under assault by loggers, poachers, hunters, miners, and agricultural interests. Vast areas have been cleared by logging and turned into grassland for cattle. The destruction is more than a local threat to the environment. The tropical rain forest holds such an enormous variety of fauna and flora that it is a potential storehouse of medicines and other chemicals that have yet to be discovered. In addition, the trees consume huge quantities of carbon dioxide and breathe out

Life in the Rain Forest

An enormous number of animals live in tropical rain forests. Many live in the canopy and never touch the ground. They live off of the leaves, fruits, and nuts produced by the trees. Tree climbing snakes hunt them, as do other predators including large birds. These permanent tree dwellers include bats, gibbons, monkeys, squirrels, parrots, toucans, sloths, galagos, and marmosets. Some animals fly, such as flying squirrels and lemurs, while others, such as monkeys, anteaters, opossums, and porcupines are able to hang by their tails. Animals on the floor of tropical rain forests include deer, hogs, tapirs, antelopes, and rodents. They feed on roots, seeds, fruits, and leaves that fall from the canopy. Jaguars, and other large cats including tigers in Asia, hunt them. In some areas of African rain forests, chimpanzees live on the ground; most of the great apes and other primates can be found in tropical rain forests.



Rain forest exploitation by Northern Hemisphere corporations threatens such species as the Brazilian parrot.

oxygen; tropical rain forests are in part the earth's respirator. The amount of carbon that they hold is enormous; if loosed into the atmosphere it would have a devastating greenhouse gas effect.

Protecting rain forests is a global priority. Until about 200 years ago, a belt of green tropical rain forests encircled the globe; now they are disappearing at an alarming rate. Overpopulation is not the main cause of forest decline. Rather, excessive exploitation by tropical forest governments and by corporations from the Northern Hemisphere is the biggest threat to the world's rain forests.

SEE ALSO: Biodiversity; Climate, Tropical; Cloud Forests; Forests; Timber Industry; Tropical Forests; Tropical Medicine.

BIBLIOGRAPHY. Adrian Forsyth and Kenneth Miyata, *Tropical Nature: Life and Death in the Rainforests of Central and South America* (Simon & Schuster, 1987); Kathlyn Gay and Mildred Vasan, eds., *Rainforests of the World: A Reference Handbook* (ABC-CLIO, 2001); Thomas Marent, *Rainforest* (DK Publishing, Inc., 2006); Mohan Munasinghe, Mary Dyson, and Kevin Cleaver, *Conservation of West and Central African Rainforests* (World Bank Publications, 1992); S.E. Place, ed., *Tropical Rainforests: Latin American Nature and Society in Transition* (Scholarly Resources, Inc. 2001); P.K. Schoonmaker, E.C. Wolf, and Bettina Von Hagen, eds., *The Rainforests of Home: Profile of a North American Bioregion* (Island Press, 1997); D.D. Southgate, *Tropical Forest Conservation: An Economic Assessment of the Alternative in Latin America* (Oxford University Press, 1998); Jan Vansina, *Paths in the Rainforests: Toward a History of Political Tradition in Equatorial Africa* (University of Wisconsin Press, 1990).

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Ranchers

RANCHERS ARE COMMERCIAL range livestock producers. In addition to a market-orientation, ranchers have exclusive, divided access to land (whether privately owned or leased); in contrast, pastoralists—who may be subsistence and/or market producers—share access to land and regulate use through mechanisms other than private property and contract. Many ranchers are found in the western United States, in Australia and New Zealand (known there as graziers), in the Iberian peninsula and parts of South America (known as *ganaderos* in Spanish), and in parts of sub-Saharan Africa.

Ranchers in North America rose to prominence just as the earlier rural American ideal—the Jeffersonian farmer—was foundering on the arid and semi-arid areas of the interior West. Periodic droughts and economic crises from the 1890s to the 1930s squeezed out thousands of small farmers, and ranchers who could afford to bought up their homesteads, consolidating sometimes very large holdings. The Cattle Boom—itself a victim of drought and depression—was interpreted as a Tragedy of the Commons that would require exclusive land tenure and fencing to control livestock numbers.

Progressive era reforms and agencies, notably the U.S. Forest Service, favored ranchers over pastoralists and subsistence producers, seeing efficiency in dealing with a smaller number of large operators who had the revenue streams to pay lease fees and the capital to make improvements such as fencing and artificial water sources. This was a racial preference as well, since many smaller and/or nomadic livestock producers were not Anglos. With the Taylor Grazing Act of 1934, exclusive leasehold was extended to the unclaimed public domain (today's Bureau of Land Management lands) and pastoralist livestock production disappeared from the United States. In the sparsely populated interior West, ranchers were a dominant political and economic force for most of the 20th century.

Ranchers' power provoked a backlash beginning in the 1940s, when historian and journalist Bernard DeVoto published a series of articles in *Harper's* excoriating ranchers for abusing public lands and for lobbying to devolve leased lands to the states, counties, or private ownership. Since roughly half of U.S. ranch lands are publicly owned (primarily by federal agencies), DeVoto's accusations found a wide constituency, and the backlash intensified with the emergence of environmentalism in the 1960s and 1970s.

Although the evidence of rangeland degradation is widespread and compelling, it is unclear where the blame should be laid: Conditions have generally stabilized or improved since the Cattle Boom, and the expectation that reducing or eliminating grazing will restore degraded rangelands rests on obsolete ecological theories. Indeed, such theories informed the policies and practices of federal agencies, which may therefore deserve as much (or as little) blame as the ranchers.

With the suburbanization of the interior West and the industrialization of livestock production on feedlots in recent decades, the basis of ranchers' wealth and power has shifted from livestock to real estate. Ranchers who lease federal grazing lands own an estimated 107 million acres of private land in the West, and half depend on nonranch sources for more than half of their income. Some are independently wealthy—ranching has attracted affluent investors since the Cattle Boom—but many others are not, and as the market value of their land has come to exceed what livestock production can justify, their commitment to ranching as a "lifestyle" and heritage conflicts with economic imperatives. Recognizing the ecological importance of undeveloped private ranch lands, a growing number of environmental groups such as The Nature Conservancy have decided to work with ranchers to prevent land use change.

SEE ALSO: Cattle; Grazing; Land Use and Cover Change; Livestock; Overgrazing.

BIBLIOGRAPHY. B.J. Gentner and J.A. Tanaka, "Classifying Federal Public Land Grazing Permittees," *Journal of Range Management* (v.55/1, 2002); S.P. Hays, *Conservation and the Gospel of Efficiency* (Harvard University Press, 1959); T. Ingold, *Hunters, Pastoralists and Ranchers: Reindeer Economies and Their Transformations* (Cambridge University Press, 1980).

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Rappaport, Roy A. (1926–97)

ROY A. RAPPAPORT was one of the most influential ecological anthropologists of the 20th century. He received his Ph.D. from Columbia University in 1966, studying under other major scholars of ecological anthropology, such as Marvin Harris, Harold Conklin, and Andrew Vayda. It was Gregory Bateson, however, who exerted the strongest influence over Rappaport's work. Bateson introduced Rappaport to systems theory and encouraged him to think about cultural practices as optimizing human adaptation and maintaining ecological balance. Rappaport's work played an important role in the development of theories regarding how people relate to, adapt, and manage their environments. More specifically, he was devoted to understanding why ritual should order ecosystems and human life.

Rappaport made a significant theoretical shift from the cultural ecology model, the dominant framework of environmental anthropology in the early 20th century. Instead of focusing on culture as the unit of analysis, as Julian Steward, the founder of cultural ecology did, Rappaport viewed ecological populations as the primary unit of analysis. In Rappaport's system-centered paradigm he saw the part (human populations) as subject to the regulatory forces of the whole (the ecosystem). In this system, culture is understandable only in terms of its material effects and is seen as a means for human populations to adapt to the environment. In using an ecosystem approach in anthropology, Rappaport and others borrowed concepts from the ecological sciences that promoted a more holistic approach to understanding human populations and their adaptations to specific environments.

Rappaport wrote three influential books but is best known for his *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People* (1968), a case study of human ecology among the Tsembaga Maring people of highland New Guinea. In *Pigs for the Ancestors* Rappaport develops an elaborate model of how ritual cycles among the Maring operate to regulate warfare, pig slaughter, and swidden gardens, thus regulating the land use system and the size of human and animal populations. In his analysis of Maring ecological and ritual behaviors, Rappaport focuses on humans as a species that participates in ecosystems in ways that are fundamentally similar to how other animals participate. *Pigs for the Ancestors* has become a classic case study in environmental anthropology, exploring the role of culture in resource management and the application of systems theory to an anthropological population.

While *Pigs for the Ancestors* is one of the most widely read books in ecological anthropology, Rappaport has also been heavily critiqued for his highly functionalist approach. Most introductions to human ecology include reading and evaluating *Pigs for the Ancestors* in light of more recent theories in ecological anthropology. Critics have argued that by rejecting culture as a unit of analysis Rappaport's systems approach was too reductive, and that his environmental determinism resulted in overlooking the importance of events and individuals. More recently, scholars of ecological anthropology have moved far beyond the boundaries of Rappaport's self-contained human ecosystem in their exploration of human-environmental interactions. Recent research in ecological anthropology places far more emphasis on local-global articulations, the relationships between villages and the state, and the importance of external power relations in shaping local resource use decisions.

Rappaport was deeply concerned with the social policy implications of his work. In an approach he called "engaged" anthropology, Rappaport advocated bringing anthropological findings to bear on important social issues. Rappaport served as consultant for the state of Nevada on the question of storing nuclear waste at Yucca Mountain and was a member of the National Academy of Science Task Force addressing the social and cultural impacts of off-shore oil drilling in Alaska. To Rappaport the ethnographic tools of an anthropologist are uniquely suited to solving the world's problems. It was his vision that anthropology should be a politically engaged practice with a mission for human survival.

SEE ALSO: Anthropology; Cultural Ecology; Ecosystems; Human Ecology; Yucca Mountain.

BIBLIOGRAPHY. Aletta Biersack, "Introduction: From the 'New Ecology' to the New Ecologies," *American Anthropologist* (v.101/1, 1999); Conrad Kottak, "The New Ecological Anthropology," *American Anthropologist* (v.101/1, 1999); Ellen Messer and Michael Lambek, eds., *Ecology and the Sacred: Engaging the Anthropology of Roy A. Rappaport* (University of Michigan Press, 2001); Roy A. Rappaport, *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People* (Yale University, 1968).

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Rational Choice Theory

OVER THE LAST decades, Rational Choice Theory (RCT) has radically influenced social and political sciences, as well as psychology, social psychology, and criminology. The theory is rooted in and closely linked to the key concepts of individuality, rationality, methodological individualism, choice, and exchange. Initially, RCT was applied to economics, management and marketing, where the questions of preferences, economic habits, consumers' choices, and market behavior are issues of paramount importance.

The basic assumption of RCT is that every social act is fundamentally "rational," namely, it is based on a more or less well-calculated understanding of means and aims for the making of specific decisions of economic or social nature. This idea is related to modern readings of Adam Smith's economic theory. By illustrating utilitarian modes of behavior, RCT assumes such individual decision-making to explain larger economic patterns and outcomes.

According to RCT, a system of rational calculations of likely costs and benefits of a given individual action, as well as the evaluation of possible profits or other positive and negative consequences, are the elements that frame behavior. Sociological approaches like Talcott Parsons's functionalism—influenced by Max Weber's rationalization theory—underline aspects of rationality, functionality and utility maximization in the examination of social structuring and of social institutions.

The works of Peter Michael Blau and James Coleman are among the most significant in RCT. Blau attempted to examine choices of individuals, assuming them to be made rationally and for reasons of utility, in order to understand social interaction through social exchange. Coleman, who also saw choices and individual action made on a basis of utility, focused on the social background, norms and relationships behind these choices, as well as the meaning that individuals give to their action.

Apart from economics, RCT has been influential in political science—for instance, through the examination of voting behavior and political beliefs—and in sociology through the exploring of changing social norms—for instance, in the fields of family, migration, and social mobility. Elsewhere RCT has influenced organizational psychology through the behavioral research of individual decision-making and work attitudes and in the field of criminology, where traditional sociological explanations of crime (addressing society, economy, and context), have been replaced with explanations that suggest offenders act rationally for the maximization of utility and profit after a rational investigation of a given opportunity to commit crime.

In environmental theory and research, RCT has been most influential in the development of environmental economics, where willingness to pay for environmental goods and services is seen as the key vehicle for environmental protection. It also provides the crucial logical underpinnings of the Prisoner's Dilemma and the Tragedy of the Commons, in which actors rationally pursue their own ends to the expense of the collective good. As such, RCT is fundamental to the emergence of Common Property Theory, an influential approach for the management of fisheries, water, and other resources.

Critics of RCT approaches emphasize that the distinction between rational and nonrational actions and motives is theoretically and empirically problematic and conceals the social pressures imposed on individuals and their actions by society, political power, and social norms. In other words, the concept of rational choice establishes an apolitical category of action that neglects a series of broader mechanisms of power, violence, and coercion that also define social needs and actions.

Other critics have argued that not all human actions can be explained by models of rationality, since several forms of action are structured by emotional criteria, affect, or nonrational factors. One more critical argument is that acting rationally for the maximization of utility implies that individuals are well aware of the rules of the social situation in which they enter and are also informed about the benefits and costs of their actions. Such an assumption is not, however—as critics have underlined—empirically tested. Finally, although RCT attempts to examine the social contexts in which individual choices are made and meaning is produced, still, as critics underline, RCT remains a highly individualistic approach which neglects important aspects of social structuring, stratification, and social control.

SEE ALSO: Common Property Theory; Prisoner's Dilemma; Tragedy of the Commons.

BIBLIOGRAPHY. Peter Michael Blau, *Exchange and Power in Social Life* (John Wiley, 1964); James S. Coleman, *Foundations of Social Theory* (Belknap Press, 1990); David Garland, *The Culture of Control: Crime and Social Disorder in Contemporary Society* (Oxford University Press, 2001); John Scott, "Rational Choice Theory," in G. Browning, A. Halcli, and F. Webster, eds., *Understanding Contemporary Society: Theories of the Present* (SAGE, 2000); Mary Zey, *Rational Choice and Organizational Theory: A Critique* (SAGE, 1998).

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Reagan, Ronald Administration

RONALD WILSON REAGAN (1911–2004) was the 40th president of the United States from 1981 to 1989 and represented the Republican Party with Vice President George H.W. Bush, who succeeded him as president. Reagan had previously been a movie actor and he was widely acclaimed in the United States as "the great communicator" for his ability to renew patriotism and confidence in the country.

The Reagan administration's attempt to reduce the role of government in the country and greatly increase the role and power of the private sector was almost wholly negative for the environment. The ability of the administration to put through its policies was facilitated by the unpopularity of outgoing president Jimmy Carter and the subsequent swing toward the Republicans, which gave the party the highest level of power it had enjoyed for a quarter of a century. Reagan's policies were marked by intense social conservatism, anticommunism, and reliance upon supply-side or "trickle-down" economics.

Support for environmental issues grew enormously during the 1980s as many new environmental concerns became apparent. Emergent problems included acid rain and greenhouse gas emissions, water pollution from agricultural and industrial sources, and the leakage of toxic substances into groundwater and rivers.

The Reagan administration placed Anne M. Gorsuch (later Burford) in charge of the Environmental Protection Agency (EPA), which had been established by the Richard Nixon administration in 1970 to oversee all national environmental protection regulations. Gorsuch's tenure was marked by incompetence and scandal and, eventually, she and 20 top managers were forced to resign after being found guilty of contempt of Congress. The budget and scope of the EPA were reduced by nearly a quarter and, although its work did continue to improve pollution indices in many American cities, these cuts, combined with tax cuts and slashing of regulations controlling business, led to more environmental problems.

The tenure of James G. Watt, who served under Reagan as Secretary of the Interior from 1981 to 1983, was also marked by controversy. During this period a preliminary effort to turn control of Federal lands over to states—termed by its supporters as a Sagebrush Rebellion—faltered, largely due to lack of interest on the part of states and private land buyers.

Accusations of conflict of interest concerning many top appointed officials whose business concerns may have benefited from government decisions characterized the Reagan administration's response to these problems. Privatization of public land for possible exploitation by oil and gas companies or for commercial development was highly controversial in a time when people were being evacuated and towns temporarily abandoned because of toxic spills. Concern over the ability of the administration to secure nuclear power plant facilities also mounted in this period, while programs aimed at developing renewable energy sources from the Carter administration were significantly reduced.

Perhaps one positive impact on the environment to result from the Reagan years was the reinvigoration of the environmentalist movement, which had started to lose energy and focus during the 1970s. Reagan himself had little understanding or interest in the environment and once infamously claimed that trees caused more pollution than automobiles did. Conversely, while as governor of California his environmental performance was in some ways commendable; some critics say this was largely the result of pandering to his electorate.

During the Reagan administration, Congress was active on the environmental front and passed the most far-reaching environmental bills since the 1970s. Reagan signed most of the bills into law, sometimes reluctantly. He vetoed some, only to see them repassed over his veto or reworked and sent back to him, winning his grudging approval. Reagan slowed the flow of regulations a little during his first term, but the basic laws held and then were amplified as Congress went back on the offensive. Environmental bills that had been perennial losers finally passed.

SEE ALSO: Bush, George H.W. Administration; Carter, Jimmy Administration; Communism; Environmental Protection Agency (EPA); Nixon, Richard Administration; Nuclear Power; Sagebrush Rebellion; Watt, James G.

BIBLIOGRAPHY. Douglas Trevor Kuzmiak, "America's Economic Future and the Environment: Shaping Tomorrow through an Awareness of Yesterday," *Managerial Auditing Journal* (v.10/8, 1995); Ronald Reagan, *An American Life: The Autobiography* (Simon & Schuster, 1990); Ronald Reagan Presidential Library, www.reagan.utexas.edu (cited November 2006); Richard Reeves, *President Reagan: The Triumph of Imagination* (Simon & Schuster, 2005).

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Reclamation Act

THE HISTORY OF the United States has been one of continual territorial expansion. This expansion has necessitated legislation and infrastructure to bring newly acquired territory into efficient, productive use. The Reclamation Act of 1902, passed during the presidency of Theodore Roosevelt, was one of the more important examples of the legislation necessary to bring the land of the western United States into productive agricultural use. This land had been settled, but offered insufficient fresh water resources for the agricultural activities settlers wished to practice. Water was drawn from rivers and streams for irrigation, but increasing demand led to calls for government action to create federal-level storage and irrigation projects to supplement and overhaul those local initiatives that had failed for lack of technical know how and money.

The Reclamation Act added to the extensive state-level investment in physical and transportation infrastructure that was essential for the creation of a stable society. President Roosevelt approved of the concept of "homemaking" that the reclamation activities would enable, since it would help promote the growth of agricultural farmsteads across the western United States, which would have numerous social and economic benefits.

The act led to the formation of the U.S. Reclamation Service within the U.S. Geographical Survey and, for the next few years, studies were launched to identify suitable projects on designated land sites. In the years before 1924, reclamation projects often did as much harm as good as technical problems overwhelmed the Reclamation Service, but these were eventually overcome. The Fact Finders Act of 1924 systematically identified the problems and outlined the measures necessary to rectify them. Subsequent projects included the Hoover Dam of 1928 and, although the record was not one of unalloyed success subsequently, it was much improved. Reclamation continued until the 1980s before being scaled down as it became clear that nearly every practicable water resource had been harnessed.

Reclamation projects provide irrigation water to more than 9,000,000 acres of land and provide water for household and industrial use to around one third of the American West's population. Additionally, 56 hydropower electricity stations provide power to supplement the total grid. More recently, additional acts have been passed to modify the effects of the Reclamation Act and more attention has been paid to the broader environmental impacts of land reclamation. As new projects are no longer urgently required, the attention of the Reclamation Agency has switched to the maintenance and protection of existing water resources and the lands in which they flow.

SEE ALSO: Irrigation; United States, Great Plains; Water; Water Demand.

BIBLIOGRAPHY. Peter L. Bass and Edward M. Kirshner, "Demographic, Economic, and Fiscal Impacts of Alternative Westlands Reclamation Act Enforcement Scenarios," *American Journal of Agricultural Economics* (v.60/5, 1978); Donald C. Jackson, "Engineering in the Progressive Era: A New Look at Frederick Haynes Newell and the U.S. Reclamation Service," *Technology and Culture* (v.34/3, 1993); U.S. Bureau of Reclamation, www.usbr.gov (cited July 2006).

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Reclus, Elisée (1830–1905)

THE FRENCH GEOGRAPHER and anarchist Elisée Reclus wrote extensively but is best remembered for two grandiose works: the *Nouvelle Géographie Universelle: La Terre et Les Hommes* [New Universal Geography: The Earth and Its Inhabitants], published in 19 volumes between 1876 and 1894, and *L'Homme et la Terre* [Man and Nature], whose six volumes were published posthumously between 1905 and 1908. His *The Earth or Description of the Life Phenomena in the Globe* (1867–68) was also probably the first geographic work influenced by Charles Darwin. Reclus's anarchist political orientation motivated his affiliation with the First International, his friendship with Peter Kropotkin (another geographer) and Michael Bakunin, and his participation in the Commune of Paris (1870), after which he had to exile himself from France. He returned in 1879 but left again to take a position as professor in the University of Brussels in 1892.

Reclus's influence was more noticeable in political as opposed to academic circles. In academia, he was virtually ignored until his rediscovery by French radical geographers such as Yves Lacoste and in the journal *Hérodote* in the 1960s and 1970s. Lacoste and others emphasized the use of the human environment tradition from a dialectical point of view and introduced class relations as part of geographical analysis.

Like many anarchists and utopian socialists of the 19th century, Reclus was optimistic about the future of the human race and a great enthusiast of science and technology as valid instruments for the establishment of an egalitarian society. In a context in which education and knowledge were fundamental human aspirations, Reclus saw geographical knowledge as the study of the rupture of the equilibrium between the human and the nonhuman worlds. According to his anarchist ideal, the state and the class-based society were responsible for the breakdown of the once-harmonious relationships between humans and their environments—hence the need to return to an original pattern of settlement adapted to local natural conditions. Poverty and hardship were not nature-given (as in the Malthusian view) but the result of the unjust access to resources and a deficient relationship with the environment.

Although in some cases Reclus may be misinterpreted as an environmental determinist (for example, in his description of Corsica or the Greek city-states), he also argued forcefully that humans were active transformers of the natural world. Aware of the importance of education and learning, Reclus also wrote books for children. In them, he traces another view of geography with many parallels to that of George Perkins Marsh—he describes the (perverse) effects of human modifications of the environment. Reclus was therefore one of the first geographers to show not only the environmental but also social consequences of presumed natural hazards. From experiences in the Alps, Reclus described the role of deforestation in inducing devastating floods and landslides. In *Histoire d'Une Montagne* [History of a Mountain], a book for young readers, he links deforestation to class relations, showing how landowners cut forests for timber without any concern for the landslides aggravated by deforestation that would kill poorer people downstream.

SEE ALSO: Communism; Darwin, Charles; Deforestation; Disequilibrium; Equilibrium; Geography; Hazards; Justice; Kropotkin, Peter; Malthusianism.

BIBLIOGRAPHY. John Clark and Camille Martin, *Liberty, Equality, Geography: The Social Thought of Elisée Reclus* (Artemis, 1997); Elisée Reclus, *The Ocean, Atmosphere, and Life* (Harper and Brothers, 1873); Elisée Reclus, *The Earth and Its Inhabitants: The Universal Geography* (H. Virtue and Co., Ltd., 1882–95); Elisée Reclus, *L'Homme et la Terre* (Librairie Universelle, 1905–08).

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Recreation and Recreationists

SINCE ANCIENT TIMES, various forms of recreation have developed and evolved. Studies of societies such as the bushmen of the Kalahari and the Australian aboriginals have estimated that acquiring shelter, clothing, and food would have taken up only half their waking time. This would have left much time for the perfecting of hunting skills, the making of tools and ornamental items, and the maintenance of strong folklore traditions. In the Neolithic period, there was also cave painting, and, eventually, the making of ornaments. It seems likely that play-acting and music would also have been recreational activities in ancient societies, as well as athletics and also some competitive hunting techniques such as using bows and arrows, spears and the like.

In large empires, there was a need for major recreational activities of craftwork and sport. Although families had often kept cats and dogs, the former to keep down the number of mice or rats, and the latter for protection, the Egyptians and others started keeping pets for their own sake, with the great Egyptian love of cats, and many different types of cat being bred.

For the Greeks and Romans, sports included athletics, ball-games, swimming, rowing, hoop-bowling, weight-lifting and chariot-racing. The Greeks also maintained the Olympic Games from possibly the 12th century B.C.E., to the 4th century C.E., by which time it was run by the Romans. Among many recreations during the Greco-Roman world was travelling, especially to shrines, oracles, or places with "healing" waters.

In China and nearby countries, similar recreations and hobbies existed, with minor variations. There were also interactions with neighboring civilizations and visiting delegations. Chinese and Indian pilgrims also travelled to holy temples, especially Buddhist shrines, and visited the house of Confucius. With the advent of the Christian era in the West, traveling on pilgrimages to shrines, distant churches, tombs of saints, and further afield to Rome and to Jerusalem became popular. Along these pilgrimage routes, hotels and hostels started to appear. In Rome various hostels were converted for English, French, Scottish, and Irish visitors.

Well-to-do men in Europe took part in mostly outdoor sporting activities including archery, throwing the javelin, rowing, running, jumping, wrestling, boxing, and swimming. and more dangerous sports such as jousting. In China, there was judo and taekwando, and in Japan kendo and other martial arts. For women throughout the world, sewing, embroidery, needlework, and the making of tapestries were important pastimes. Village fairs and fetes also brought out many other activities with clowns, jugglers, fire-eaters, sword-swallowers, soothsayers, fortune tellers and others entertaining people with jokes and stories. Animals such as bears and monkeys were also used for amusement.

From the early part of the 18th century it was common for many wealthy young men in Europe to take part in what became known as the "Grand Tour." British, French, German, Italian and Russian men travelled around Europe visiting important places such as Paris, Florence, Venice, and Rome. Later, the development of the railway network encouraged many people to use the train for traveling.

In 1841, while the railway network was still being built, Thomas Cook established a tourism company which allowed British, and later other travelers to visit Egypt and other parts of the Near East. The advent of paid holiday leave saw the establishment of many holiday resorts on beaches and elsewhere for middle-class travelers with small savings and a few days or more in holidays, to relax. Although spa resorts had existed from prehistoric times, the tourist boom from the mid-19th century made places such as Bath in England, and Vichy and Lourdes in France, popular. Seaside resorts were also established for countries with coastlines. For those such as Switzerland which were landlocked, there were mountain resorts. Although many people were content to sunbathe, beach games such as volleyball, swimming, surfing, and life-saving became popular at many beaches.

It was not long before many guidebooks started to be published about travel, leading to its further popularization. With the fall in airfares from the 1970s, Rough Guide and the Lonely Planet started producing guidebooks for most of the world, along with Fieldings, Frommers, and many other companies. Modern mass tourism has had great cultural and ecological consequences, however, and recent trends have led to the development of the still imperfect solution of ecotourism.

Besides travel and many indoor forms of recreation, which run the gamut from stamp collecting to computer games, today many people enjoy outdoor pursuits such as walking and gardening. Interest in tropical gardens has led many people in more temperate climates to try to reproduce or imitate tropical gardens in Britain, France, and the United States. For sports, there are a wide range of sports which are played either socially, or with local teams, as well as town/city and national teams. These include baseball, diving, football, soccer, swimming, tennis, and golf.

SEE ALSO: Ecotourism; Golf Courses; Hunting; National Parks; Tourism; Urban Gardening and Agriculture; Zoos.

BIBLIOGRAPHY. John Arlott, *The Oxford Companion to Sports & Games* (Oxford University Press, 1975); Piers Brendon, *Thomas Cook: 150 Years of Popular Tourism* (Secker and Warburg, 1991); H.A. Harris, *Sport in Greece and Rome* (Thames and Hudson, 1972); Anthony Hern, *The Seaside Holiday* (The Cresset Press, 1967); Christopher Hibbert, *The Grand Tour* (Weidenfeld and Nicolson, 1969); Michael Loewe, *Everyday Life in Early Imperial China* (Batsford, 1968); John Scarne, *Encyclopedia of Games* (Constable & Company, 1976); Malcolm Todd, *Everyday Life of the Barbarians, Goths, Franks and Vandals* (B.T. Batsford Ltd., 1972); Paul Werner, *Life in Rome in Ancient Times* (Liber, 1977).

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Recycling

ACCORDING TO THE Global Recycling Network, recycling refers to a "process by which materials that would otherwise become solid waste are collected, separated or processed and returned to the economic mainstream to be reused in the form of raw materials or finished goods." Recycling turns waste into resources. In addition, it generates environmental, economical, and social benefits. Recycling is normally associated with materials such as glass, metal, plastics and paper; but the recycling concept can also be applied to water. This article will address recycling in both developed and developing countries, as well as water recycling concepts.

The amount of garbage produced today can be attributed to two legacies of the 20th century: Population explosion and the Industrial Revolution. While population growth has increased waste generation, it can also be attributed to the constant development of new or improved products, such as new car models, to stimulate consumption and, therefore, economic growth. In developed countries, many goods that could still be used fill up landfills. In the past, garbage was more organic in nature and thus assimilated easily, but many of the materials used today are inorganic (e.g., plastics) and degrade very slowly. This increase in consumerism and the limited availability of land to dispose of waste eventually led to efforts to reduce consumption and to reuse and recycle goods. The word "recycling" hardly existed in the lexicon of developed economies of the West until a few decades ago.

Recycling is one of the environmental success stories of the late 20th century. Recycling (including composting) diverted 72 million tons of material away from landfills and incinerators in 2003, up from 34 million tons in 1990. By 2002, almost 9,000 curbside collection programs served roughly half of the American population. Curbside programs, along with drop-off and buy-back centers, resulted in a diversion of about 30 percent of the nation's solid waste in 2001.

Besides diverting wastes from landfills, some of the benefits of recycling are that it conserves resources for future generations; prevents emissions of many greenhouse gases and water pollutants; saves energy that would be used to produce material from new raw materials; supplies valuable raw materials to industry; and creates jobs and stimulates development of innovative greener technologies. Recycling has some downsides as well; boxes and bottles of brand names may be used to sell substandard or spurious products. At times, small recycling industries create more pollution.

Basil Rossi

During the 1960s, there was a move toward increasing the recycling of goods throughout Western countries, and in the 1970s, Australian expatriate Basil Rossi established the Asian Recycling Association in Manila, the Philippines, to study the possible use of recyclable waste there.

Rossi had worked in Singapore, Britain, and Spain before moving to the Philippines, and had been involved in the reuse of agricultural waste, as well as industrial waste. Central to his ideas was the use of the worm *Lumbricus rubellus*, or the "red wriggler," which eats organic waste. The worms themselves were largely protein and could be turned into biscuits for feeding to animals, while their droppings provided excellent fertilizer. The biscuits sold well in Taiwan, but the major problem in the Philippines was not organic waste, which decomposed quickly, but industrial waste, which did not.

The use of these worms was also tied to plans to establish a small sustainable farm on which a family produce their own food and even much of their own power. They would raise their own chickens and crops, using the chicken waste as fertilizer, leading to the smallest possible ecological footprint. The British Broadcasting Corporation made a series of radio programs about this project in the mid-1980s. Rossi included many of these concepts in his book *Recycling & Non-Waste Technology 1979*, which was published in Manila and co-authored with his wife Portia A. Nayve, but Rossi took ill during the late 1980s and died in the late 1990s before he was able to fully develop many of his ideas.

RECYCLABLE MATERIALS

According to a 1987 World Watch Study, every time an aluminium can is recycled, the energy equivalent to production of a half a can is saved. One ton of remelted aluminium eliminates the need (in the original process) for four tons of bauxite ore and seven hundred kilograms of petroleum coke or pitch, while reducing emissions of air polluting aluminium fluoride by 35 kilograms. The report concluded that by doubling worldwide aluminium recovery rates, over a million tons of air pollutants would be eliminated. It has been found that making a new aluminium can from a used can takes 95 percent less energy; 20 recycled cans can be made with the energy needed to produce one can using virgin ore.

Besides the well-known materials such as plastic, paper, aluminum, and glass, other materials that can be recycled are as follows:

1. Yard waste consisting primarily of leaves, branches, and tree trimmings can be used mainly to produce compost, landscape mulch, and intermediate landfill cover or can also be used as biofuel. If the compost has to be used in agriculture or gardens, however, strict guidelines need to be followed.
2. Construction and demolition waste resulting from either renovations, construction, demolition of buildings, repairs of buildings, roads, bridges, etc., mainly consists of concrete, asphalt, bricks, dirt, wood products, paint, metals, plaster, glass, insulation material, and pipes. The main incentive to recycle or reuse most of this waste is high-tipping fees at landfill sites, where applicable.
3. Wood waste can vary depending on the source. It can be from forest clearing, yard waste, furniture shops, construction and demolition waste, paper mills, and other industries. The origin of the wood waste determines how and where it can be recycled or reused.
4. Recycling of household batteries is not easy because most plants do not have the technology to do it, but lead-acid batteries are normally crushed to recover lead, plastic, and sulfuric acid.
5. The main generators of tires are consumers changing tires, garages, automobile shops, and factories. The main recycling opportunities for tires are retreading and remanufacturing tires; use in boiler fuels in waste-to-energy recovering plants; to produce rubber-modified asphalt (though many paving contractors do not like to use it); to create artificial reefs, erosion control structures, muffler hangers, floor mats, and more.
6. Nonferrous metals such as copper, lead, nickel, steel, tin, and zinc are recovered from common household items such as kitchen cookware and appliances, ladders, and outdoor furniture; from construction and demolition projects; and also from commercial and industrial products. Most of the copper recovered from wire, tubing, plumbing, and fixtures can be reused. Lead, which can be recovered from tire weights, batteries, cables, and solders, can be recycled in batteries, solder, bearings, shots, and alloys. Recycled nickel can be used in high strength and corrosion-resistant alloys and stainless steel; recycled zinc can be used in galvanized products, brasses and alloys.

The limitations to what can be recycled are market demand and technical issues. To recycle economically there has to be a demand for the recycled product. Until and unless a commercial enterprise uses a recovered material to manufacture a new product, there is no point in recovering a material. Technical difficulties in recovery stem from the fact that municipal waste is heterogeneous in nature. For successful recycling there has to be separation at source or as near to source as possible. Ideally, the separation should be done either in the households by the waste generators themselves or the waste should be separated in different bins. Otherwise, separation of recyclable components from mixed waste is difficult and uneconomical. Storage facilities and costs may also limit the recycling of certain materials.

DEVELOPING COUNTRIES

Recycling is different in developing countries, where small per capita incomes keep consumption low. This also encourages the reuse and eventual recycling of much material. In the recycling process, rag-pickers pick up things from litter, segregate it and sell it to either junk-dealers or middlemen. Alternatively, junk-dealers buy things from households and sell them to the middleman who in turn sells the same to primary industry. Materials such as metal, plastic, and paper get out of the stream of waste going to landfill sites.

THE CASE OF INDIA

In many Western countries, where campaigns are organized by government departments, industry and municipalities offer incentives and subsidies for the collection and separation of wastes. In India, these activities are self-organized through a chain of self-employed individuals or groups of dealers and agents for whom this work is a source of good income. The following examples are based mainly on information from Delhi, or India in general, but much of it is true for similar developing countries.

U.S. curbside collection programs helped divert about 30 percent of the nation's solid waste in 2001.

Waste paper is one of the principal raw materials used by small paper mills. The waste paper mills are estimated to constitute about 27 percent of the effective installed capacity for the manufacture of paper and paper boards. Apart from this, some of the paper collected is also used for the "hand-made paper" industry and some of it is used to make envelopes, toilet paper, tissues, and packaging materials. Large quantities of newspaper are used in the fruit industry for packing.

Most of the plastic (PVC) collected is sold to factories, while such items as old plastic toys and plastic pens are resold in markets. Plastic bag waste is also being used by women in indigenous industries to make mats and other handicraft items. Of the recycled plastic, the highest grade scrap is used for making good quality articles of both household and industrial use such as buckets, mugs, water pots, and footwear. Low quality scrap is generally converted into shopping bags, inexpensive toys, pipes, and bottles. Recycled plastics have also begun to replace traditional packaging and natural materials such as paper, cloth, jute, and leather.

Out of the reprocessed plastics waste material (which is mainly converted into consumer items), PVC accounts for 45 percent, low-density polyethylene (LDPE) and high-density polyethylene (HDPE) for 25 percent and 20 percent, polypropylene for 7.6 percent, and other polymers like polystyrene for 2.4 percent. It is interesting to note that 35–40 percent of all plastic consumed is recycled. Iron is one of the metals recycled in India; it is generally sold to factories. Glass is also recycled in India—glass bottles are reused and other glass items are recycled.

WATER RECYCLING

With the growing demand for water, an increase in competing users, and a decrease in water quality, demand for water reuse has increased, and technologies to recover water are being developed. Some countries, such as the United States, have also come up with legislation and regulations for water recycling. Water recycling has a number of environmental benefits such as: it decreases the diversion of water from sensitive ecosystems; it helps in decreasing wastewater discharges in water bodies, thus reducing or preventing further water pollution; and it can also be used to create or enhance wetlands and riparian habitats. At times, the demand for water recycling is not driven by the need for more water but by the fact that water needs to be treated before being discharged into a water body.

Water recycling may involve collection, storage, and treatment of rain water or the recycling of wastewater from previous uses. This can mean the reuse of domestic sewage effluents or municipal wastewater, preferably excluding industrial effluents containing chemicals. Recycled sewage water may be reclaimed from bathrooms and laundry effluents (grey water), or from the entire domestic sewage stream (black water). Many factors limit the potential of recycled water for potable uses.

While water recycling is a cost-effective and environmentally-sustainable option, and has long been used on California farms and in drought-prone countries such as Australia, the treatment of wastewater for reuse and distribution systems for the supply of such water can initially be expensive. Also, recycling of water may not be looked upon favorably in many cultures. There can also be institutional barriers and regulations that make it difficult to implement water recycling projects.

SEE ALSO: Ecosystem; Garbage; Plastics; Waste, Solid; Wastewater.

BIBLIOGRAPHY. F. Ackerman, *Why Do We Recycle?* (Island Press, 1997); E. Goldsmith and N. Hildyard, eds., *The Earth Report: Monitoring the Battle for Our Environment* (Motchell Beazley, 1988); V.I. Grover, "The Recycling and Management of Household Waste in India," *IWM Proceedings* (v.3, 1997); G. Tchobalogious, H. Theisen, and S.A. Vigil, *Integrated Solid Waste Management* (McGraw-Hill, 1993).

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Red Tide

RED TIDE IS the common term used to refer to the dramatically increased concentration of microscopic phytoplankton or algae which tend to accumulate near marine or fresh water surfaces. Currents play an important role in providing nutrients and transporting the algae, while the red in their name comes from the algae's reddish pigment, which gives the appearance of a red color to surface waters. Not all red tide blooms are harmful, or even red in color. Some, however, can produce toxins that work their way up the food chain leading to severe negative impacts on an ecosystem.

Scientists more accurately refer to these as harmful algal blooms (HABs) and they are known to adversely affect higher life forms that might directly or indirectly ingest them. These algal toxins have led to large-scale fish kills, marine bird, large marine mammal, and human illnesses and mortality. Naturally, the frequency and intensity of HABs also significantly impact coastal economies and communities dependent on fisheries and other associated recreational activities.

Of the thousands of algae that form the basis of the marine food chain, only a very few are associated with HABs. Some of these include the dinoflagellates *Alexandrium tamarense* and *Pfiesteria piscicida* that are responsible for fish kills and whale deaths, and the diatom *Pseudo-nitzschia australis*. Since the 1980s HABs have been recorded from numerous sites across the globe including Ireland, Sweden, Guatemala, New Zealand, and U.S. coastal areas, to name a few.

Recent research, enhanced by an improved ability to monitor coastal fisheries systematically and detect such blooms, suggests the possibility of a number of human-induced and natural forcing factors influencing the global spread and frequency of HABs. These factors include the increased discharge of agricultural and human effluents and aquaculture by-products causing for nutrient rich waters stimulating algal growth, changes to the chemical composition of estuarine and coastal ecosystems, the possible dispersal of harmful algal species from global shipping and ballast water discharges, long term climate variability, and oceanographic parameters including currents and nutrient upwelling.

Engaging in the mitigation and control of HABs is complicated by their multidimensional nature, including their physiology and toxicology, the distributed nature of their impact on ecosystems, and their occurrence across global coastal waters. Thus far, monitoring programs provide early public health warnings to minimize human impacts. However, longer term mitigation strategies would need to consider controls on land-based nutrient runoff and would be considerably more difficult to implement. Within the United States, the Harmful Algal Bloom and Hypoxia Research and Control Act (HABHRCA) of 1998 provides the federal government a role in combating HABs. The recent reauthorization of this act aims to involve resource managers in developing monitoring and mitigation activities best suited to local conditions.

SEE ALSO: Estuaries; Eutrophication; Marine Pollution; Runoff.

BIBLIOGRAPHY. D.M. Anderson, "Toxic Red Tides and Harmful Algal Blooms: A Practical Challenge in Coastal Oceanography," *Reviews of Geophysics* (Supplement, 1995); K.L. Bushaw-Newton and K.G. Sellner, "Harmful Algal Blooms," in National Oceanic and Atmospheric Administration (NOAA), *State of the Coast Report,* state-of-coast.noaa.gov (NOAA, 1999).

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Redundancy, Ecological

ECOLOGICAL REDUNDANCY REFERS to the concept that natural environments may contain more than one species of flora and fauna capable of performing various required ecological functions, not all of which are immediately obvious. Consequently, one of the important issues involved in restoring or managing ecosystems is to document all involved organisms and attempt to understand their ecological functions. However, this is rarely possible or practical and the result has been environmental degradation and failed restoration efforts in many cases.

The theory of ecological redundancy is controversial. It has been contested on various grounds, including the intuitive, which suggests that conservation of effort or of energy would be better served if species living in close proximity with each other had complementary functions rather than identical ones. If systems were being designed *a priori*, then it would not represent a compelling case. One of the most influential paradigms for thinking about the numbers and roles of species within an ecosystem is the Lotka-Volterra Model, independently conceived at the same time by two scientists. This model is posited on the presence of predators and prey and the rates of change of the two relative populations. Models based on the Lotka-Volterra Model suggest that functional redundancy is incompatible with stable coexistence. However, the complexity of ecological systems mean that only a partial body of empirical evidence exists and this has been used in various ways to examine the proposition.

One body of thought has been devoted to the concept of ecological resilience, which refers to the ability of an ecosystem to return to a stable state after a period of perturbation (probably caused by an external shock) or to transition between two or more stable states that the ecosystem could inhabit. Functional biodiversity in such ecosystems provides a form of safety buffer for occasions when the ecosystem suffers environmental change. The adaptive capacity of ecosystems describes the level and dynamics of the resilience that they possess and the factors that affect it. In general terms, when the level of redundancy increases, the level of adaptive capacity increases and, hence, the level of resilience increases.

In modern agricultural systems and in industrial exploitation of natural resources, rational systems design calls for minimization of variables and unknown factors. This has led to the elimination of pests through the use of chemicals and the reforestation of plantations with single species. These systems minimize redundancy, which is seen as a negative feature of the system, with potentially dangerous outcomes. Redundancy is a symptom of the chaotic and unpredictable course of the development of ecosystems and their interaction with external phenomena. The sudden introduction of previously unknown species into a local ecosystem can have disastrous results.

SEE ALSO: Ecological Footprint Analysis; Ecological Imperialism; Ecosystem; Lotka-Volterra Curve; Resiliance, Ecological.

BIBLIOGRAPHY. Donald A. Falk, Margaret A. Palmer, and Joy B. Zedler, eds., *Foundations of Restoration Ecology: The Science and Practice of Ecological Restoration* (Island Press, 2006); Lance H. Gunderson, "Ecological Resilience—In Theory and Application," *Annual Review of Ecology and Systematics* (v.31, 2000); Michel Loreau, "Does Functional Redundancy Exist?" *Oikos* (v.104/3, 2004); Brian H. Walker, "Biodiversity and Ecological Redundancy," *Conservation Biology* (v.6/1, 1992).

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Reforestation

REFORESTATION REFERS TO the re-emergence of forest vegetation (secondary growth) following clearing of old growth (primary) forest. Reforestation is thus the opposite of deforestation, which involves the removal of forest cover. Reforestation differs from afforestation, which involves tree planting in areas not previously forested. Reforestation is also different from but related to forest restoration, which involves recovery of forest ecosystem functions and is the opposite of forest degradation.

Reforestation is of ecological and social value. Ecologically, forest regrowth provides habitat for many species, including those adapted to disturbed forest ecosystems. Reforestation also protects soils from erosion that can damage stream networks and river chemistry. On the global scale, reforestation sequesters atmospheric carbon in plant biomass, reducing carbon dioxide levels that contribute to climate change. Socially, reforestation is of value because it ensures the supply of timber, a renewable resource that has numerous applications. Reforestation also slows the movement of water during rains that could otherwise result in flooding, thus avoiding property damage and loss of life.

Historically, forests have declined in extent over time, because deforestation exceeded reforestation. While there are many types of forests, and consequently many definitions of what counts as "forest," there are many estimates of forest cover over time for many parts of the world. According to the United Nations Food and Agricultural Organization (FAO), there are about 4 billion hectares of forests worldwide. The FAO's 2005 Global Forest Resources Assessment indicates that during 2000–2005, approximately 13 million hectares of forest were cleared, but the net change in forest cover was a decline of 7.3 million hectares. This implies that approximately 5.7 million hectares were reforested. During 2000–2005, forest cover declined in the Americas, Africa, and Oceania, but rose in Europe and Asia. Forest decline is particularly high in South America and Africa, both of which lost roughly 4 million hectares per year. A notable change from the 1990s to the new millennium is China's forest planting program. China declared it has planted 24 million hectares with trees as of 2005, and this accounts for the switch from net forest decline in Asia of 800,000 hectares per year during 1990–2000 to a net rise of 1 million hectares per year during 2000–2005.

There are many explanations offered to account for reforestation. Several human decisions can result in reforestation. Some decisions allow "passive" reforestation, as when land managers decide to fallow land (i.e., allow previously productive land to rest), or when they abandon land. In both cases, whatever species of vegetation are present (or arrive via dispersal by animals, wind or rain) grow naturally. Other decisions involve "active" reforestation as via decisions to consciously plant and manage the growth of specific tree species, as in tree plantations. Whereas passive reforestation often involves hardship for land users, it may result in more biodiverse forests, while active reforestation may bring greater economic benefits though homogeneous tree stands.

Decisions by land managers to reforest are greatly influenced by the broader context consisting of social institutions and the biophysical environment. If land prices fall in areas of agricultural production, or if urban wages rise relative to rural incomes, land abandonment and rural-urban migration may result, with the consequence that agricultural land may revert to forest. Since 1800, Europe has experienced roughly a doubling in forest area as many countries there experienced industrialization, urbanization, agricultural intensification (increased agricultural productivity per hectare, which reduces demand for cleared land), and other processes associated with "modernization." It is less clear that modernization necessarily results in reforestation, particularly in developing countries, where forest decline continues alongside industrialization, urbanization, and agricultural intensification. This can in part be explained by domestic and international demand for forest and agricultural products from developing countries, as well as by the distinct biophysical environment in many tropical countries, where unsustainable land use practices may degrade fragile soils and prevent forest recovery.

Many other large-scale social factors also influence reforestation, such as cultural support for reforestation programs due to identification with forest landscapes, especially for their recreational value. National policies have historically been important in many European countries, which sought to address fuel wood scarcity in the 19th century via reforestation programs. International environmental agreements are also significant, notably the United Nations Convention on Climate Change (i.e., the Kyoto Protocol), which identifies reforestation as a means of offsetting carbon emissions from burning fossil fuels.

SEE ALSO: Deforestation; Kyoto Protocol; Land Use and Cover Change; Plantation Forestry.

BIBLIOGRAPHY. Marcy Trent, *The Aes Corporation: The Guatemala Reforestation Project* (World Resources Institute, 1992); X. Wang, H.S. He, and X. Li, *The Long-term Effects of Fire Suppression and Reforestation on a Forest Landscape in Northeastern China After a Catastrophic Wildfire* (Elsevier, 2006); Fred R. Weber, *Reforestation in Arid Lands,* 2nd ed. (Vita Publications, 1986).

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Regions

A REGION IS an important way in which the spatial organization of both human society and the natural world can be represented, analyzed, and managed. A region denotes a land area that might be defined by administrative, political, or economical boundaries; a particular sphere of interest (such as commercial); or a common natural phenomenon. In addition to these physical parameters, it might contain certain social or physical features that characterize its distinction. In terms of their scale, regions might range from a few hundred square kilometers to the size of entire continents. Thinking in terms of regions facilitates the management of transportation, industrial activity, business development, planning, administration, and democracy. More theoretically, writers have paid attention to how regions are historically, economically, politically, and culturally produced (such as through empire) and reproduced (such as by heritage industries).

The concept of region lies at the heart of the discipline of human geography, which grew in the late 19th and early 20th centuries as a recognizable academic discipline by carefully describing and mapping all human activity captured within regions. Indeed, regions were considered to be the basic building block of bigger orders such as nation-states or the world. The justification for the scale of analysis was made by Mackinder's influential 1919 book *Democratic Ideas and Reality*. Mackinder argued that the region could serve as the basic explanatory unit of human life because regional identities and activities had the ability to transcend and dissipate social divisions. The most well-known works at the turn of the 20th century included Patrick Geddes's regional survey, which studied regions through the interrelationship of their area, and the work and folk held "within." In the same tradition, during the 1930s, Dudley Stamp published detailed regional land-use maps from his Land Utilization Survey of the United Kingdom. Greater interpretation of human attachment to place was displayed by the French geographer, Vidal de la Blanch, who described French regions in terms of the interrelationship of local cultures and local landscapes in works including *Tableau de la Geographie de la France* (1903) and *Principles in Human Geography* (1921).

For analytical purposes, regions can be classified into four broad types: natural, formal or administrative, functional, and vernacular. Natural regions—such as the Arctic or the Amazon—refer to areas that share similar climate, soil, flora and fauna, and landform features. The concept of the natural region is useful in describing and analyzing habitats, ecological communities, and biomes. Formal or administrative regions refer to the territorial segments with which a country can be organized and usually have government functions and powers. Depending on the political context, regional administrations may be responsible for the delivery of health, housing, and recreation and regulating economic policy. A good example of this type of region would be the special administrative regions created in China to facilitate free-market economic development. Formal regions may also be supra-national. Regional trading blocs, such as the European Union (EU) and North American Free Trade Agreement (NAFTA), are types of formal regions.

A functional region is distinguished by its socioeconomic rather than administrative and political elements. Functional regions are usually characterized by a high concentration of economic and social interactions and usually consist of urban areas connected by infrastructural and economic networks and clusters. The concept of the functional regions illustrates well the interdependencies between people, organizations, and economic activities in space. These regions are commonly identified in regional planning and city-regional governance. In contrast, vernacular regions are primarily defined around social and cultural characteristics. In the United States, "the South" is often described as a vernacular region, where cultural identity is expressed in terms of accent, food, religion, and way of life. "Regional consciousness," based on shared senses of history, belief, and political affiliation, is a common characteristic of vernacular regions. The meaning and identity of vernacular regions are often represented in art and literature. The cultural power of vernacular regions frequently forms the basis of regionalism, a socio-political movement which can fuel claims for greater independence from central government.

For environmental management, the concept of the region is essential, though problematic. Traditional managerial jurisdictions for overseeing water, land, or wildlife resources have historically followed political boundaries (e.g., county or state lines). Environmental materials and systems, however, tend to follow their own patterns and flows, making such regional management territories extremely problematic. A recent shift to watershed management, where integrated decision making occurs in a region whose boundaries are determined by the flow of water within a drainage system, has sought to ameliorate this problem. Though a promising effort, it is important to remember that not all environmental systems (e.g., air pollutants) may follow watershed boundaries. The process of determining and using regions, therefore, must be geared to the context of decision making, which may itself change over time. Since there are no "natural" regions, our use of boundaries to manage society and nature must always be considered partial and incomplete.

SEE ALSO: Geographic Information Science; Geography; Maps.

BIBLIOGRAPHY. Michael J. Bradshaw et al., *Contemporary World Regional Geography: Global Connections, Local Voices* (McGraw Hill, 2004); Vidal de la Blanch, *Principles in Human Geography* (Constable, 1921); Harold Mackinder, *Democratic Ideas and Reality* (Penguin, 1919).

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Religion

RELIGIONS HAVE HAD important roles in influencing people in environmental and societal conduct.

EASTERN RELIGIONS

To begin with an example from the religions of the Indian subcontinent, Hinduism, or Vedism as it was first known, was based on the worship of nature with three gods—Indra (rain), Surya (sun), and Agni (fire). In the present day, the reverence for cows is well-known, and there are many animals represented as gods such as Nandi (bull), Ganesha (elephant), and Hanuman (monkey). This has led to many actual animals being cherished in Hindu temples. The Karni Mata temple in Rajasthan, India, is inhabited by thousands of rats; and there are also monkeys in many Hindu temples, the Durga Temple at Varanasi (Benares) is home to hundreds of them, and the Sangeh Monkey Forest on the Indonesian island of Bali adjoins a seventeenth century Hindu temple. Also in Bali there is the Goa Gajah Elephant Cave, although it has been a long time since elephants have been there.

One of the predominant social aspects of the Hindu society is the caste system by which particular castes have specific social positions that cannot be changed. The Brahmans, the highest caste, are priests and religious teachers, while the lowest, the untouchables, collect trash and work in the most unpleasant jobs. In between there are castes for kings, warriors, and officials, another for merchants, businessmen, lawyers, doctors, and the like. Another lower position is reserved for farmers, servants, and those engaged in menial but not unpleasant tasks. How much the caste system owes to long entrenched Hinduism, or is just a necessary social/racial divide in the vast Indian society is an area in which experts cannot agree.

The personal habits of Hindus, such as vegetarianism, spring from the reverence for nature and the belief in reincarnation. Hindus should avoid intoxicants and take part in numerous pilgrimages, the most important being washing themselves in the Ganges River. While cremation is a feature of Hindu belief, it may well have a basis in commonsense hygiene, as of course do most, if not all, the dietary requirements.

Another religious belief emanating from India is Jainism. In this monastic order, monks take a vow of nonviolence and keep a strict vegetarian diet and don't eat after dark because it increases the possibility of harming insects that might be attracted to the food. All drinking water must be carefully strained first to ensure there are no life forms in it. A very fine net mask is also used to breathe through to prevent the accidental breathing in of insects.

Buddhism, which also originated in India, preaches nonviolence, and most Buddhists try to develop a certain harmony with their natural environment, with many Buddhists being vegetarians. Lord Buddha (624–544 B.C.E.) himself grew up in a very sheltered environment, with his parents anxious not to expose him to bad things in life. However, he once alighted from his carriage, according to legend, and saw the suffering of the people—the beggars, the diseased, the old, and the dead—and he cut his long hair, put on old worn clothes, and went out into the world. Out of this long episode came his teachings about life. He talked of conduct toward others providing a social code that was much needed at that time and ever since—it became known as the Middle Path. This was developed by people who wish to achieve Nirvana, and thus avoid the pain of rebirth, an ever-present threat in Hinduism.

Buddha also made a statement against having large families, which was used by Mechai Viravaidya in Thailand to promote his family planning programs from the 1970s. The teachings of Buddha have spread throughout Asia, Europe, Australia, and North America. Mention should also be made of Shintoism, the national religion of Japan, and Taoism and Confucianism in China. All of them involve reverence for ancestors, and maintaining one's order with nature.

Sikhs owe their existence to Guru Nanak (1469–1539), a teacher who founded what is a brotherhood based on common beliefs between Hinduism and Islam. Converts can become Sikhs if they accept the reformed Hinduism they preach, with the basic tenet referring to the worship of nature. The Sikhs have, probably because of their early battles for survival, as Punjabis, a strong political and military outlook with a definite strict personal code of conduct. Socially Sikhs place great importance on loyalty, showing of gratitude, philanthropy, justice, and honesty. In civilian life, Sikhs gravitate to skilled trades such as farming and mechanics. There are Sikh communities around the world.

In terms of worshiping, Hindu, Jain, Sikh, and Buddhist societies have all built temples. Many of these are modest, but some are massive and tower over where the worshippers live. Buddhists in particular have built massive statues of Buddha—such as the 8,202-feet-high Bamiyan Buddhas in Afghanistan (destroyed in 2001) and reclining Buddhas like those in Thailand, Japan, or Sri Lanka.

MIDDLE EASTERN RELIGIONS

Moving to the great religions of the Middle East, Abraham (c. 2100–2000 B.C.E.) is recognized as the father of Israel, from which the monotheistic

Jewish religion has developed over the centuries. Moses (14th–13th centuries B.C.E.), after his flight from Egypt with the Hebrew slaves and others, received further teachings at Sinai, and proceeded to the Promised Land, which Abraham had previously known, but Moses only got to see from a distance. His followers went on and settled in what is now Israel and Palestine.

From the books of the Old Testament and other sources came the Talmud, the main statement on Judaic law and ethics, based on justice and righteousness. In terms of the environment, Judaism has definite rules detailed in the Talmud. It is forbidden to destroy fruit-bearing trees, things of nature that are useful, such as plants and other living creatures, food, and discarded objects that may be useful to other people. Not to pay attention to the needs and feelings of animals and birds is also wrong—indeed it is taught that the animals should be fed first and attended to before the owner commences his own meal.

In social and relational terms, the Talmud has firm rules about human rights, possession, and sharing of property, business conduct and the treatment of labor. On an individual level, lying, obtaining information by deceit, and reminding a person of his past or his origin to his detriment is forbidden. Conditions apply to the types of food to be eaten and their preparation and mode of consumption. The care of the poor is a major concern in Judaism, not least is the concept of constructive charity whereby a person who is down on his luck is offered a way to change his life. Charity is regarded more in this way than a permanent source of help, except, of course, for the aged and infirm.

Followers of Zoroaster (c. 589–39 B.C.E.) originated in present-day Iran, but persecution of them over many years has seen large considerable communities established in India. Because of their respect for the elements—fire, water, and earth—they reject cremation and burial, and instead place their dead on open towers where the flesh will be eaten by birds of prey. Education plays a large part in Zoroastrian or Parsee/Parsi households, with girls' education and social freedom a strong feature. Parsees are, as a rule, very successful businessmen and women, and are known for their charitable work, giving money to other groups. In India, the Parsees were the first to take up cricket, endearing them to the British in India.

Islam owes its origin to Mohammed (c. 555–619 C.E.), born in Mecca, orphaned young, and adopted by an uncle. In his mid-20s he married Khadiyah, a woman of means, and some 15 years older than himself. They had six children, and from one daughter's (Fatima's) union with Ali, Mohammed's cousin, the direct line of the family begins. Mohammed was 40 when he had a vision of the Archangel Gabriel who revealed the basic ideas of the monotheistic religion, consolidated in the Koran. Islam came into being in an arid and harsh natural environment, and it is no surprise that the belief spread to more fertile areas. Great emphasis has been placed on gardens, flowing water, cool buildings, and city quarters—Kasbahs—that maintained a steady environment regardless of the climate outside.

Perhaps the most significant social asset of Islam is that there is no distinction among the faithful of color or race, symbolized on the Hadj—the pilgrimage to Mecca—by the universal wearing of a seamless white garment, so that everyone, regardless of wealth and position, is the same before God. At a personal level, Islam forbids gambling, usury, intoxicants, idolatry, and the consumption of pork. Prayers are said five times a day with certain disciplines to be observed. Various Islamic organizations, with access to funds never before available, now conduct many social services, such as housing, health, education, and security.

CHRISTIANITY

The Christian Church dates from the birth of Jesus Christ in c. 6 B.C.E., and incorporates much of the teachings and tenets of Judaism as in the Old Testament. Thus, its initial attitude to the environment and society were not much different to those of Judaism. Perhaps because Christianity has spread so widely over time, it has demonstrated the ability in most areas to change its ideas and cope with new ones. The treatment of nonbelievers, of women, of animals, and other living things has undergone significant changes.

Socially the embracing of the equality of the sexes, while taking centuries to accomplish, now provides opportunities for all, both in moral terms, and also legally. Education is now a basic tenet, as is access to health services and a decent standard of living. The social work of the Christian Church is today widespread and draws no distinction between believers and nonbelievers. At a personal level, there are customs that arose during medieval times, including the eating of fish on Fridays, and fasting or giving up something during Lent, which still exist. During the period after the Protestant Reformation, the Anglicans and Episcopalians, the Baptists, the Calvinists, the Lutherans, the Methodists, and the Presbyterians have all followed different rules of religious and societal conduct. Some groups such as the Amish and the Quakers have followed much stricter rules of societal conduct especially in regards to nonviolence.

SEE ALSO: Cattle; Gardens; Movements, Environmental; Policy, Environmental; Preservation; Vegetarianism.

BIBLIOGRAPHY. Isidore Epstein, *Judaism: A Historical Presentation* (Penguin Books, 1959); Alfred Guillaume, *Islam* (Penguin Books, 1954); Christmas Humphreys, *Buddhism* (Penguin Books, 1962); K.M. Sen, *Hinduism* (Penguin Books, 1961).

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Remote Sensing

REMOTE SENSING IS the field of integrating the information, technology, and analysis of data collected by both satellite and airborne sensor systems of the earth's surface, atmosphere, and near subsurface. Remote sensing could generally be described as the observation of objects or phenomena from afar, and is the opposite of *in situ* observation where those measuring are in direct contact with objects or phenomena. But since the 1950s, when the term was coined by Ms. Evelyn L. Pruitt of the U.S. Naval Office of Research, the term has come to mean more specifically the use of aerial photography and satellite imagery for monitoring the earth's surface (including atmosphere, and more recently, some substrate). The mechanism that acquires the information is referred to as a sensor, and the vehicle that carries it (an aircraft or satellite) is referred to as the platform; taken together, these are called a sensor system.

Early remote sensing efforts were limited by two factors: camera equipment and means of putting that equipment into the air. Passive or optical remote sensing uses the sun's energy and measures reflections of that energy. The human eye is sensitive to energy from the visible portion of the electromagnetic spectrum, ranging over 400–700 nanometer wavelengths and associated with blue, green, and red light in order. The first permanent photograph was taken by Frenchman Joseph Nicéphore Niépce in 1826 over an eight-hour exposure.

AERIAL PHOTOGRAPHY

Once optical equipment and darkroom techniques were sufficient for photography, many creative attempts to take photos from above were performed using hot air balloons and even pigeons. The benefit of seeing the earth's surface from above (known as a nadir or orthogonal perspective) was the ability to capture information over a large area at once (called a synoptic view) without the danger of direct contact. The development of aerial photography was thus often advanced by military and defense efforts.

One notable example came in the development of techniques that could record the reflection of the sun's energy beyond that which the human eye could detect: infrared, the light that is just past the red light humans can see. The wavelength of infrared light closest to red (called near infrared or NIR) is given off very strongly in healthy, green vegetation in amounts two to five times higher than the green light reflected by vegetation that human eyes can see. (This light, or electromagnetic energy, is not to be confused with far infrared, also known as thermal infrared, which humans sense as heat.) Researchers and military strategists discovered that with infrared photography they could easily tell the difference between real vegetation and camouflage used to hide tanks and troops. The power of lenses for the sensors improved, with greater zoom capability. With increasing lens power, aircraft could fly higher and still discern important details. Typically, cameras were mounted on the underside of planes and the film developed once back on the ground.

Combining multiple forms of remotely sensed data has proven effective in assessing damage, targeting rescue attempts, and planning for future disaster management and mitigation in areas hit by earthquakes, tsunamis, and hurricanes.

SATELLITES

Many countries' oldest air photos are associated with military efforts during World War II and subsequent international conflicts and wars. During the decades that followed, improvements in technology facilitated satellite testing and launching (particularly for meteorological purposes), and offered a choice of platform for observing even larger portions of the earth's surface. Declassified by President Clinton by executive order in February 1995, the CORONA satellite photography database includes over 880,000 photos taken from the CORONA, ARGON, and LANYARD satellite missions from 1959 to 1972. A further challenge involved with high altitude photography was how to send the film back to the earth's surface for development, which was typically achieved by sending the film in canisters to be caught midair by military planes waiting below.

The next advance in technology pushing remote sensing forward was the advent of digital acquisition and relay of photography, called imagery when collected and provided in digital form. Using a digital environment alleviated the need to send film back to the earth's surface; instead, the data were sent digitally to stations on the ground (known as receiving stations) as the satellites passed overhead. Multiple digital devices recorded light reflectance in multiple portions of the electromagnetic spectrum and an image of each was held for transmission.

The first such satellite sensor system was launched on July 23, 1972, and was originally known as ERTS-1 (Earth Resource Technology Satellite), but was soon renamed Landsat MSS (multispectral scanner) 1. Landsat 1 had four bands or portions of the electromagnetic spectrum it imaged: green, red, and two in the near infrared. In the digital process, the earth's surface was digitally divided into square cells (called pixels, short for picture elements) and the average reflectance for each band was recorded in that cell. Landsat 1 cell sizes were nominally 79 meter resolution, meaning each cell represented an area on the ground of roughly 79 meters by 79 meters (standard remote sensing interpretation requires at least four cells to accurately identify an object). The Landsat sensor system series has provided the longest running and noncommercial acquisition of publicly available satellite imagery in the world, with Landsats 2 and 3 providing similar information, and a new TM (thematic mapper) sensor put onboard for Landsats 4, 5, and 6 (though Landsat 6 failed to achieve orbit). The TM sensors added sensor capability in the blue, middle infrared, and far infrared (thermal) portions of the electromagnetic spectrum, moved the other band placements to avoid atmospheric interference, and improved spatial resolution to 30 meters (except thermal, which was 120 meters). Landsat 7 ETM+ (Enhanced Thematic Mapper, launched in 1999) added a higher resolution panchromatic (black and white) sensor with 15 meters resolution and improved thermal resolution to 60 meters. Currently no approved and budgeted plan exists for the next earth resource satellite, and the lifetime expectancy of these sensor systems suggests that in the near future many people will have to turn to other governments or the commercial sector for basic earth resource information and monitoring that likely will not be subsidized and/or easily available to the public.

Applications of passive or optical remote sensing have grown considerably during the history of remote sensing, and extend far beyond military and defense. Satellite imagery is now considered a critical tool for basic mapping and environmental and resource management for federal, state, and local U.S. government agencies; and it is used for managing, protecting, and monitoring homeland security, forestry, agriculture, emergency/hazards planning, transportation planning, land zoning, city and rural population estimates, geological surveying, coastal zone management, and air and water pollution.

RADAR AND LIDAR

The advent of active sensor systems (those that record the return of an energy source of their own making, such as a laser pulse) has increased the toolkit available for integrated management. RADAR (radio detection and ranging) systems, flown on both aircraft and satellites, can penetrate some cloud conditions obscuring optical sensing and also can provide some level of penetration of vegetation cover (e.g., detecting human settlements under dense forest cover) or surficial soils (e.g., detecting changes in the upper levels of the substrate and soils as associated with subsidence). LIDAR (light detection and ranging) systems provide extremely accurate and detailed information regarding the height of the earth's surface for producing topographic maps of higher quality and definition than can be manually surveyed. Such maps have recently proven extremely useful for monitoring coastal zone erosion, subsidence, and modeling water flow for floodprone areas. LIDAR systems also have some penetrative capabilities, useful for vegetation and geological applications.

Most recently, combining multiple forms of remotely sensed data has proven extremely effective in assessing damage, targeting rescue attempts, and planning for future disaster management and mitigation in areas hit by earthquakes, tsunamis, and hurricanes. While remote sensing is associated with indirect data collection, most remote sensing applications involve some level of fieldwork to help in model testing (calibration) or accuracy assessment (validation). The integration of field data, whether from household interviews or groundwater readings, is typically achieved by spatially integrating the data sources (often in a GIS, or Geographic Information System). Acquiring the spatial location of all field datapoints is typically enabled through the use of GPS (Global Positioning System) technology.

SEE ALSO: Geographic Information Science; Global Positioning Systems (GPS); Maps; Satellites; Topographic Maps.

BIBLIOGRAPHY. John Jensen, *Remote Sensing of Environment: An Earth Resource Perspective* (Prentice Hall, 2006); Willis T. Lee, *The Face of the Earth as Seen from the Air: A Study in the Application of Airplane Photography to Geography* (American Geographical Society, 1922); Diana Liverman et al., eds., *People and Pixels: Linking Remote Sensing and Social Science* (National Academy Press, 1998); Roger M. McCoy, *Field Meth-*

ods in Remote Sensing (Guilford Publications, 2004); National Aeronautics and Space Administration, "Dr. Nicholas Short's Remote Sensing Tutorial," rst.gsfc.nasa .gov (cited May 2006); John Spencer et al., eds., *Global Positioning System: A Field Guide for the Social Sciences* (Blackwell Publishing, 2003); United States Geological Survey Eros Data Center, "Earth Resources Observation and Science," edc.usgs.gov (cited May 2006).

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Renewable Energy

THE TERM *renewable energy* describes sources of energy that exist within the natural environment including the sun, wind, water, plant material, and geothermal heat. These sources are either continuously available, like heat from the sun, or are rapidly replaced after their depletion, like wood. Renewable energy is also considered clean energy. It generally does not produce carbon dioxide or other harmful pollutants or wastes. Renewables such as hydropower and wood already contribute 15 percent of total world energy production. The so-called "new renewables," including solar and wind, while accounting for only 2 percent of energy production, are the fastest-growing sources of energy. Since the early 1990s installed capacity of both solar power and wind energy has increased by more than 20 percent annually. With concerted action, renewable energy technologies have the potential to meet half or more of the world's energy needs within a few decades.

HYDROPOWER

Hydropower is the most successful type of renewable energy. Humans have been using the power of flowing rivers for centuries to grind flour and turn rudimentary machinery. Hydro has been used to produce electricity for over 100 years. Rivers are dammed, impounding water in reservoirs, which is then used to turn turbines. Hydro produces 17 percent of the world's total electricity, 10 percent of U.S. electricity, and more than 90 percent of electricity in Norway and Iceland. Forty other countries get more than 50 percent of their electricity from hydro. The cost of hydropower is low and is competitive with the cheapest fossil fuels. Hydro is a domestic source of energy, which is especially beneficial for less-developed countries faced with importing expensive oil. Dam projects have other benefits such as flood control, irrigation, recreation, and municipal water supply. Hydropower has a number of drawbacks, including the loss of farmland, displaced people, and the destruction of habitat and fisheries. Droughts pose another problem, and silt can dramatically reduce the life of a reservoir.

The Three Gorges Dam on the Yangtze River in China is the world's largest dam project. It will produce 10 percent of China's electricity, thus reducing dependence on dirty coal. However, the reservoir has displaced 1.5 million people and resulted in the loss of 115,000 acres of farmland, showing that hydro is not always benign. Nevertheless, the potential for hydropower is vast, especially in poorer countries. In rich countries, high construction costs and political opposition mean that fewer large dams are likely to be built in the future.

SOLAR POWER

Solar power uses the energy of the sun for heating and to produce electricity. There are four main types of solar energy systems. Passive solar relies on the design of structures to capture heat in the winter and to keep spaces cool in the summer. For example, a greenhouse is heated by the sun. A well-designed passive system can provide nearly 100 percent of the space heating for a home. Active solar systems are most commonly used to heat water and swimming pools. They rely on flat plate collectors, generally mounted on rooftops, to circulate and heat water. Photovoltaic systems use silicon wafers or chips to convert sunlight directly into electricity. Calculators use photovoltaic cells, as do panels on homes and in places not connected to power lines. Solar thermal electric systems heat water to produce steam to generate electricity. A commercial plant in the Mojave Desert of California uses a series of curved mirrors that track the sun to produce enough power to supply electricity to 170,000 homes.

The great benefit of solar is that the energy of the sun is nearly limitless and has the potential to meet most of the world's needs. Passive, active, and small-scale photovoltaic technologies are already widely used. Solar energy is decentralized and near the user, which could benefit nearly two billion people in less-developed countries who live in rural areas not connected to a power grid. The main problem with solar energy is that while sunlight is plentiful, it is not uniformly available. It is inconsistent, varying by region, season, time of day, and weather conditions. The ability to store power in batteries is limited, and backup systems are needed. Solar power is a good supplement to conventional systems. The other problem is that solar-generated electricity costs about four times as much as coal power. Nevertheless, costs have fallen rapidly in the past two decades and will continue to decline as technology improves.

WIND POWER

Windmills have been used for nearly 2,000 years to pump water and for grinding grain. Today, wind power is the world's fastest-growing source of electricity generation. Advanced technology has made wind power cost-competitive with coal and about half the cost of nuclear power. Europe is the leader in wind power, with three-quarters of global capacity. Wind machines in Europe generate an output equivalent to 35 large coal-burning power plants. Germany accounts for half of Europe's total and produces 5 percent of its electricity from wind. Twenty percent of Denmark's electricity is generated by wind. The United States is the number two world producer, but wind accounts for less than 1 percent of U.S. electricity.

Wind power has tremendous potential and could meet 20 to 30 percent of global electricity needs. The largest wind machines are 600 feet tall, have 200-foot blades, weigh 18 tons, and can generate power for 5,000 homes. The main drawback is that the wind does not blow all the time, so again, a backup system is needed. Wind machines are now being placed offshore in the ocean where winds blow more consistently. Other concerns include visual blight, noise, and potential harm to birds. Nevertheless, wind power is an important part of a mix of energy sources. It is also a good complement to solar because the wind is often blowing when the sun is not out.

GEOTHERMAL AND TIDAL POWER

Two lesser-known sources of renewable energy are geothermal and tidal power. Geothermal power is derived from the heat of molten magma beneath the earth. Geysers and hot springs are examples of geothermal processes. Wells tap into hot water and steam under the ground, which can be used to drive steam generators or heat water and homes. Only 0.25 percent of U.S. electricity is produced by geothermal. However, 85 percent of homes in Iceland are heated by geothermal wells. El Salvador generates 40 percent of its electricity from geothermal, and this resource is important in areas of New Zealand, Japan, Russia, and Italy. Geothermal is limited to geologically and volcanically active areas. Also, hot water and steam can contain damaging minerals and the poisonous gas hydrogen sulfide.

Tidal power involves constructing a dam across the mouth of a bay to capture water at high tide. Some areas of the world, especially at far north and south latitudes, have daily tidal ranges of up to 20 feet. At low tide, water is let out through a turbine to generate electricity. Tidal power has yet to be applied commercially because it is limited to areas with large tidal ranges, and power can only be generated intermittently during the tide cycle. Also, the damming of bays and estuaries has environmental implications.

BIOFUELS

Energy from biomass or biofuels is derived from plant and animal products. Fifteen percent of the world's total energy demand and 3 percent of that in the United States is currently met by biofuels. The most important biofuels are wood, biogas, ethanol, and biodiesel. Wood has been burned for thousands of years and is still the primary source of energy for half the world's people. However, wood is severely depleted in many countries, and burning wood is a source of air pollution. Biogas is made by decomposing crop residues and manure to produce methane. Methane is also given off from landfills. Thirty-five million homes in China use village-based biogas systems for cooking, heating, and lighting. However, methane, like carbon dioxide, is a greenhouse gas. Ethanol is alcohol that is distilled from crops such as corn, sugarcane, and soybeans. In cars, it can be blended with gasoline up to 20 percent without modifying the engine. So-called flexible fuel vehicles automatically adjust to run on any mix of fuel from pure gasoline to 85 percent ethanol. Brazil has led the way in using ethanol as a transportation fuel. Fifty percent of nondiesel fuel in Brazil is ethanol, and almost all cars sold today are flex-fuel. The United States is the second leading producer, but only 2 percent of U.S. fuel is ethanol. Nevertheless, there are four million flex-fuel vehicles on the road. Global production of ethanol has doubled since 2000 and will more than double again by 2020. Biodiesel is derived from vegetable oils and can be mixed in any proportion with petroleum-based diesel or used in pure form. Europe produces 95 percent of the world's biodiesel, and Germany is the leading producer.

Ethanol and biodiesel have a number of advantages over petroleum-based fuels. They are cost competitive, less hazardous to handle, and less polluting. They are also carbon neutral. Carbon is captured from the atmosphere by plants when they are growing and then released again when the fuel is burned. Biofuels could replace large amounts of imported oil. The technologies are proven and large-scale production is already in place. The biggest drawback is limited farmland. Crops for biofuels may someday compete with food production, and the expansion of farming into marginal lands causes soil erosion and habitat destruction. In addition, large-scale monoculture agriculture relies on petroleum-based transportation fuels, pesticides, and fertilizers, and distilleries are often powered by fossil fuels. However, in the future biofuels will be made from straw, wood, and other nonedible cellulose-type materials. If the environmental and sustainability questions can be addressed, biofuels will have even greater potential.

HYDROGEN

Hydrogen is another renewable energy resource. Like natural gas or propane, hydrogen can be burned in homes and factories, and it can be shipped in existing natural gas pipelines. The by-product of burning hydrogen is water vapor, and it emits no carbon dioxide. A promising new technology is the hydrogen fuel cell. A fuel cell resembles a battery, but it uses hydrogen and oxygen, which react with a cathode and a catalyst to produce electricity. A vehicle is powered by an electric motor. Prototype hydrogen fuel-cell vehicles are now on the market, and several European cities operate fuel cell buses. The 1937 *Hindenburg* airship disaster left a lasting impression that hydrogen is not safe. However, hydrogen in vehicles is no more dangerous than gasoline, which is also flammable.

The main drawback is that a large supply of hydrogen is not easily recoverable from nature. One way to obtain hydrogen is through electrolysis, which uses electricity to split water molecules. Water is very abundant, but electrolysis requires a lot of electricity, which is expensive and energy-intensive. Hydrogen made with electricity from fossil fuels results in the release of carbon dioxide and other pollutants into the atmosphere. Nuclear power could be used, but that technology is controversial. Hydrogen can also be separated from natural gas, gasoline, methane, or ethanol. Ironically, hydrogen technology can alleviate local and regional air pollution, but contribute to global warming. The only way hydrogen is truly clean is if renewable energy is used to make it.

Substantial amounts of renewable energy are available with current technologies, and hydro, wind, and biofuels are already economically competitive. A proactive energy policy is needed. Hundreds of billions of dollars annually go to subsidizing fossil fuels and nuclear power. Even a modest shift of support toward renewables could spur new industries and stimulate demand as the technology advances and costs come down. While no single source is likely to provide all of society's energy needs, as part of a total energy package, renewable energy can contribute to lessening dependence on fossil fuels and to a cleaner and more sustainable future.

SEE ALSO: Bioenergy; Carbon Cycle; Coal; Dams; Fossil Fuels; Geothermal Energy; Greenhouse Gases; Hydrogen Fuel; Hydropower; Methane; Nuclear Energy; Solar Energy; Wind Power.

BIBLIOGRAPHY. Daniel Chiras, *Environmental Science: Creating a Sustainable Future* (Jones and Bartlett, 2006); "Crossroads for Planet Earth," *Scientific American,* Special Issue (September 2005); Susan Cutter and William Renwick, *Exploitation, Conservation, Preservation: A Geographic Perspective on Natural Resource Use* (Wiley, 2004); Suzanne Hunt and Janet Sawin with Peter Stair, "Cultivating Renewable Alternatives to Oil," in *State of the World 2006* (Worldwatch Institute, 2006); Michael Parfit, "Powering the Future," *National Geographic* (August 2005); Janet Sawin, *Worldwatch Paper #169: Mainstreaming Renewable Energy in the 21st Century* (Worldwatch Institute, 2004); U.S. Department of Energy, National Renewable Energy Laboratory, www.nrel.gov/ (cited May 2006).

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Research Methods

THE DEVELOPMENT OF methods that allow integrated analysis is central to current research on nature-society relations. Integrated methods combine qualitative and quantitative approaches aimed at understanding human-environment relations. Great challenges are involved in developing such integration due to the strong epistemological barriers that exist between the humanities, social, and natural sciences. Methods are framed by philosophical traditions that reflect key assumptions such as views of the social and natural world (constructivism or realism), positions regarding what is important to know (contextuality or generalizations) and perspectives regarding the nature of knowledge (subjectivity or objectivity).

The common assumption is that natural sciences and certain social sciences such as economics are grounded in logic and that they employ verification and replication, using experimental and quantitative methodologies, whereas most of the social sciences and the humanities emphasize subjectivity and relativism and provide explanations through the use of qualitative methodologies. In order to properly understand how the biophysical environment relates to social processes, however, methods that consider both approaches are necessary. Quantitative and qualitative methods are broad terms that include a huge range of specialized topics and approaches. Quantitative and qualitative methods contribute to research on human-environment relations but have limitations when it comes to understanding nature-society problems; mixed methods are also employed in human-environment research.

QUANTITATIVE METHODS

Quantitative methods are based on the ability to measure reality and on the objective representation of reality through such measurements. Quantitative methodologies provide the means to test theory according to logical reasoning and to verify explanations grounded in value-free observations. Quantitative techniques allow for the projection of alternative pathways into the future, and to conduct experiments that test our understanding of key human-environment processes. Variables under these methods are related together empirically and they are analyzed through the extensive use of statistical approaches. Quantitative methods require operational definitions and formal language to interpret patterns between variables. Casual explanation and universal truth are the aspiration of such methods, and the results of empirical testing and statistical analysis are (or are not) backed by explanatory, law-like theories.

A quantitative study first identifies and defines research questions that are theoretically conscious and that can be tested empirically. To be theoretically conscious means that the researcher needs to be familiar with existing research about a specific topic; for instance, if the research question involves the social drivers of landscape change, then the researcher has available a large body of research findings in areas ranging from economic theories of human behavior to studies on the relations of cultural values and the environment. Under such an approach, therefore, knowing where and how to contribute to such a range of theories is critical.

Second, the components of the research question need to be measurable and susceptible to rigorous statistical analysis. Finally, once the research questions are at hand and appropriate data is obtained, it is important to define the way the data is analyzed. Data analysis is mostly of a statistical nature, ranging from descriptive statistics to advanced sta-

Differences in approaches in social and natural sciences are a barrier to work on human-environment problems.

tistical modeling. In general, statistics are applied to variables that represent a measurement of a social or environmental attribute. Certain attributes are straightforward to quantify within certain limits of certainty like human populations, incomes and most biophysical variables. Measurement of opinion and attitudes is possible through ranking, survey questions and structured observations including, for example, variables such as educational level and socio-economic status.

First of all, variables are analyzed through descriptive or inferential statistics. Descriptive statistics describe and summarize data showing the central tendency of the variables, for instance averages, mode and standard deviations. Inferential statistics provide a way to identify differences between groups, to look for relationships between variables and create models that allow simplification and the ability to make predictions (e.g., multivariate regressions, analysis of variance—ANOVAs). A very important part of statistical analysis is the ability to calculate the likelihood that a difference or a relationship between variables actually exists and that it is not the result of a random process or chance; this is referred to as the statistical significance level of a statistical test.

Quantitative methods aim to simplify the complexity of human-environment systems through the use of mathematical models. Models could be divided in theoretical and empirical models. Methods and data used in theory-based models test social and environmental theories through an evaluation of statistical relations between the explanatory variables and the question in place. These models can also provide predictions, or simulate outcomes of human-environment interactions. For example, when looking at the relation of plant invasions and agricultural practices in rural areas, a theoretical model will try to show the factors that affect the decision of a subsistence farmer to either continue cultivating an invaded agricultural plot or permanently abandon the plot and cultivate elsewhere. Using an agricultural household model of land-use choices and using data from a household survey, the model will test if households maximize utility subject to constraints on land, labor, and income

Empirical models attempt to fit socio-ecological variables to human-environment processes. For example, distance measurements such as distance of land parcels from roads fit spatial patterns of deforestation and provide better predictions from a statistical point of view; however, such variables might be too simplistic in explaining the social processes that lead to deforestation. Another example of empirical models is simulations; the goal of such models is to recreate a process with the use of a smallest number and the most critical variables possible. Sometimes better predictions will fall short in trying to explain the mechanism behind specific human-environment interactions.

Quantitative models have grown in complexity thanks in part to the increasing power of computers. In land change science, major advances have been possible through applying the sophisticated tools of geographic information systems (GIS) and remote sensing analysis. Such tools have been at the forefront of measuring environmental changes and relating them to social processes in a spatially explicit manner.

Traditional statistical methods are of limited use in a quantitative approach. They rely on replicates, homogeneity, randomness, normal distributions, and controlled experiments. Finding such characteristics in human-environment systems is rare and adequate samples in the real world are very difficult and require enormous resources and ways to prioritize research questions. Human-environment relations are often complex, non-random, non-normal, and non-replicable and—oftentimes—they go against traditional statistical assumptions. To solve such issues, researchers are beginning to consider human environment systems as complex systems and to apply different sets of methods. Studies in complex systems use dynamic modeling as their primary methodological approach. Dynamic modeling includes feedback processes and the adaptation of human environment relations and it looks for common underlying structures despite the apparent differences within a given system. The goal of dynamic models is to define the general structure and behavior of complex systems through mathematically complex relations with the use of high-level computer assistance. There has been quite an increase in the use of dynamic modeling looking at human-environment systems, and most of the techniques had been borrowed from climatic and ecological modeling where dynamic models have been successful at explaining mechanisms of how atmosphere, ocean, and land are related.

A recent and growing methodology that incorporates the dynamics of social, economic and ecological systems is agent-based models. These models are characterized by a combination of a cellular automata model representing the landscape of interest with an agent-based model that represents decision-making entities. Agent-based models claim to be extremely flexible about the representation of heterogeneous decision makers, who are potentially influenced by interaction with other agents and with their natural environment. These models aim to represent the interaction of complex decision making with a complex natural environment. The major weakness of such methods lies in the difficulty of standardizing and finding general mechanisms in social processes, which make it seem, therefore, that there is a particular mathematical dynamic model for each defined human-environment system.

Quantitative approaches tend to look at the dynamics of human-environment relation as the result of the links to various components of the human-environment system. In order to understand such dynamics, the social and natural system must be documented and analyzed. Once the pieces are understood, they should be linked with the use of models that incorporate the complexity of the interactions. For example, in understanding the processes of land use and cover change, a quantitative approach will look at the socioeconomic conditions, based on studies of land-use history and current land-management practices shown in household surveys; spatial landscape conditions, based on remote sensing and GIS analysis of past and current distributions of land covers; and environmental conditions, based on ecological transects and landscape ecology metrics. Once the pieces are understood they are linked in land-change models to explain current land changes and predict scenarios of such changes in different regions. What is critical in this approach is the need to assess the coupled human-environment system as a whole rather than as an assemblage of isolated major components.

QUALITATIVE METHODS

Qualitative methods emphasize the interpretive, value-laden, contextual, and contingent nature of knowledge produce by social and natural sciences. Studies through a qualitative approach attempt to make sense of human-environment relations in terms of the meanings people bring to them. These methods reveal the way different practices make the world visible. At the core of qualitative research is the interpretation of the world through observers; information is collected through field notes, interviews, and conversations. Qualitative research, in contrast to quantitative research, stresses the socially-constructed nature of reality, the relations of the subject and object of study, and the limits to knowledge. Examples of such methods are participatory observation, ethnographic methods, and historical analysis. Such methods have been commonly used by anthropologists, historians, and geographers of various social theoretic standpoints (e.g., feminism, post-structuralism, and postmodernism).

Representative qualitative methods looking at human-environment linkages are case studies, participatory observation, and discourse analysis. Case studies have been largely used by researchers interested in understanding human-environment relations. Case studies are defined as depth studies whose goal is to identify and describe the complexity of the linkages between humans and the environment before trying to analyze them and theorize about them. Their objective is to understand the case rather than generalize from it. Case studies can be seen as a methodology that allows for the use of combined methods. The weakness in the use of multiple methods to explore human-environment problems is in that it is not possible to generalize statistically from the case study to the population as a whole.

Case studies are common when looking at the relation of rural communities to environmental change such as deforestation, land degradation, or climate change. Through several case studies, deforestation can be shown to be the result of complex interactions of the behavior of farmers, political economic forces, and ecological processes that are intertwined in producing specific patterns of deforestation in a particular region. The ways variables relate are different from one study to another depending on the region; for instance, deforestation in the Brazilian Amazon is a large-scale forest conversion and colonization for livestock-based agriculture, whereas regions in Africa show patterns of deforestation related to cropland expansion by small landholders, and which are the result of changes from pastoralist to sedentary agriculture. Case studies identify the differences and uniqueness that result from the interaction of a set of variables, and explanations derived from case studies are often criticized for their inability to generalize beyond the particular case.

Methodologies involved in participatory observation generally lack a specific design of how the information is going to be collected. The researcher, in this case, has to go with the flow of social action that unfolds as the study progresses. This type of methodology requires a significant amount of time spent in the field becoming familiar with the subjects of the study, collecting data, understanding social and cultural meanings for people in situ, and representing the social world in which people live and interpret their lives. Information is collected through field diaries and open ended questionnaires.

Discourse analysis is concerned with the investigation of language and the way knowledge is produced and communicated, particularly what is regarded as truth in relation to power relations in society. It focuses primarily, but not exclusively, on language processing (linguistics), and criticizes the notion that language is transparent or neutral. Discourse analysis is particularly critical of the claim of scientific knowledge to universality, objectivity, and neutrality. The objective of discourse analysis is to reveal the socio-historical situation of how knowledge is constructed and how texts or other social representations (e.g., mass media) are produced. Discourse analysis looks at how different realities, representations and imaginations relate to each other in producing or changing conceptions of human-environment relations. For instance, the analysis of the discourses on global environmental change evaluates how scientific knowledge is produced and analyzes the relation of dominant forms of knowledge to environmental politics that construct different regions in terms of their importance in global climate change, like the Arctic or the Amazon basin.

MIXED METHODOLOGIES

The use of mixed methods has become increasingly popular due to the ability to gather and represent human-environment phenomena with numbers as well as with words. These methods combine different kinds of data collection and analysis and sometimes different types of research design within the same study. If quantitative methods and qualitative methods involved a wide range of approaches, with mixed methods the possibilities increase. Mixed methods aim to illuminate statistical findings with case studies, or generalize from case studies using quantitative methods while representing graphically elements in terms of their heterogeneity and context.

Combining numerical and tabular data with some sort of narrative provides a valuable contribution to the understanding of human-environment relations. For example, land degradation from a natural sciences perspective will show the decrease in soil fertility and its effects on microclimate, but interviews and participatory observation will show the way farmers adapt through changes in land management practices and how such changes in fertility really represent degradation or not.

The Resilience Alliance (a multidisciplinary research group that explores the dynamics of complex social-ecological systems in order to discover foundations for sustainability) provides an interesting example in terms of integrating methodologies when addressing human-environment linkages. The proposed methodologies to be used by a recent research program looking at the role of water in sustaining resilience in social and ecological systems that are characterized by agricultural land use and that are vulnerable to water changes consist of formal mathematical models looking at water cycles; participatory approaches to stakeholder-driven analysis of particular regions (case studies); informal group analyses; agent-based models; Bayesian Belief Networks; historical profile analysis and scenario development. The goal is to compare the case studies and develop controlled experiments in the laboratory and the field on interactions between individuals, institutions, and their common resources.

Among the examples of how combined methods provide a complete understanding of human-environment relations is research looking at land change, which has been a pioneer in the use of combined methodologies. Landscape is seen as a coupled human-environment system, created by and with consequences for the interactions among human and biophysical subsystems creating it. People-pixel methods combine social data (people) with biophysical and remotely sensed data (pixels). The approach could be either to understand the biophysical process and the spectral signature to the use of social science data, or to understand social processes through the resulting patterns from remote sensing analysis. Difficulties, however, still arise when social, biophysical and geographical data are subject to differences in cartographic structures, space and time scales, and units of measurement. This challenge seems to be more conspicuous when linking remote sensed data and social data at the local or micro level. There is not an overarching theory or formulae in how people and land should be linked; on the contrary, such links should be designed differently in different settings and should be responsive to the needs and conditions of such variations.

Another example of combined methods comes from recent research in political ecology that produced methodologies that reconcile concerns with the subjectivities of human actors with quantitative methods in order to produce an objective understanding of environmental and social relations. Specific examples exist in integrating conventional positivist methods and traditional, local environmental knowledge arrived at usually through participatory techniques and oral histories. Rocheleau, for instance, provides an example of how mixed methods illuminate a better understanding of how gender relationships within households in the Dominican Republic shape environmental and economic change locally and nationally. Using a feminist approach, the study questions the objectivity of forestry programs and provides an explanation of how women are key participants in such programs. It invokes quantification in order to gain legitimacy through an analysis that shows the magnitude and distribution of gender differences, the understanding of landscapes, livelihood systems, and ecologies. Still, most nature-society research is approached in terms of either social/qualitative methods or scientific/quantitative methods.

Differences in methodological approaches from social and natural sciences could be considered one of the barriers to addressing human-environment problems. It is important to recognize the conflicts that exist within the social sciences, in similar fashion to those existing between natural scientists and humanities. For example, the economists' use of optimization models that reflect a profit maximizing behavior contrast with narratives explaining how culture and value systems affect human choices used by anthropologists and sociologists. Methods in economics then seem to be closer to those of the natural sciences, a reason for why we see integrated methods develop through ecological economics differently from integrated methods in political ecology or ecological anthropology. Overall, epistemological barriers need to be resolved among the disciplines to approach environment-society questions in a more holistic manner.

SEE ALSO: Geographic Information Science; Land Use and Cover Change; Political Ecology; Remote Sensing.

BIBLIOGRAPHY. N.K. Denzin and W. Lincoln, ed., *The Landscape of Qualitative Research: Theories and Issues* (SAGE, 2003); J.C. Green, H. Kreider, and E. Mayer, "Combining Qualitative and Quantitative Methods in Social Inquiry," in B. Somekh and C. Lewin, eds., *Research Methods in the Social Sciences* (SAGE, 2005); G. Gutman et al., *Land Change Science: Observing, Monitoring, and Understanding Trajectories of Change on the Earth's Surface* (Kluwer Academic Publications, 2004); D.C. Parker, T. Berger, and S.M. Manson, "Agent-based Models of Land-Use and Land-Cover Change," *LUCC Report Series No. 6* (v.124, 2001); R.R. Rindfuss, S.J. Walsh, and J. Fox, "Linking Household and Remotely Sensed Data," in J. Fox et al., eds., *People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS* (Kluwer Academic Publishers, 2003); D. Rocheleau, "Maps, Numbers, Text, and Context: Mixing Methods in Feminist Political Ecology," *The Professional Geographer* (v.47, 1995); B. Somekh et al., "Research Communities in the Social Sciences," in B. Somekh and C. Lewin, eds., *Research Methods in the Social Sciences* (SAGE, 2005); B. Walker et al., "Resilience, Adaptability and Transformability in Social-Ecological Systems," *Ecology and Society* (v.9, 2004).

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Reserves (Conditional, Hypothetical, and Proven)

THE TERM *RESERVES* refers to the known and estimated amounts of resources (mineral or hydrocarbon) that remain for later exploitation. Oil reserves are specifically statements reporting calculations of the amount of petroleum existing in the world. Strictly speaking, the only oil reserves are those that have been pumped from the ground and are currently in a container vessel somewhere. The amount is measured in tons or barrels, a 19th-century measure still being used from the days when oil was shipped in wooden barrels. All other measures of reserves of oil that are still in the ground are estimates. The reason for this is because the oil that is still in the ground is hidden from view. However, the means for estimating the amount of oil have developed over the years with good reliability. The terms used to estimate oil resources are proven reserves, conditional reserves, and probable reserves. The latter are hypothetical reserves or at times speculative reserves. These measures are dependent upon a number of possible factors.

Proven oil reserves are estimates of the amount of petroleum that can be pumped from fields that are known and have been explored. Proven reserves in a new prospect increase as the field is explored and developed. The amount of oil in the field will always be much more than the amount that can be recovered. As the field is exploited it "ages" and eventually produces less and less oil at the current price of oil. Proven reserves are calculated by multiplying the length of the field by the width of the field by the thickness of the field by it porosity and by its expected percentage of recovery. All the oil in a proven field is rarely extracted. It is a very highly productive field if 50 percent of the oil is recovered. About 30 percent of the oil from a field is extracted by pumping. An additional 10 percent can be extracted by "secondary methods" such as pumping with water or gas under high pressure. A final 10 percent can be recovered with tertiary methods that heat the oil.

Indicated reserves are the portion of the oil resource in a field that is known from exploration and the amount that may be extracted with improved recovery techniques. Another term is *field growth* (or *inferred reserves*), which is that part of a field that is greater than the proven portion of the field. It is the difference between the proven reserves and those added to a field from further discoveries on the margins of the field and from improved recovery.

Conditional reserves are known resources whose recovery is not currently economically feasible. Conditional reserves are estimates of the size, number, or volume of oil that may exist in an area, assuming that anything is actually present. Conditional estimates, therefore, do not incorporate the risk that the area may be devoid of oil. In other words, conditional estimates are assumptions that oil is there and how much is there, but without any sure knowledge. Proven reserves as a figure are mushy because they usually come from national governments. The governments in third world countries may have political or ulterior motives for overestimating or underestimating their oil reserves.

HUBBERT'S PEAK

Some geologists and oil engineers use a method for estimating the amount of oil globally as the ratio of the known reserves to the rate of production, which is expressed as R/P. In the 1950s Dr. M. King Hubbert developed a model for estimating the amount of oil in the world. He argued that as the amount of oil discovered is matched by the amount of oil recovered, a peak in production would eventually come, followed by a rapid decline. The peak is now called Hubbert's Peak. Estimates of oil discovery and consumption have generally not been completely accurate.

After the verification of Hubbert's Peak for oil production in the United States, there was a steady decline in American production in the early 1970s. However, the efforts of the Organization of Petroleum Exporting Countries (OPEC) to set the price of oil stimulated a global search for oil in which many new sources have been found, increasing the proven reserves globally. About two-thirds of the known reserves are in the politically unstable Middle East. The demand for oil is still increasing, which is pushing companies to search ever deeper under the sea or in ever more remote locations.

HYPOTHETICAL RESERVES

Hypothetical reserves are speculative reserves. They are resources that are thought to be there, but are not yet proven. For example, it is believed that there is more oil in the Gulf of Mexico, but some areas have never been drilled, so there may or may not be oil. Many a dry hole has been drilled in locations that were thought to contain oil. The global estimate of the crude oil existing in the world is two trillion barrels. One trillion barrels are estimated to be in proven reserves, with much of that in the Middle East.

However, geologists have estimated that there are two trillion barrels of oil in oil sand tars in Canada alone. Sand tars are deposits of bitumen that are trapped in sandstone or unconsolidated sands. In addition, there are at least two trillion barrels of oil that are trapped in shale in the United States alone, according to some geologists. Shale is a fine-grained sedimentary rock that in the case of oil shale contains kerogen, which can be distilled to produce liquid hydrocarbons or gaseous hydrocarbons that can be converted into gasoline or other products.

SEE ALSO: Energy; Fossil Fuels; Mining; Oil Spills; Organization of Petroleum Exporting Countries (OPEC); Petroleum.

BIBLIOGRAPHY. C.P. Cozic, *Global Resources: Opposing Viewpoints* (Greenhaven Press, 1998); K.S. Deffeyes, *Hubbert's Peak: The Impending World Oil Shortage* (Princeton University Press, 2001); K.S. Deffeyes, *Beyond Oil: The View from Hubbert's Peak* (Farrar, Straus, and Giroux, 2005); David Goodstein, *Out of Gas: The End of the Age of Oil* (W.W. Norton, 2005); Richard Heinberg, *The Party's Over: Oil, War and the Fate of Industrial Societies* (New Society Publishers, 2005); P.W. Huber and Mark Mills, *The Bottomless Well: The Twilight of Fuel, the Virtue of Waste, and Why We Will Never Run Out of Energy* (Basic Books, 2005); W.F. Lovejoy and P.T. Homan, *Methods of Estimating Reserves of Crude Oil, Natural Gas, and Natural Gas Liquids* (Resources for the Future, 1965); Leonardo Maugeri, *The Age of Oil: The Mythology, History and Future of the World's Most Controversial Resource* (Greenwood Publishing, 2006); Paul Roberts, *The End of Oil: On the Edge of a Perilous New World* (Houghton Mifflin, 2005); M.R. Simmons, *Twilight in the Desert: The Coming Saudi Oil Shock and the World Economy* (Wiley, John & Sons, 2005).

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Reservoirs

RESERVOIRS ARE ARTIFICIAL lakes that are created by building a dam with advanced construction technologies. The construction of such dams and reservoirs usually have four key objectives: flood protection and control, secure navigation, providing water for irrigation and for urban population, and generating electric power.

Major infrastructure projects such as building reservoirs and related structures are often supported in dictatorships, especially in communist regimes. As a result of accelerated industrialization and energy inefficiency, such economies seek new power sources. Arguments regarding the creation of reservoirs cover cultural, political, and environmental issues. General concerns are that such reservoirs interfere with nature and the enormous costs are a burden to the economy. Specific issues may arise concerning ground water, natural environment, agriculture, and fisheries in the area. Hydrologists are concerned with long-term impacts on habitat, water levels, water pollution, drinking water, and water tables. However, the supporters of the reservoirs emphasize the future benefits of the control of floods, secured river navigation, cheap and renewable energy, water intake for irrigation and for drinking water, and a possibility for holiday resort upon the water surface.

Some dams and reservoirs have generated a great deal of controversy, such as those along the Colorado River. There the Glen Canyon, Hoover Dam, Parker Dam, Davis Dam, Palo Verde Diversion Dam, and Imperial Dam projects provide life-sustaining water for irrigation, drinking, and other uses for communities in the arid American southwest. One of the largest reservoirs is Lake Powell. This controversial project was created by the Glen Canyon Dam. The area of the lake and around it became the Glen Canyon National Recreation Area, a now popular summer destination. Lake Powell is arguably the most scenic lake in America, situated in some of Southern Utah's most beautiful desert country.

Lake Nasser in Egypt is one of the largest and most controversial artificial lakes in the world. The reservoir was created by two dams straddling the river. The objectives were to prevent the river's flooding, generate electricity, and provide water for agriculture. The idea of the reservoir emerged in the 19th century and the British completed the construction in 1902. To create more adequate protection against floods planning for a new dam began in 1952. During the construction significant amounts of nonrefundable loans, design, engineers, and machinery were provided by the Soviet Union.

Along with the construction, an international debate arose concerning the negative effects of the project. Over 90,000 people were displaced, Lake Nasser flooded valuable archeological sites, and the silt that made the Nile floodplain fertile was held behind the dam. Silt deposited in the reservoir is lowering the water storage capacity of Lake Nasser, poor irrigation practices are waterlogging soils, and there is resulting salinization. Mediterranean fishing declined after the dam was finished because nutrients that used to flow down the Nile to the Mediterranean were trapped behind the dam. The need to use artificial fertilizers is causing further pollution. Indifferent irrigation control has also caused some farmland to be damaged by waterlogging and salinity, a problem complicated by the reduced flow of the river, which allows salt water further into the delta. The eastern basin of the Mediterranean is low in fertility because the marine ecosystem depended on the rich flow of phosphate and silicates from the Nile.

One of the many communist reservoir-dam projects was the infamous Gabcikovo-Nagymaros complex. The idea was taken up in 1952 by the Czechoslovakian and Hungarian governments, and an agreement was signed in 1977. However, in the early 1980s, significant opposition began to grow in Hungary. Engineers, environmentalists, and politicians brought forth complex and scientific arguments. By the end of the 1980s, groups opposing the dam and reservoir had become significant citizen movements. One of them, the Danube Circle, organized a scientific conference along with the World Wildlife Foundation and called for a mass demonstration where about 30,000 people participated in front of the parliament. At the same time, a campaign to collect signatures intensified, and over 140,000 signatures were presented to the parliament at the end of February 1989. Eastern Europe has never seen larger environmental protests before or since.

SEE ALSO: Colorado River; Dams; Electricity; Fisheries; Habitat; Hoover Dam; Lakes; Mediterranean Sea; Movements, Environmental; Russia (and Soviet Union); Three Gorges Dam; United States, Southwest (Arizona, Nevada, New Mexico, Utah); Waterlogging; World Wildlife Fund.

BIBLIOGRAPHY: John Fitzmaurice, *Damming the Danube: Gabcikovo and the Post-Communist Politics in Europe* (Westview, 1998); Sanjeev Khagram, *Dams and Development: Transnational Struggles for Water and Power* (Cornell University Press, 2004); Patrick McCully, *Silenced Rivers: The Ecology and Politics of Large Dams* (Zed Books, 2001).

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Resilience, Ecological

NATURAL SYSTEMS ARE dynamic, complex, and interdependent. *Ecological resilience* describes the amount of change such a system can undergo and still remain within the same state. This definition is also referred to as *engineering resilience*, since it concentrates on stability at a presumed point of equilibrium, resistance to a disturbance, and the speed of return to equilibrium.

As applied to ecosystems, or to integrated systems of people and the natural environment, ecological resilience therefore has three defining characteristics: the amount of change a system can undergo and still retain the same controls on function and structure, the degree to which a system is capable of self-organization, and the ability to build and increase the capacity for learning.

The key concepts to explain ecological resilience are nonlinearity, adaptive cycles, panarchy, adaptability, and transformability. Nonlinearity can be illustrated by a ball in a basin. The state of this two-dimensional system is the ball. Its dynamics cause it to move to the bottom of the basin. The system can change regimes either by the state changing, or through changes in the shape of the basin.

Ecological systems are never static, and they tend to move through four recurring phases, known as *adaptive cycles*, the second key concept. Generally, the pattern of change is a sequence from a rapid growth phase (exploitation) through a conservation phase in which resources are increasingly unavailable, followed by a release phase that quickly moves into a phase of reorganization, and then into another growth phase. For example, a tropical rain forest may be afforested, established, destroyed by a fire, then regrow again. Multiple possible transitions among the four phases are possible and the pattern may not reflect a cycle. The growth and conservation phases together constitute a relatively long developmental period with fairly predictable, constrained dynamics; the release and reorganization phases constitute a rapid, chaotic period during which capitals (natural, human, social, built, and financial) tend to be lost and novelty can succeed.

The third element is panarchy. Adaptive cycles never occur only on one scale, but all systems exist and function at multiple scales of space, time, and social organization, and the interactions across scales are fundamentally important in determining the dynamics of the system at any particular focal scale. This interacting set of hierarchically structured scales has been termed a *panarchy*.

Fourth, adapatability is the capacity of systems to alternate regimes (sometimes called adaptive capacity). It involves either or both of the following two abilities: The ability to determine the trajectory of the system state (the position within its current basin of attraction), and the ability to alter the shape of the basins, that is, move the positions of thresholds or make the system more or less resistant to perturbation. The abilities to affect both of these are determined by a combination of attributes of both the social domain and the ecosystem.

The fifth and final key concept of ecological resilience is transformability. In cases where a system is already in an undesirable regime and efforts to get it back into a desirable regime are no longer possible (or worse, make the undesirable basin larger), one option for resolving the predicament is transformation to a different kind of system—new variables, new ways of making a living, different scales—a different panarchy.

Although all natural systems are inherently resilient, since they can withstand shocks and rebuild themselves when necessary, resilience can be reduced if disturbances become greater than they can handle. And even in the absence of disturbances, gradually changing conditions, such as nutrient loading, climate, or habitat fragmentation can surpass threshold levels, triggering an abrupt system response. When resilience is lost or significantly decreased, a system is at high risk of shifting into a qualitatively different state. The new state of the system may be undesirable, as in the case of productive freshwater lakes that become eutrophic, turbid, and depleted of their biodiversity.

As an example, coral reefs are spectacular marine ecosystems known for their diversity of eye-pleasing fish and corals. In the Caribbean, overfishing and increased nutrient loading from land water runoff is believed to be responsible for declines in herbivorous fish populations which allowed the sea urchin *Diadema antillarum* to dominate the coral reefs. In 1981, a hurricane severely damaged the coral reefs. The sea urchin continued to graze on the algae, which allowed the coral to recolonize the reefs. In subsequent years, the urchin was hit hard by a pathogen and, as a consequence, was no longer in a position to control the algae. Fleshy brown algae came to dominate the reefs. The adult algae that now cover the reefs are largely unpalatable to the remaining herbivores, which serves to keep the reefs in this state of algal dominance.

Restoring a system to its previous state can be complex, expensive, and sometimes impossible. The key to resilience is diversity. Biodiversity plays a crucial role by providing functional redundancy. For example, in a grassland ecosystem, several different species will commonly perform nitrogen fixation, but each species may respond differently to climatic events, thus ensuring that even though some species may be lost, the process of nitrogen fixation within the grassland ecosystem will continue.

SEE ALSO: Conservation; Biodiversity; Biosphere; Coral Reefs; Disequilibrium; Equilibrium; Eutrophication; Habitat; Redundancy, Ecological.

BIBLIOGRAPHY. S. Carpenter et al., “From Metaphor to Measurement. Resilience from What to What?” *Ecosystems* (v.4, 2001); G.H. Gunderson, “Ecological Resilience—In Theory and Application,” *Annual Review of Ecology and Systematics* (v.31, 2000); L.H. Gunderson and C.S. Holling, eds., *Panarchy. Understanding Transformations in Human and Natural Systems* (Island Press, 2002); C.S. Holling, “Resilience and Stability of Ecological Systems,” *Annual Review of Ecological Systems* (v.4, 1973); C.S. Holling, “The Resilience of Terrestrial Ecosystems. Local Surprise and Global Change,” in *Sustainable Development of the Biosphere* (Cambridge University Press, 1986); M.S. Scheffer et al., “Catastrophic Shifts in Ecosystems,” *Nature* (v.413, 2001).

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Resource Conservation and Recovery Act (RCRA)

WIDESPREAD POLLUTION OF water has become a major problem throughout the world and waste disposal has always been a serious cause of pollution. Often, the places where people used to think it was safe to swim or to use the water for drinking were no longer safe. Due to the seriousness of the environmental damage, the U.S. Congress passed the Solid Waste Disposal Act in 1965 to improve the methods of managing waste disposal, but it was found to be inefficient and was amended by the Resource Recovery Act; this act as well yielded weak results over time. Congress finally took stronger measures and enacted the Resource Conservation and Recovery Act (RCRA) in 1976 to safely manage and dispose of massive amounts of municipal and industrial waste by empowering the Environmental Protection Agency (EPA) to regulate waste disposal and cleanup. The RCRA was efficient in dealing with waste management because it processed the waste from the point of origin to the point where the waste was being disposed.

The goal in enacting the RCRA was to protect the nation’s waters by cleaning up any spilled or leaked waste. The act also worked in a way to eliminate or reduce certain waste from getting into the environment. RCRA is not only responsible for taking care of large-scale toxic wastes but is also in charge of municipal wastes. It involves related federal and state agencies in waste management and coordinates them to achieve better results.

In 1998 the RCRA Orientation Manual was published and the RCRA program set out within the document has been evolving ever since. The RCRA manual covered different areas such as solid waste management and management of hazardous waste. The measures of the RCRA require not only coordination among federal and state agencies such as the EPA’s Office of Solid Waste, Emergency Response, EPA Regional Organizations, and state waste and environmental departments, but also the industries and businesses regulated by the RCRA, and the general public.

The RCRA also manages and establishes control measures for underground storage tanks for waste management. Normally, these underground storage tanks contain petroleum or very hazardous substances that are dangerous or flammable; the mere act of burying the substances does not render them 100 percent safe, so the tanks must be well constructed and maintained so that they provide adequate safety while operating. Those who own underground storage tanks must secure loads in order to comply with the environmental regulations. There is no guarantee that the underground storage tanks will not leak, so Congress amended RCRA in 1986 to create the Leaking Underground Storage Tank (LUST) Trust Fund to facilitate and clean up any leakage of the underground storage tanks.

Solid wastes are defined as abandoned or recycled materials that are considered useless, but industries and businesses are increasingly encouraged to reuse recoverable solid waste as much as possible. It must be determined first if the recycled materials are RCRA-regulated or not before being processed, since that would establish guidelines for their handling. Hazardous waste has four types: ignitable, corrosive, reactive, and toxic. These wastes have to be tested for toxicity in order to determine characteristics. In order to recycle hazardous waste efficiently and safely, measures within the RCRA facilitate the proper management of commonly recycled waste streams. The EPA's Office of Solid Waste (OSW) is responsible for reducing waste by conserving resources and preventing future waste disposal problems by establishing regulations and having all leakage and waste areas cleaned up.

In spite of the government organizations that have been created to protect the environment, public involvement is just as important. As part of the RCRA's measures, communities play a major role by involving and educating all the citizens who participate in different programs administered by the EPA.

SEE ALSO: Environmental Protection Agency; Green Production and Industry; Pollution, Water; Recycling; Waste, Solid; Underground Storage Tanks.

BIBLIOGRAPHY. U.S. Department of Energy, "Resource Conservation and Recovery Act," www.eh.doe.gov (cited April 2006); U.S. Environmental Protection Agency (EPA), "Basic Information: The Office of Solid Waste (OSW)," www.epa.gov (cited April 2006); U.S. EPA, "RCRA Online," www.epa.gov/rcraonline (cited April 2006).

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Resources

RESOURCES, TRADITIONALLY MEANING natural resources, are at the center of many aspects of our economies, societies, and environmental concerns. Before there was environmental management, there was natural resource management, and indeed some of the resource management professions such as forestry, mining, and wildlife management go back thousands of years, with significant texts going back at least several centuries.

A resource is basically something useful to people and their societies and economies. Resources have always been used by human societies, and arguably even nonhuman societies to a limited degree. What has changed over time and space is the variety of resources used and the magnitude of resources extracted from natural systems and consumed. As the majority of human societies have moved from exclusively hunter-gatherer economies through agricultural to industrial and now a globalized industrial economy, their consumption of an ever greater range of resources has increased exponentially, along with the production of wastes from production and consumption. The history of these changes is a vast and sometimes contentious topic, but clearly it has been catalyzed in complex and interdependent ways by settlement; science and technology of many sorts, but especially transportation, energy, and communication; population growth; and social and cultural changes and developments. Human societies almost everywhere on the globe today, albeit to varying degrees, are linked by flows of resources, goods, labor, and information that greatly supplement the resources available locally.

An important feature of resources is that they represent a wide variety of things that are valued, needed, and wanted by societies at any particular time and place. In 17th- and 18th-century North America, the great forests of the continent were mostly cursed by European fur traders and even early settlers because they impeded travel and had to be cleared for agriculture. A century later, they were found to be of great value for export to Europe and for use in the growing, industrializing cities of eastern North American and the Great Lakes Basin. Similarly, many minerals had little value until industrial processes developed to use them, such as petroleum products in the late 19th century, or uranium well into the 20th century. Other minerals, of course, such as iron, copper, gold, and coal, were traded and used for millennia by Greek, Roman, European, Asian, and American aboriginal societies.

Of course the things generally considered to be resources are usually also parts of the earth's biophysical systems, of ecosystems, or food webs, or biogeochemical cycles. Some would ascribe a value to that as well, whether again anthropocentric as when we speak of the economic arguments for conserving biodiversity or maintaining essential ecological life services as in the Millennium Ecosystem Assessment, or ecocentric in terms of intrinsic value. Before returning to these issues, it is necessary to discuss what resources are in a bit more detail. Natural resources can be grouped or classified in a range of ways. Common ones include types or sectors of resources, renewable/nonrenewable, discrete/continuous, flow/stock, and public/private.

CATEGORIES OF RESOURCES

The most common sectors or categories of resources are water, air, land, agriculture, and food, minerals and fossil fuels, energy, fish and wildlife, forests, recreation, and population or human resources. Of course there are overlaps between these categories, in theory and in practice, and some are arguably more fundamental or critical than others. Water resources include freshwater and marine. Both are significant for navigation, recreation, and biodiversity, including fisheries; and freshwaters of course are critical to human individual survival and often industry. Both fresh and marine waters are subject to pollution threats, and freshwater resources face quantity threats from overuse as well. Air or atmospheric resources are equally critical to human and other life, playing a range of essential roles in biological and physical processes from respiration and photosynthesis to weather and climate regulation. Pollution of various kinds is the principal threat. Land resources are highly diverse, and relatively scarce compared to (salt) water. They support terrestrial life, and are crucial to a wide range of other resources, notably agriculture, and economic activities such as mining and land development. Land can be contaminated and ruined from a soil fertility perspective, and in places of high demand can be in short supply.

Agriculture and food resources are clearly central to human societies and sustainability. They include good soils and sites, and crop varieties including domesticated and wild progenitors. Agricultural resources are vulnerable to soil degradation, pollution and climate change, conversion to other uses, especially urban, and loss of diversity. Range, ranch, or grazing, resources may be a subset of agricultural resources, or sometimes singled out for discussion. They are of particular interest in terms of often complex mixes of public/private ownership and their joint significance to both local individuals or communities and to corporate interests.

Minerals are a very broad category that includes the typical metals like gold, iron, and copper; energy-related elements such as uranium, and even fossil fuels in some classifications; and nonmetal minerals such as salt, potash, and sand and gravel, used in industry and construction. Minerals, as the mining industry likes to point out, are central to almost every aspect of modern economies and societies. While actual mineral extraction directly impacts small areas, temporarily, the indirect effects of water and air pollution from extraction, processing and refining are often significant and contentious. Energy resources are equally central to human activity, and include minerals such as coal, oil, natural gas (fossil fuels), nuclear, and also numerous other renewable energy sources, from biomass to solar, wind, tidal, and geothermal.

Fish and wildlife are resources of significance from ecosystem and biodiversity perspectives, as sources of wild and domesticated food for people, and for their roles in recreational activities as well. Both are vulnerable to overexploitation and habitat loss, and fish, especially, to pollution. Forest resources are also central to societies and economies in many ways: to biodiversity; to ecosystem services such as runoff and flood control, CO_2 sequestration and climate moderation; to production of timber and pulp and paper, and numerous nontimber forest products in various parts of the world. Forest resources are vulnerable to overexploitation, pollution, conversion to agriculture and climate change. In many places, forests are also used for recreation, along with water and coastal areas, fish and wildlife, and human, built resources such as recreation facilities.

Population can also be seen as a resource, in terms of labor, knowledge and progress. The relationships of people, and population, to resources and environment is a huge topic but obviously significant. People and population create environmental problems, through production and consumption activities, but can also contribute to solving problems through their actions, knowledge, and inventions. At the least it must be recognized that population as such interacts with resources and environment through products, technologies, and lifestyles which can vastly multiply their consumption of resources and environmental impact (e.g., internal combustion engines and nuclear power versus walking or windmills) or reduce it (e.g., solar voltaics and high efficiency building design).

There are also other resources that are cultural such as folklore, history and music, and built or human-made resources such as heritage buildings, but these are beyond the scope of this article.

Other categories of resources span across these, and often reflect human interactions with resources. First, we divide resources into renewable and nonrenewable. Renewable resources are, at least in principle, renewable after we use them. Fish and wildlife, water and air, forests, agriculture, and food resources fall into this category. They grow and replace themselves within a reasonable timeframe from a human perspective. Nonrenewable resources do not replenish themselves. Minerals, coal, oil and natural gas are the prime examples which are replaced only on geological timescales. Some groundwater resources in deep aquifers also have very long replenishment times. It is, of course, possible to use renewable resources faster than they can be renewed, and then we commonly say we are mining them. Some renewable resources are more properly infinite or perpetual, at least under any reasonable assumptions, such as solar energy or air; other renewables can be said to be infinite as long as harvesting rates are below their rate of replenishment. Nonrenewable and overexploited renewable resources are finite (even if, in some cases, very, very large).

From a management perspective we also distinguish discrete and continuous resources. The former, such as wildlife, forests, and mineral deposits are distinct and bounded. Continuous resources such as air, and for practical purposes rivers and oceans, are not readily bounded and defined. Continuous resources are, of course, much harder to manage than discrete. Land falls somewhere in between, and while continuous over great areas, is readily measured and divided up—which has been a major part of the human conquest of nature and resources.

The consideration of renewability of resource use and ownership of resources falls under resource management. The need for management can be seen as deriving from scarcity, real or perceived: the belief there are not enough resources to meet all actual or potential demands on them. Of course early, and even classical modern, economists have seen natural resources as unlimited, or at least not limiting relative to the other economic resources of labor and economic capital. The great exception was Thomas Malthus who argued that population would increase exponentially while resource availability was ultimately finite and at best availability could only increase linearly—thus society was headed for collapse. Malthus was certainly a pessimist about human adaptability, learning, and technological inventiveness, but his basic point is good. Garret Hardin's 1968 argument about the Tragedy of the Commons, and his later lifeboat ethics drew on this perspective to emphasize the perils of what we would now call open-access resources, and the need for resource ownership, management, and control.

OWNERSHIP AND ACCESS

Building on some of these ideas, private, public, common, and open access resources are distinguished. Private resources are those owned and managed by individuals or organizations, often corporations or nongovernmental organizations. One way or another such resources must have been made discrete: definable and boundable in order to be assigned to an owner. Public resources are usually those owned by governments, to a greater or lesser degree for the public interest. In many countries there are large areas of land, forest, and water that are owned and managed by governments. Rights to use these resources are often sold to private interests, as in forestry and mining, but ownership remains with government. Generally, it is national and provincial or state governments that have the greatest role in resource ownership and government, although local governments can have a role within their lands. And international agreements can define roles for international or transnational agencies and instruments.

Common resources, sometimes confused with public and open access, are resources owned in common by communities or other groups of people, and whose use is usually governed by traditional, local cultural practices and beliefs in a sustainable way. Open access resources are just that: Owned and managed by no individual organization, and therefore free for the taking by whoever gets to them first. There are very few true open access resources, perhaps closest are the high atmosphere and the high seas.

Common property resources are ever diminishing as their management regimes are vulnerable to disruption by government economic, political, and land policies. While there can be little doubt the global trend is toward public and private ownership of resources, there are often not completely clear distinctions between them, as governments often retain some rights in relation to privatized resources (water, forests and minerals are often particularly complex this way).

The need for and benefits of private ownership of resources have long been a subject of debate. On the one hand, following Hardin and earlier political economic philosophers, private ownership is seen as encouraging careful management and stewardship, in contrast to open access, common, or even government regimes of misuse and mismanagement. The other side of the argument is that under economic policies of significant discount rates and poor internalization of resource development externalities, and limited regulation of resource development, private resource owners have incentives to develop resources faster than in the long-term public interest, without enough incentives to minimize local and global impacts of resource development.

At the extremes these positions are highly conflicted and influenced by deeper political views of the role of government and markets. The American "wise use" and "takings" movements and controversies are examples of very strong private property movements that oppose any substantial government control of resource development at levels from the local to the international.

More moderate debates focus on the relative roles of markets for resources and incentives for their conservation or sustainable use (e.g., taxes, subsidies, royalties) versus law and regulation. The last 10 or more years have seen considerable retreats from law and regulation in many countries, in favor of incentives and market mechanisms, and industry self-regulation.

This trend has been reinforced by actual and proposed policies and agreements under the General Agreement on Trade and Tariffs (GATT) and the World Trade Organization (WTO). In some contexts, such as North America under the North American Free Trade Agreement (NAFTA) it is argued that trade agreements have reduced individual nations' ability to control resource development to seek domestic benefits from resources while reducing costs of development.

RESOURCE MANAGEMENT HISTORY

The history of resources and resource management reflects these positions in the several phases it is commonly seen as having gone through. These phases are also linked to broader philosophical perspectives on human relationships to nature. The earliest phase is a "frontier," dominionistic, utilizationist, or individualistic phase in which resources are largely open access and abundant; government regulation, if not ownership, largely absent; and resource development goals are essentially short-term (private) profit maximization. Arguably this was the European development of much of North America before the mid-19th century.

Modern resource management emerged in response to that, and to observations and writing about resource degradation in eastern North America, southern Europe, and elsewhere by George Perkins Marsh, Gifford Pinchot, and others, in the mid- to late 19th century. This was a movement not so much against resource development and use, as against wasteful, extremely short-term resource development and use. It argued for stewardship, or conservation in the original sense of wise use of resources (similar to the modern sense of sustainable development), and for controlling some of the worst side effects of resource development including pollution and flooding from deforestation.

It was this movement that led to many of the early land and resource management agencies in the United States (e.g., U.S. Forest Service, Fish and Wildlife Service, Department of Agriculture), soon replicated in many other countries, and many of the first systematic surveys of resources and efforts to control their rates of exploitation. The movement's goals were broader, anthropocentric rather than individualistic, and included notions of the public interest and public good, and seeking the most benefit for the most people (Pareto optimality).

Simultaneously, there were the beginnings of more preservationist movements, led by the early Audubon Societies, John Muir, the newly-founded Sierra Club, and numerous older organizations in England. These movements sought to prevent use and development of resources, from bird feathers for fashion, to scenic and natural areas protected in parks. The goals of preservationist movements are more ecocentric, recognizing intrinsic values of species, ecosystems, and resources. The late 20th century environmental movement has roots in both conservationist and preservationist perspectives, catalyzed by particular pollution crises.

Resource management has been strongly influenced by the planned development of resources as an engine for broader economic and political development. Mineral development, agricultural settlement, hydroelectric development, and related transportation infrastructure have been core elements in many governments's plans, policies, and initiatives for catalyzing economic development, settlement, and national progress. How effective resource development is as a catalyst of broader socioeconomic development is highly variable, and tied to other social characteristics as well as how well resource development fosters secondary and tertiary economic activity: Processing, manufacturing, governance, and management. In the absence of such linkages, what economists call multiplier effects will be low and most of the economic benefits will flow out of the development region itself. This remains a problem in remote parts of many countries, from Canada and Russia to Brazil and Indonesia. It is also manifested in the boom-and-bust development cycle of many resource frontiers and towns. At the extreme it produced gold or other mineral rushes that last just a few years; more commonly one saw so-called resource towns built, operated, and then completely shut down and emptied after a few decades. Governments often subsidize resource development in remote regions, through paying for infrastructure to make it feasible, developing access or power generation facilities, selling power at reduced prices to industry, buying resources or surplus power at guaranteed prices, guaranteeing loans, or offering reduced royalty (resource tax) rates. In the absence of requirements and incentives for resource developers to ensure local benefits (through, for example, local employment, purchasing, value-added activities as well as extraction) such practices reinforce the imposition of development costs on resource regions without concomitant benefits. Recognition of these problems has arguably led to improved policies and practices in many places in the last 20 years, but in others there are certainly still problems.

The practices of resource management have certainly evolved over the last century. Early efforts focused on inventorying resources and determining methods for setting long-term extraction levels. During the Great Depression and droughts and Dust Bowl of the 1930s resource management was an arena for employment of many people in the United States, in land and forest reclamation and other activities. In the post-war period multiple demands on particular resources, e.g., forests, lead to development of multiple use management approaches which sought to facilitate varied and more or less simultaneous or adjacent use of resources.

By the 1960s these often technically-focused approaches were well developed and began to be criticized and modified by more systems-oriented, and integrated, management approaches that went beyond traditional, economic cost-benefit analyses. Among these concepts was maximum sustainable yield (MSY), particularly applied to renewable resources such as fish, wildlife, and trees, which sought to maintain a population at the level where its annual growth was greatest—thus maximizing a sustainable economic yield from that population. Like much in traditional resource management it implied detailed knowledge of the specific population, its behavior and environment, and assumed its essential isolation from other species and populations. Such detailed information is rarely available, and the assumption is even more rarely true, and the failures of ecologically simplistic, if mathematically complex MSY calculations, especially in fisheries, are now widely known.

These were influenced by early computer simulation efforts, by the move toward environmental impact assessment, by experience in integrated watershed management, and by broader social movements that encouraged attention to the broad public interest, and especially participation of the public in planning, policy and management of resources (and many other issues).

SUSTAINABLE DEVELOPMENT

By the 1980s, these approaches were supplemented by sustainable development notions that emphasized ensuring resources remain available in the future for future generations to meet their needs. Rehabilitation and restoration of degraded resources and ecosystems such as soils, wetlands, rivers, and forests became increasingly feasible and common in the late 20th century. They cannot replace conserving and protecting ecosystems and resources in the first place, but can be part of a comprehensive approach to resources and ecosystems.

The noneconomic or nonmonetized effects of resource development and processing are numerous, and were certainly a major factor in the development of environmental impact assessment beginning in the 1960s and 1970s. These impacts include physical alteration of the environment, loadings (wastes or pollution), and direct effects of harvesting renewable resources on species and ecosystems. These impacts may affect local ecosystems, species, and human health; often particularly impacting traditional subsistence lifestyles. Rural landscapes also see impacts from agricultural intensification and industrialization, and sand and gravel extraction for nearby urban areas. EIA has been much improved and broadened to include social and cumulative effects, as well as economic and environmental, over the years. But it is still very difficult to assess and quantify many social and environmental impacts. Environmental economics has developed methods such as contingent valuation for indirectly valuing resource and environment systems, but it remains difficult. The effects of economic discount rates in devaluing future development of a resource, on decisions about resource extraction versus remain a particular challenge, along with properly accounting for externalities, or full-cost accounting and life-cycle analysis as these areas have developed.

COMMUNITY INVOLVEMENT

Many current developments in resource management emphasize local and community relationships and management of resources. Comanagement represents joint management of resources, usually by government and local or aboriginal people. Community-based conservation or natural resource management (CBNRM) is broader and emphasizes more comprehensively inclusive management processes and ownership at local levels. Comanagement initiatives are often resource-specific; CBNRM may be as well, but is often broader addressing multiple resources in an area. Neither is a panacea. Neither simplifies, or speeds up, resource management, or guarantees broad benefits to a local region. Communities are complex and rarely unitary in terms of interests and perspectives. But these approaches do help to balance the traditional, top-down, technocratic forms of resource management.

These traditional, top-down efforts to control resources and ecosystems are particularly criticized for their history of unexpected side effects, and outright failure to achieve lasting development or sustainability. Emerging approaches to resource theory and management, including adaptive management and governance, or ecological modernization, emphasize learning and learning to deal with uncertainty, most of all not seeking to eliminate uncertainty by controlling natural systems. Other responses include approaches derived from complexity sciences, or the precautionary principle, as well as more radical ideas such as bioregional self-sufficiency.

CURRENT CHALLENGES

In the early 21st century we are seeing rising, if fluctuating, resource prices, especially for energy. Dire forecasts of resource scarcity and decline go back to the 1960s, or even Malthus 200 years ago, and have often been wrong; but it is likely we are entering an era of greater scarcity, and cost, for at least some major resources. Estimates of remaining resources, whether known economic reserves, currently uneconomic resources, or probable or possible future discoveries, are notoriously difficult to make. Rising prices stimulate new exploration, make more resources economic, and also encourage new technologies that can increase reserves or find substitutes for declining resources.

What one considers to be the appropriate response depends on one's view of the capacities of science and technology to find substitutes for declining resources and waste assimilation problems. The Green Revolution that vastly increased agricultural production is pointed at as a great success. But other perspectives identify negative social and environmental consequences in the greater energy consumption and chemical usage, and loss of traditional crops and practices, that the Green Revolution has created in many parts of the world.

It is the production of wastes, the residuals or externalities, that many would argue provides the hardest limit to resource development and consumption—the capacity of the earth's system to absorb pollution such as waste heat, ozone, carbon dioxide, nutrients, sediment, and persistent toxic chemicals. Climate change is widely recognized as perhaps the strongest global manifestation of this very difficult challenge. A different global challenge emerges from the very unequal distribution of resources between and within countries. There are arguments, and concerns, that there will be growing international and intranational conflict over scarce resources, most obviously freshwater.

Other, perhaps deeper, approaches to resource scarcity and the side effects of resource consumption seek to minimize resource consumption, as a start through recycling, reducing, and reusing products and resources. The "3 R's" can be implemented in household, industrial, and commercial sectors with support of various government levels. These may be especially important for nonrenewable resources, where the precise meaning of sustainability is not completely clear. Going further requires redesigning industrial processes, and products, to make them more efficiently and fundamentally reusable, recyclable, and less productive of waste—called cradle-to-cradle approaches. Deeper reductions of production and consumption, to make more significant changes to ecological footprints (a measure of resource and ecosystem service consumption) may well require lifestyle changes, which are even more difficult. Lifestyle change depends on complex cultural and technological changes in, for example, urban design to bring work, home, and shopping closer together; vastly improved public transit; or greater use of communication versus transportation technologies.

The nature, uses, and proper management of resources have been debated for centuries, in many disciplines. Those debates will likely continue, for there can be little doubt that the societal and economic significance, the complexity of resources and ecosystems, and the diversity of actual and potential approaches to resources and their management are not going to go away.

SEE ALSO: Biodiversity; Cattle; Community-Based Conservation; Drought; Ecosystem; Food; Food Webs (or Food Chains); Forest Management; Forestry; Fossil Fuels; General Agreement on Tariffs and Trade (GATT); Green Revolution; Hunter-Gatherers; Lifeboat Ethics; Livestock; Malthus, Thomas; Management, Environmental; Mining; Nuclear Power; Socialism; Water; Wildlife; World Trade Organization.

BIBLIOGRAPHY. Edward R. Barbier, *Natural Resources and Economic Development* (Cambridge University Press, 2006); Daniel R. Buckles, *Cultivating Peace: Conflict and Collaboration in Natural Resource Management* (IDRC Books, 2004); Daniel D. Chiras, John P. Reganold, and Oliver S. Owen, *Natural Resource Conservation: Management for a Sustainable Future* (Prentice Hall, 2004); Tim W. Clark, *The Policy Process: A Practical Guide for Natural Resource Professionals* (Yale University Press, 2002); C.S. Holling and G. Meffe, "Command and Control and the Pathology of Natural Resource Management," *Conservation Biology* (v.10, 1996); W. McDonough and M. Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (North Point Press, 2002); John R. McNeill, *Something New Under the Sun: An Environmental History of the Twentieth-Century World* (W.W. Norton & Co., 2001); Charles R. Menzies, ed., *Traditional Ecological Knowledge and Natural Resource Management* (University of Nebraska

Press, 2006); Bruce Mitchell, ed., *Resource and Environmental Management in Canada: Addressing Conflict and Uncertainty*, 3rd ed. (Oxford University Press, 2004); Emilio F. Moran, *People and Nature: An Introduction to Human Ecological Relations* (Blackwell Publishing, 2006); B.J. Weddell, *Conserving Living Natural Resources in the Context of a Changing World* (Cambridge University Press, 2002); K.S. Zimmerer, ed., *Globalization and New Geographies of Conservation* (University of Chicago Press, 2006); Erich W. Zimmerman, *World Resources and Industries* (Harper & Row, 1951).

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Restoration Ecology

THE REPAIR AND restoration of ecological communities has been undertaken as a conscious endeavor at least since the 1890s, and has grown to become a recognized sub-discipline within academic ecology, as well as a sprawling professional and amateur practice. Although environmental reclamation and rehabilitation attempts have been attempted throughout human history, resembling acts of "restoration ecology" *avant la lettre*, as a disciplinary practice it thus only became possible with the reification of "the ecosystem" as an object of study in the ecology of Ernst Haeckel and Frederick Clements. Using the mechanistic metaphors of the day, the first ecologists in the late 1800s reasoned that if human actions degraded an ecosystem, then repair was possible and even necessary; the task took on epic dimensions in the context of George Perkins Marsh's 1872 *Man and Nature*, in which he linked the fall of classical civilizations to the destruction of ecosystems. The advanced state of German forest science, and its influence on North American environmental management in the late 1800s, makes it unsurprising that the first attempts to repair ecosystems as such were made in the context of silviculture.

U.S. interest in restoring pre-settlement ecologies has its roots in a distinctly American romanticism.

The restoration of native biotic communities for their own sake was first widely articulated by Aldo Leopold during his tenure at the University of Wisconsin's Arboretum, both in his book *A Sand County Almanac* and his design for the arboretum. Unlike most such institutions, this arboretum was intended to showcase native ecosystems, and consisted of large areas of the oak savanna and prairie native to southern Wisconsin. It was intended as a laboratory rather than a museum, and the first ecologists to study restoration as a special case of plant community succession worked under Leopold there in the 1940s and 1950s: Henry Greene, John Curtis, and Grant Cottam. While academic interest in native ecosystems faded with the turn to systematics in ecology during the 1960s, in the 1970s the arboretum became the focus for the rising popular environmental movement.

Restoration ecology as a discipline and activity grew out of at least two other areas of technical practice, however: mine reclamation and dredge spoil disposal. These forms of industrial reclamation, areas of applied ecology, have increasingly drawn on the principles of restoration ecology to achieve the stability and repair of mine sites and navigable waterways. However, their goals are not to restore native ecosystems, but rather to design ecosystems that will perform certain desired functions (such as toxic remediation or spoil stabilization). The scientific practice of wetland restoration ecology, for example, grew largely out of the activities of the Dredged Material Research Program of the U.S. Army Corps of Engineers in the 1970s.

The European tradition of restoration ecology came from these kinds of industrial mitigation concerns, rather than from the interest in pre-settlement ecologies that characterized American practice and that must be recognized as rooted in a peculiarly American romanticism. English restorationists such as A.D. Bradshaw came to the discipline through concerns about the treatment of mine leachate, while the thriving Dutch academic restoration community grew from initial work on maintaining polderland agro-ecosystems. There is thus something of an international cultural divide in restoration ecology; Europeans tend not to be concerned with "original conditions" as much as with the construction of viable and stable ecosystems of sufficient complexity. Americans respond that native ecosystems are precisely those that are likely to be the most viable, stable, and complex. While all landscapes have been shaped by humanity, geological change, and climate to the point where asking questions about "original conditions" can be thoroughly critiqued, there remains at the heart of American restorationist practice a hard core of prelapsarian (or Edenic) commitment. That is, while it may be impossible to know or return to original conditions, the overall ideology of the approach often guides those who advocate it toward somewhat romanticized ideals.

As an area of academic ecology, restoration ecology has drawn from three disparate areas of ecological theory. For some, the restoration of particular species has been grounded in population ecology, nonequilibrium dynamics, and metapopulation studies. For others, the restoration of ecosystems has been grounded in a Clementsian notion of climax in community ecology and in assembly theory. A third orientation is to approach the restoration of nature using the tools of landscape ecology and considerations of scale, fragmentation, and spatial dynamism. These theories point in very different directions, and break on the belief in such a thing as a coherent "community" that is to be restored, a proposition that population and systems ecology have rejected since their inception. Complicating this debate is the large community of amateur enthusiasts and professional technicians practicing restoration ecology—now a multimillion-dollar industry driven by requirements of environmental law to repair and restore environmental damage.

Restoration as a popular movement and a bureaucratic imperative requires "the ecological community" as a unit on which to affix the romantic imaginary and environmental governance, respectively. In short, the stochastic existence of a metapopulation of an endangered species doesn't excite the same level of passionate environmentalism, nor serve to extend the same kind of governmental management oversight, as does the existence of a "tallgrass prairie" community. Debates over the proper aim, methods, and theory behind restoration ecology have occupied the pages of the main professional journal (*Restoration and Management Notes*, now *Ecological Restoration*) and the main academic journal (*Restoration Ecology*) since their inceptions in 1981 and 1993 respectively, as well as the annual meetings of the Society for Ecological Restoration, founded in 1987. Social scientists have entered the debate as well, finding in restoration ecology fertile ground for investigating the human acts of boundary making between natural and social/cultural phenomena.

SEE ALSO: Ecology; Ecosystem; Landscape Ecology; Leopold, Aldo; Native Species; Nature, Social Construction of; Preservation; Pristine Myth; Succession.

BIBLIOGRAPHY. Donald Falk, Margaret Palmer, and Joy Zedler, *Foundations of Restoration Ecology: The Science and Practice of Ecological Restoration* (Island Press, 2006); Paul Gobster and R. Bruce Hull, eds., *Restoring Nature: Perspectives from the Social Sciences and Humanities* (Island Press, 2000).

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Reverse Osmosis, Drinking Water and

ONE OF THE more common methods of treating water is through the process of reverse osmosis. Reverse osmosis is probably best known for its role in desalinization, which is how seawater is turned into consumable freshwater. Reverse osmosis is based on the process of osmosis, which moves water or other liquids from one side of a semipermeable membrane to another. To produce clean water from a contaminated sample, water is forced at high pressure through a semi-permeable membrane. Through this process, contaminants are left on one side of the membrane while cleaner water proceeds through it. Pressure is applied to the contaminated water which is a concentrated solution, reversing the natural flow of water and forcing the contaminated water, which is now cleansed, through the membrane and into a now dilute solution. The newly treated water is collected into an attached storage container and the unwanted water is washed away as waste. Different levels of contamination require different amounts of pressure to treat the water. For example, the process of producing purified water from a tap requires 10 times less water pressure than seawater.

Reverse osmosis is frequently used to reduce the levels of total dissolved solids and even suspended particles in water. It can also help to reduce the amounts of organic materials, inorganic materials, and bacteria which may possibly contaminate drinking water. Some of the materials and elements that reverse osmosis removes from water include: aluminum, arsenic, asbestos, barium, benzene, cadmium, calcium, chloride, chlorine, chromium, copper, fluoride, iron, lead, magnesium, manganese, mercury, nitrate, potassium, radium, radon, silver, sodium, sulfate, and zinc. However, reverse osmosis may not always remove hydrogen sulfide, a gas with a distinctive rotten egg odor. Reverse osmosis can also filter microorganisms out of water, but it is not recommended for this use since it may cause deterioration to the membrane used in the filtration system. In turn, it can cause recontamination because the microorganisms can eat through the membrane and pass through the process unharmed.

Many reverse osmosis systems are in the 75–80 percent recovery efficiency range, meaning that for every 100 gallons of water used in the system, 75–80 gallons of pure product water are produced. The temperature of the contaminated water has a great effect on the amount of water treated, and for every degree below the standard 77 degrees F, the amount of water treated decreases by 1–2 percent.

The typical reverse osmosis water treatment system involves a pretreatment filter, membrane, storage tank, flow regulator, dispensing faucet, and a post-treatment filter and can be quite costly. Before implementing a reverse osmosis system, owners should have their water checked professionally by a lab or a local health department. Additionally, it should be understood by system owners that no reverse osmosis system can completely remove all contaminants from water sources.

SEE ALSO: Drinking Water; Fluoridation, Drinking Water and; Lead; Mercury; Water Harvesting; Water Quality.

BIBLIOGRAPHY. Bill Andresen, "Treating Drinking Water Through Reverse Osmosis," *Prairie Water News* (v.3/1, 1993), www.quantumlinx.com (cited May 2006); Michael Kamrin, "Reverse Osmosis for Home Treatment of Drinking Water" (1990), www.gem.msu.edu (cited May 2006); Jodi Kocher, "Drinking Water Treatment: Reverse Osmosis" (2003), ianpubs.unl.edu/water (cited May 2006).

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Rhine River and Valley

AT ABOUT 820 miles (1,320 kilometers) in length, the Rhine River is one of the longest and most important rivers in Europe. It extends from the Swiss Alps to the North Sea, flowing through six countries: Switzerland, Liechtenstein, Austria, Germany, France, and the Netherlands, defining the border along some of these nations. Large and important cities such as Bonn, Rotterdam, Basel, Strasbourg, Mannheim, Ludwigshafen, Neuss, and Cologne are located along the river or its larger tributaries. The Rhine serves as a constant source of water for the countries it flows through: it provides drinking water and is also used by the industrial, agricultural, energy, and transportation sectors. Furthermore, the river is a natural habitat for diverse plant and animal life including many birds, fish, and other species.

As an international river, the Rhine has played a role in shaping political forces and national boundaries. Control of the river's waters has already been defined as a priority by these principal countries, thus creating tension in the region. Originally, conflicts occurred over the definition of the frontier and rights to transportation use. Currently, conflicts are more related to water quality and problems in river ecology and are opportunities for creative cooperation.

Historically, these countries tried to find non-confrontational ways to solve their disputes. They created organizations related to the Rhine basin, some of which still exist. The Central Commission for Navigation on the Rhine (CCNR), which is the oldest active European organization, was created in 1815 by the Congress of Vienna, and was revised in 1868 and again in 1963. The main purpose of the CCNR is to ensure the freedom of navigation on the Rhine and its tributaries.

In 1970, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) founded the International Commission for the Hydrology of the Rhine Basin (CHR) in order to promote closer cooperation in international river basins. The CHR's projects focus on sustainable water resource management of the Rhine. In 1950, the International Commission for the Protection of the Rhine against Pollution (ICPR) was created, but it did not receive its legal foundation until the conclusion of the Convention of Berne in 1963. At present, the legal basis for the work of the ICPR is the new Rhine Convention, which was signed in April 1999 with the European Union included. Its new name is the International Commission for the Protection of the Rhine. Additionally, there are numerous projects in progress and planned for the future of the Rhine, all of which focus on the principle countries' cooperation and integrated sustainable water management.

The Rhine River is also part of the PC-CP (From Potential Conflict to Cooperation Potential), UNESCO and Greencross International's project created to address the possible challenges of shared water. Areas of concern for this project are: Flooding; the fishing industry, which is being harmed by navigation and hydropower interests; and pollution, as most of Europe's important industrial plants can be found along the Rhine discharging toxic substances into the river. Also contributing to pollution is wastewater discharged by agriculture and households.

SEE ALSO: European Union; Pollution, Water; Rivers; Water Conservation; Water Quality.

BIBLIOGRAPHY. C. Dieperink, "International Regime Development: Lessons from the Rhine Catchment Area," *TDRI Quarterly Review* (v.12, 1997); "Rivers of Europe: Rhine River," www.public.asu.edu (cited December 2006); United Nations Educational, Scientific, and Cultural Organization and Greencross International, "From Potential Conflict to Co-operation Potential," in *PC-CP Program Case Study: Rhine* (2003); Aaron Wolf, "Conflict and Cooperation Along International Waterways," *Water Policy* (v.1/2, 1998).

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Rice

RICE, ALTHOUGH PRODUCED in similar quantities to wheat and maize, feeds more people on the planet than any other grain and has done so for many centuries. Yet, in many forms of its cultivation it has led to significant environmental modification. The rice plant (*Oryza sativa Linn.*), often known as paddy (*padi*), is a varied and adaptable crop. Varieties of the rice plant are adapted to a wide range of environments, and rice will grow across a broad spectrum of climatic and soil types; different cultivars offer variations in taste and texture. Rice is found in the tropics, but also in sub-tropical and warm temperate regions. Some varieties suit unirrigated swidden agricultural systems and may be grown on steep hill slopes; others require a very wet environment, and some will grow best in swamps. The most intensive rice cultivation systems have evolved in places where water is controlled so that it is freely available during planting and growing periods, but absent for ripening and harvesting. Where growing conditions were optimal in this way, it was common for two crops of rice to be harvested each year from the same piece of land—this very high rate of productivity supported high population densities and often complex and stratified societies.

Humans first domesticated rice about 7,000 years ago, probably in China. Its spread and development as a staple food in Asia went hand in hand with the social, economic, and environmental transformation of large parts of the region. Because the control of water often required large-scale operations, involving cooperation or coercion, states and societies emerged that were able not only to exert social control over a wide area, but also to extract surplus from rice producers in the form of labor and crops.

With intensification of cultivation, food output increased and populations expanded in a spiral that led to the emergence of some of the most densely populated agricultural regions in the world. States such as Ayutthiya and Angkor emerged in Southeast Asia, and in southern China and Japan similar regions of intensive cultivation supported large and multifarious social and political units. Such large-scale systems often developed in river deltas and floodplains where it was possible to manage water flow through drainage and irrigation. Elsewhere, smaller-scale systems were in evidence in river valleys, where river flow could be diverted, or even on steep hillsides where intricate terracing systems were coupled with the channeling of water supply. In Bali, scarce land resources and tight water management allowed the development of a highly productive rice economy.

Such pre-modern "wet" (or *sawah*) rice systems were usually characterized by the development of technologies not only for water control and plant cultivation, but also a high degree of innovation regarding issues such as land tenure and social relations, as well as rice production. Although these systems were highly intensive and involved the construction of capital in the form of canals, irrigation works, and transport systems, they were relatively low input systems, reliant on the natural environment and, often, a supply of nutrients from seasonal flooding. Although the rice crop dominated and provided a staple food, biodiversity was high: Many different varieties of rice were cultivated and supplementary food sources (fish, ducks, chickens, tree crops, and off-season crops such as pulses) coexisted alongside and within the rice paddies. So-called "dry" or rain-fed rice systems were marked by less intensive production and less dependence on water control. Tropical shifting cultivation gardens supported rice with an association with an even wider range of other food sources.

Rice production systems worldwide have been transformed in the past century. In general, colonial authorities preserved and extended many of the traditional rice farming systems in places such as India and Indonesia, though they introduced new techniques for seed selection and breeding. Irrigation and drainage works were sometimes promoted, and expanded transport linkages opened rice farming to new markets and sources of inputs. However, the major transformation of rice production was in the postcolonial period when new technologies associated with the Green Revolution profoundly affected not only rice output, but also the environments, societies, and economies associated with the crop.

Between 1961 and 2001, world rice production rose from 216 million tons to 598 million tons.

At the core of the Green Revolution was the breeding and dissemination of new seed varieties that were high yielding, but more critically, fast growing. They were bred to respond well to artificial oil-derived fertilizers that delivered a nitrogen boost to growing plants. Thus, in a sense, the Green

Revolution has involved the conversion of one form of energy (in oil) to another (rice). The new varieties also tended to require even closer management of water supply and, without built-in resistance to pest and disease attack, they often required complementary use of chemical sprays for protection. Because of their rapid growth and high yields, two and three crops per year were possible in many places and output expanded significantly.

Production increased markedly in the established rice producing countries such as China, India, Indonesia, Bangladesh, Vietnam, and Thailand, but there was also expansion in temperate regions such as the United States, Italy, and Australia. Between 1961 and 2001, world rice production rose from 216 million tons to 598 million tons, yet the area harvested rose from 116 million hectares to only 152 million hectares. To a large extent, this doubling of rice yields over a 40-year period prevented food shortages, and several key rice producing countries such as Indonesia changed from being net importers of their staple food to being exporters.

However, these successes in rice production came at a cost: Biodiversity suffered. Only a small number of new cultivars were introduced, so that the previous diversity in rice paddies was replaced by only a handful of new varieties. The widespread use of chemicals affected other plant and insect life and created significant problems with poisoned waterways, damaged soil structure, and the ability of people to tap traditional supplementary food sources. The new systems also increased dependence, not only on fossil fuel–based fertilizers and chemicals, but also on continued applications of these products just to maintain yields, let alone increase them.

The move to high-input rice farming is also evident. As well as fertilizers and chemicals, farmers have to buy new seeds each year instead of using a portion of the previous year's crop. The high costs of inputs have meant that larger and wealthier farmers have been able to participate and profit in the new farming systems more than the poor. The latter often go into debt and sometimes lose their land. While many rice farmers in developing countries have done well from the Green Revolution, others have become landless and dependent on wage labor. Rural societies have become more varied and fluid as a result, with greater inequalities between rich and poor. And as new agricultural technologies and seeds have taken hold, the old is being gradually lost: The genetic pool has suffered and many of the old technologies of rice farming have disappeared. Cultural diversity has suffered alongside biodiversity.

There are signs of significant change yet to face rice production. High oil process and neoliberal reforms have put pressure on the heavy use of fertilizers in some places and the subsidization of rice production in Japan and other industrial countries is under threat. Much rice research in recent years has focused on the need to promote lower input and more sustainable systems of cultivation using techniques such as integrated pest management and careful management of fertilizer use and soil quality. It is also possible that genetic modification may create a new revolution in rice production.

SEE ALSO: Agriculture; China; Genetic Patents and Seeds; Golden Rice; Green Revolution; Japan.

BIBLIOGRAPHY. F. Bray, *The Rice Economies: Technology and Development in Asian Societies* (Blackwell, 1986); J. Carney, *Black Rice: The African Origins of Rice Cultivation in the Americas* (Harvard University Press, 2001); D.H. Grist, *Rice* (Longman, 1986); R.W. Hamilton, *The Art of Rice: Spirit and Sustenance in Asia* (UCLA Fowler Museum of Cultural History, 2003); Michael Lipton and Richard Longhurst, *New Seeds and Poor People* (Johns Hopkins University Press, 1989); Vandana Shiva, *The Violence of the Green Revolution: Ecological Degradation and Political Conflict in Punjab* (Natraj Publishers, 1989).

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Rift Valley

THE RIFT VALLEY, also known as the Great Rift Valley, extends over 7,000 kilometers from Syria through the Red Sea, the Gulf of Aden, and the African continent to Mozambique. Its width varies from 30–100 kilometers and depth from several hundred to several thousand meters (for example, Mount Kenya peaks at 5,200 meters, and the Danakil Depression is 155 meters below sea level). Formation of the Great Rift Valley along a tectonic rift began in the Eocene and became more active in the Mesozoic period, and included intensive volcanic activity and magma eruptions that formed large basaltic lava fields. Continuous uprising of the highlands and drifting apart of the African, Somali, and Arabic plates resulted in the breaking and sinking of the highlands, creating large lakes in the Great Rift Valley.

The main populated areas of the Great Rift Valley are in the middle elevations in Africa, where subsistence farming is the predominant land use. Cropping patterns are dependent on climatic conditions that are determined by elevation. High elevations (over 3,000 meters) are generally marginal for crop production and are used for grazing small stock. Intermediate elevations (2,500–3,000 meters) with sufficient average annual rainfall are suitable for rain-fed agriculture (such as root crops, legumes, barley, and wheat), while crop-livestock systems are most common. As rainfall varies considerably, small-scale farmers have to deal with recurrent droughts that threaten agricultural production. Vegetation is strongly shaped by anthropogenic influences. At lower elevations, pastoralism is the predominant land use. Where water is available, commercial agriculture (mainly cotton and sugar cane) is common. Growing population pressures are causing significant land cover changes throughout the Great Rift Valley.

Population densities and land use in the Great Rift Valley are generally determined by the availability of water. Some of the lakes, like Lake Victoria, are used for commercial fisheries, irrigation, and industrial purposes. Rivers are mainly used for domestic purposes, livestock, and irrigation. Changes in the quality and quantity of water resources are occurring due to population growth, urbanization, and large-scale agricultural development that rely on irrigation and other (potentially harmful) agricultural inputs. Soil erosion is a common problem and is largely caused by increasing rates of resource utilization, such as deforestation, inadequate agricultural practices, and overgrazing.

The Great Rift Valley Lakes, as a consequence, suffer from increased levels of sedimentation, as well as increased nutrient loads and eutrophication, causing die-off of fish and algal blooms. Large commercial irrigation schemes have considerable impacts on the water levels of lakes and rivers, particularly during times of low rainfall and high evaporation, and cause serious water scarcity. In addition, agricultural drainage water creates serious water quality problems. Fisheries are threatened by the decline in lake levels and pollution, as breeding grounds of fish in shallow waters are affected.

Rapid urbanization in the vicinity of the Great Rift Valley Lakes Region is reducing water quality and availability. Untreated domestic and industrial wastewaters are increasingly disposed into natural water bodies, resulting in health problems and the spread of waterborne diseases, declining drinking water quality, and poor sanitary conditions. Climate change adds to the variability of rainfall, increasing the vulnerability of livelihoods to drought.

SEE ALSO: Overgrazing; Water; Water Quality.

BIBLIOGRAPHY. L. Brook, "Changes in the Limnological Behavior of a Tropical African Explosion Crater Lake: L. Hora-Kilole, Ethiopia," in *Limnologica* (24/1, 1994); R. Meyer, "Äthiopien—Eine Geographische Einführung," in H.E. Matter and A. Westpal, eds., *20 Jahre Agrarforschung des Tropeninstituts in Äthiopien* (Tropeninstitut Giessen, 1987); F. Pearce, "The Real Green Revolution," *New Scientist* (v.155/2112, 1997); K. Tekle and L. Hedlund, "Land Cover Changes Between 1958 and 1986 in Kalu District, Southern Wello, Ethiopia," in *Mountain Research and Development* (v.20, 2000); G.M. Zinabu, "Long-Term Changes in Indices of Chemical and Productive Status of a Group of Tropical Ethiopian Lakes with Differing Exposure to Human Influences," in *Archaeological Hydrobiology* (v.132, 1994).

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Ring of Fire

THE RING OF Fire is a zone around the rim of the Pacific Ocean named for its numerous active and destructive volcanoes, and also known for the common occurrence of high magnitude earthquakes. Geologically, the Ring of Fire is a zone of volcanic arcs that are associated with submarine trenches comprising geologic features known as subduction zones. The zone is probably the most active and dangerous tectonic region of the globe.

The Ring of Fire coincides with features known as trenches and their associated volcanic arcs. Some of the more famous of these pairs include: the Kermadec trench and New Zealand; the Java trench and Indonesia; the Mariana trench and the Philippines; the Japan trench and Japan; the Kurile trench, the Aleutian trench and the Aleutian Islands; the Cascadia trench and the Cascade Mountains; the Central America trench and the chain of volcanoes in southern Mexico and Central America; and the Peru-Chile trench and the Andes Mountains.

The origin of the arc-trench system is the convergence of two adjacent tectonic plates and the resulting subduction of one plate (usually the Pacific Plate) under the other. The mountains are the result of the compression and thickening of the lithosphere, and the formation of magma that makes its way to the surface and erupts to form volcanoes. Convergent plate margins are typically associated with high magnitude earthquakes and very explosive volcanoes.

Some of the volcanoes associated with the Ring of Fire have erupted in the recent past with devastating force. Examples include: Ruapehu in New Zealand; Agung, Krakatoa, Merapi, and Tambora in Indonesia; Mayon and Pinatubo in the Philippines; Fuji and Unzen in Japan; Katmai in the Aleutian Islands; the Cascade Mountains of the northwestern United States and southwestern Canada (including Mount St. Helens); El Chichon, Paricutin, and Papocatepetl in Mexico; Concepcion and San Cristobal in Nicaragua; Arenal in Costa Rica; and Cerro Volcanico and Viedma in Argentina.

Earthquakes are caused by an instantaneous, large-scale movement of an active fault. Faults are intimately associated with convergent plate boundaries, such as those that occur along the Ring of Fire. Some of the destructive earthquakes associated with the Ring of Fire have occurred in: Taiwan (1999), Kobe (1995), Tokyo (1923), Anchorage (1964), San Francisco (1906, 1989), Mexico City (1985), El Salvador (2001), Peru (1970), and southern Chile (1960). Death tolls for some of these earthquakes range from about 60 lives (San Francisco, 1989) to over 140,000 lives (Tokyo, 1923).

Plate convergence is also responsible for mountain-building. The steep, unstable terrain associated with these young and actively-forming mountains can be subject to erosion by gravity (mass wasting) in the form of landslides, mudflows, and similar types of downslope movements. Some of the volcanoes are tall enough that they have alpine glaciers on their peaks. During volcanic eruptions, these glaciers may melt, producing water that can exacerbate floods and mudflows.

The Ring of Fire is an area that generates tsunamis, and is also subject to the effects of these giant waves. Ring of Fire islands and coastal areas of the Pacific Rim are particularly prone to tsunami hazards because of their open, Pacific-facing coastlines. The earthquakes generated along the Ring of Fire may cause rupture and sudden offset of the ocean floor, or may cause submarine landslides; either of which can trigger the generation of a large surface ocean wave (tsunami) that travels at a high speed through the ocean. When the tsunami reaches a coastline, it breaks and may inundate the coastline. Because of its size, it can produce a wall of water tens of meters high when it breaks. The Pacific Rim coastlines of the Ring of Fire are most prone to the effects of tsunamis. Similar hazards exist in other oceans with active convergent plate boundaries, such as the Indian Ocean.

SEE ALSO: Earthquakes; Pacific Ocean; Tsunamis.

BIBLIOGRAPHY. BBC, "Earth's Ring of Fire," news .bbc.co.uk (cited April 2006); U.S. Geological Survey, "The Ring of Fire," pubs.usgs.gov (cited April 2006).

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Rio Declaration on Environment and Development

THE RIO DECLARATION on the Environment and Development (the Rio declaration) is an international agreement of 27 principles signed by over 170 countries during the Earth Summit in 1992 in Rio de Janeiro, Brazil. The Earth Summit, formally known as the United Nations Conference on Environment and Development (UNCED), was held to address and provide solutions to environmental degradation caused by unsustainable human development and the growing gap between the rich and poor.

The Rio declaration was one of five international agreements made at the Earth Summit, the others being: Agenda 21; a Statement on the Management, Conservation and Sustainable Development of all Types of Forest (the forest principles); a Convention on Biological Diversity; and the Framework Convention on Climate Change. Only the conventions on biological diversity and climate change are legally binding. Agenda 21, the forest principles, and the Rio declaration are voluntary agreements that cannot be enforced by international law.

The origins of the Rio Declaration draw from the 1972 Stockholm Conference on the Human Environment which resulted in the establishment of the United Nations Environment Programme (UNEP) and provided the impetus for the international community to commence negotiations on significant environmental treaties. By the early 1980s, however, it had become clear to the United Nations (UN) that negative human impacts upon the earth were escalating. In 1983 it established the World Commission on Environment and Development, otherwise known as the Brundtland Commission, to investigate strategies for how to achieve sustainability by the year 2000.

The commission produced the report *Our Common Future,* which identified the "global commons" (the oceans, space, and Antarctica), described how human development was causing unintended but significant changes to natural processes and explained that our present well-being should not be at the expense of future generations. The report called for an international conference to determine a process on how the world community was to meet the challenges presented in the report.

Thus, the Earth Summit was the outcome of the recommendation to hold an international conference and the principles in the Rio declaration were designed as a guide for countries on how they could protect the integrity of the global environment and adequately manage development. The document attempts to address significant issues associated with the complex relationships between the environment and pressures placed upon it from human development. The principles found within the Rio declaration build upon the assertion in *Our Common Future* that "the environment and development are not separate challenges; they are inexorably linked."

Principles 1 through 4 primarily focus on the rights of a state to exploit natural resources, but contest that development should take place in a sustainable manner and that environmental protection should be an integral part of all planning processes. Principles 6 and 7 reflect on the needs of developing countries and the responsibilities they have to prevent environmental degradation and unsustainable development.

Principles 8, 9, and 10 describe mechanisms to promote sustainable activities such as population management, technological improvements and exchanges, and capacity-building through the provision of appropriate information and education to individuals enabling them to make decisions that promote sustainable outcomes. Principles 11, 12, and 13 identify the legal options that could be employed to lift environmental standards at both a local and international level; while principle 14 describes how states should limit the transfer of harmful substances.

Principle 15 describes the precautionary principle. Principles 16 and 17 provide mechanisms to ensure the polluter pays for any environmental incidents and argue for the instatement of strong national authorities to assess the likely environmental impacts of proposed developments before they occur. Principles 18 and 19 describe the importance of information sharing between nation states, and principles 20, 21, and 22 identify the roles that specific sections of a society can play in managing the environment.

Principles 23 through 26 describe the importance of managing and protecting the environment and natural resources in times of war and oppression and state that any disputes should be managed and resolved peacefully. Principle 27 asks signatories to commit to the agreement in a spirit of partnership and suggests that any future developments in international law should include the principles found in the declaration.

Since the agreement was signed in 1992, the international community has met twice, once in 1997 (Rio +5) during a special session of the General Assembly of the UN in New York and in Johannesburg in 2002 (Rio +10) to assess progress and build upon the agreements made in Rio de Janeiro. It is difficult to assess precisely the impact the Rio declaration has had due to its broad nature and lack of targets. The overwhelming evidence and opinion suggests, however, that although it has helped to promote the concept of sustainability, the importance of protecting the environment and ending world poverty to world governments, very little has actually been achieved.

Environmental indicators—including species extinction, greenhouse gas emissions, and land clearing—have increased and the division between the world's richest and poorest nations has grown since 1992. After the Rio +10 meeting in Johannesburg, most industry and nongovernmental organization participants expressed profound disappointment. Oxfam issued a statement describing the outcomes as a "triumph for greed and self-interest, a tragedy for poor people and the environment." A co-author of *Natural Capitalism*, Hunter Lovins, explained that it was no surprise that governments were failing to deliver effective policies because, in a globalized economy, it is big businesses, not countries, that are in an economic position to implement the principles identified in international agreements such as the Rio declaration.

SEE ALSO: Agenda 21; Polluter Pays Concept; United Nations Conference on the Environment and Development (Earth Summit, 1992).

BIBLIOGRAPHY. P. Chatterjee and M. Finger, *The Earth Brokers: Power, Politics and World Development* (Routledge, 1995); W. Harcourt, ed., *Feminist Perspectives on Sustainable Development* (Zed Books, 1994); A. Kirby, *UK Hails Summit Success*, news.bbc.co.uk (cited April 2006); H. Lovins, *Getting Down to Business*, www.guardian.co.uk (cited April 2006); United Nations General (UN) Assembly, *Resolution A/RES/38/161* (UN, 1983), www.un.org (cited April 2006); UN, *Rio Declaration On Environment and Development*, *1992*, www.un.org (cited April 2006); World Commission on Environment and Development, *Our Common Future* (Oxford University Press, 1987).

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Rio Grande

THE RIO GRANDE, or the Rio Bravo del Norte, its formal Mexican name, rises in the San Juan Mountains in southeastern Colorado and then runs south for 1,885 miles through the state of New Mexico, passing Taos, Albuquerque, and Las Cruces before following the full length of the border between Texas and Mexico. The river empties into the Gulf of Mexico near Brownsville, Texas and Matamoros, Mexico.

Demands on the river's water from cities and agriculture all along its course continue to increase. In addition, pollution problems have been encountered due to the close proximity of hazardous waste dumps, the spilling of industrial wastes, and irrigation water returned to the main stream. Compounding the problem is a series of drought years through the 1990s and into the first decade of the 21st century, which further reduced the flow of what some have called The Forgotten River. The term was applied by conservationists in order to draw attention to the plight of the Rio Grande. It is believed that the river may become extinct because of overuse. Already, there are years when the waters of the river do not, in fact, reach the Gulf of Mexico, a condition shared with the Colorado River as it approaches the Gulf of California.

In 1978, a 200-mile portion of the Rio Grande was designated as a Wild and Scenic River and placed under the control of the National Park Service. The arrangement was expanded in 2000 when the Big Bend National Park in Texas established an enhanced planning program to ensure the success of the Rio Grande Wild and Scenic River designation. As part of the plan the Rio Grande Partnership Team was formed to generate ideas on river management and to serve as a sounding board for suggestions generated by participating groups.

Another program aimed at monitoring the biotic resources of the Rio Grande is the Lower Rio Grande Ecosystem Initiative (LRGEI), which was established by the Biological Resources Division of the United States Geological Service (USGS). The LRGEI, covering the portion of the river extending from the Elephant Butte Reservoir in New Mexico to its mouth on the Gulf of Mexico, has a number of initiatives underway in collaboration with numerous organizations in both the United States and Mexico. Among them are the evaluation of fish contamination in the river, development of a bibliographic database of natural resources, a study of peregrine falcon reproduction within the Big Bend National Park, the establishment of a geographic information system (GIS) database of land adjacent to the Rio Grande in Mexico, and the development of an internet site for researchers.

Protection for the Rio Grande was further enhanced in 1992 with the creation of the Integrated Environmental Plan, an international initiative along the United States–Mexico border. The plan calls for both countries to monitor transboundary water sources for any forms of contamination. Coordination of the activities between the two countries is under the control of the International Boundary and Water Commission (IBWC).

Attention to environmental concerns was a basic attribute of the North American Free Trade Association (NAFTA), an economic agreement involving the United States, Canada, and Mexico. From the onset of NAFTA, there was concern about environmental degradation along the United States–Mexico border due to increased population concentrations and industrial activity. NAFTA has insured that wastewater is properly treated, safe drinking water is available, hazardous wastes are treated appropriately, and industrial air and water pollution are regulated.

SEE ALSO: National Wild and Scenic Rivers Act (U.S.); North American Free Trade Agreement (NAFTA); U.S. Geological Survey.

BIBLIOGRAPHY. Paul Horgan, *Great River: The Rio Grande in North American History* (Wesleyan University Press, 1991); Pat Kelley, *River of Lost Dreams: Navigation on the Rio Grande* (University of Nebraska Press, 1986); Jan Reid, *Rio Grande* (University of Texas Press, 2004).

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Riparian Areas

RIPARIAN AREAS CONSTITUTE the margins of land adjacent to perennial, intermittent, or ephemeral rivers, streams, lakes, and other bodies of water, including estuarine areas, which experience at least periodic submergence. They are transition zones between aquatic and terrestrial systems, distinguished by gradients in biophysical conditions and ecological functions between the different systems. Linear in form, riparian zones range from narrow strips of land several feet wide in arid regions, to large swaths several miles wide in wetter climates. They are comprised of three main components: stream channel, wetland, and flood plain, the latter delineated by the frequency and extent of inundation (for example, 100-year floodplain). They are regions of high productivity, species diversity, and density, conditioned by their specific climatic, biotic, geographical, and geological context.

Riparian areas are dynamic, acting as sinks and transformers, receiving and processing large energy and material flows, encompassing water, sediments, nutrients, and organic matter from upstream areas. Periodic flooding or submergence is responsible for the removal and deposition of sediments, organic materials, and nutrients. These conditions also produce anaerobic conditions and riparian soils that are low in oxygen.

Riparian areas facilitate the processes of infiltration, filtration, deposition, adsorption, assimilation, and various biotic processes such as denitrification. Riparian areas help in protecting water quality and purifying ground water. They play a role in determining sediment loads, nutrient and pollutant concentrations, water flows, and temperature regimes in streams. This in turn impacts the species composition and abundance of fish, invertebrates, and other organisms utilizing the stream environment.

Riparian areas contribute significantly to biological diversity, at species and genetic levels, providing habitats for a diverse array of plant and animal communities. As ecotones, they provide a good example of the "edge effect," exhibiting high species diversity and abundance. Of particular importance in this respect is the prevalence of woody plants, water or soil moisture, and habitat diversity. Animals use the different habitats found within the riparian zone as places of refuge, for feeding, for their proximity to water, and as migration corridors.

Bird diversity is exceptionally high in riparian areas and a disproportionately high number of other species, including reptiles, amphibians, mammals, and invertebrates, rely on these areas, compared to adjacent upland areas. These areas also play a critical role in maintaining suitable habitats for many fish species, particularly cold water species such as trout. In arid regions, riparian areas are even more critical for both plants and animals, possessing greater soil moisture than surrounding areas, and may be the only vegetated habitat for many miles.

Riparian areas contribute to the maintenance of the aquatic systems that they border, affecting its biotic and abiotic characteristics. Healthy riparian zones stabilize stream banks, and mitigate or prevent excessive erosion, runoff, and pollution, acting as filters and buffers between the human development and land use within the watershed and the aquatic environment. Intact, they also have the capability to store water and release it slowly during lower flows, thereby mitigating high flow and potential flood events.

Some estimate that over 70 percent of the riparian habitats in the United States have been destroyed or adversely impacted by human activities, such as agriculture, livestock, logging, residential and commercial development, and have caused changes to the hydrology and geomorphology of these areas. These impacts encompass the construction of dams, water diversions, channelization, bank stabilization, and flood control projects. Although few thorough assessments of the status of riparian systems have been conducted, evidence indicates that conversion and degradation have affected many of these corridors, making them among the most threatened habitats.

Because of their ecological, biological, economic, and recreational importance, efforts have been made to protect and restore these areas. Riparian buffers or setbacks provide one means of protection, enacted at the local level. Setback regulations limit disturbance in riparian areas, creating a vegetated buffer zone in which development is constrained. Such setbacks are usually stipulated within municipal zoning ordinances. There are also a host of incentive-based programs created at state and federal levels, such as tax abatements, cost-sharing programs, and conservation easements, that seek encourage landowners to conserve these areas. Nonprofit organizations such as land trusts also play a role in developing protections of privately owned riparian areas.

In many cases, however, riparian corridors have been so degraded that legal strategies alone do not go far enough to ensure the integrity and adequate functioning of these systems. In these cases, creation and restoration may be necessary. This may encompass changes to the hydrology, substrate, stream banks, vegetation, and fauna. Buffers and protective structures such as fences may also be essential. In the arid southwest of the United States, because the hydrology of watersheds has been so altered by human activities, restoration efforts have aimed at reestablishing the hydrology of the area, reconnecting the riparian corridor to the water source, and actively revegetating these areas, rather than allowing natural revegetation to occur.

SEE ALSO: Riparian Rights; Water; Water Law; Watershed Management.

BIBLIOGRAPHY. Craig N. Goodwin, Charles P. Hawkins, and Jeffrey L. Kershner, "Riparian Restoration in the Western United States: Overview and Perspective," *Restoration Ecology* (v.5/45, 1997); Jon A. Kusler and Mary E. Kentula, eds., *Wetland Creation and Restoration: The Status of the Science* (Island Press, 1990); Nancy Langston, *Where Land & Water Meet: A Western Landscape Transformed* (University of Washington Press, 2003); Beth Middleton, *Wetland Restoration: Flood Pulsing and Disturbance Dynamics* (John Wiley & Sons, 1999); William J. Mitsch and James G. Gosselink, *Wetlands* (John Wiley & Sons, Inc., 2000); Robert J. Naiman and Henri Décamps, "The Ecology Of

Interfaces: Riparian Zones," *Annual Review of Ecology Systematics* (v.28, 1997); National Research Council, *Riparian Areas: Functions and Strategies for Management* (National Academy Press, 2002).

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Riparian Rights

RIPARIAN RIGHTS REFER to the property rights to surface water associated with adjoining land. Riparian land is the area adjacent to a water body. Riparian rights typically include the rights to access the water body and remove surface water. Riparian water rights are considered permanently tied to the riparian land and cannot be bought or sold separately. In areas abiding by riparian rights, ownership of riparian land is necessary to take water legally. The amount of water that can be withdrawn from a water body in an area of riparian rights is typically proportional to the extent of shoreline owned and must be reasonable. A riparian water right is considered inherent with land ownership and does not require separate legal filing. Significant amounts of water cannot be diverted from the water body for separate storage and later use under riparian rights. This system originated in England as part of common law and spread to the eastern United States.

The eastern United States and England have generally humid climates with frequent precipitation and regularly distributed water bodies on the landscape. The western United States, on the other hand, receives less regular precipitation and water bodies are less frequent across the landscape. Therefore, a water rights system developed not dependent on adjacency but rather based on beneficial uses of water. The appropriative rights system allows water to be taken and used by anyone, even those without adjacent land. The appropriative system began when miners in the mid-19th century needed to divert and transport water long distances for hydraulic mining. The only requirement is that the water be put to and kept in a beneficial use. Water rights under the appropriative system are not based on proportion of shoreline, but rather first in time, first in right. Whoever made use of the water first can continue to take that amount and any later users must wait for more senior rights holders to fulfill their allotment first. Western states generally follow an appropriative rights system while eastern states follow a riparian rights system, although some western courts recognize riparian rights for certain issues and appropriative rights for others, leading to customized hybrid systems, as in California and Texas.

As populations grow and demands on water resources increase, water rights continue to evolve at the state level in courts and legislatures. Such evolution lead to the hybrid systems, and will continue to redefine who has the right to access water resources, for what purposes, and how much. In addition, as technological advances have increased understanding of groundwater resources and the connections between aquifers and surface water, surface and groundwater rights will continue to become managed as a single resource.

Water rights systems have not historically involved ecological considerations. At times of low flows, all water might be allocated among out-of-channel uses. Maintaining instream flows is necessary for a variety of aquatic and riparian ecological communities. A variety of arguments have been used for instream flow protection. In the 1983 case *National Audubon Society v. Superior Court of Alpine County* before the Supreme Court of California, the city of Los Angeles was challenged over damage to Mono Lake caused by the city's upstream diversions. Lake salinity increases were harming food supplies for migratory birds, and creating land bridges for predators to access nesting sites on islands. The court ruled in favor of the National Audubon Society, holding that the government must consider public trust duties when allocating water. Under the public trust doctrine, government has the responsibility to safeguard important uses of waterways, including commerce, navigation, and environmental amenities.

The Endangered Species Act (ESA) has also seen application toward the goal of maintaining instream flows in the face of riparian and appropriative claims on water. On the Klamath River in Oregon and California, farmers sought diversions for irrigation that threaten the federally listed endangered sucker fish and threatened Coho salmon. In 2001 farmers were restricted in their allotments to provide adequate water for fish under the ESA. In 2002, flows for fish were reduced, contributing to the deaths of tens of thousands of salmon. Native American tribes including the Yurok, Hupa, and Karok on the Klamath have been heavily impacted by lost salmon runs. Native American water rights are poorly codified, but when sufficiently documented, are often considered senior to other water rights.

SEE ALSO: Anthropocentrism; Biocentrism; Endangered Species Act; Groundwater; Habitat Protection; Irrigation; Klamath Basin; Native Americans; Property Rights; Public Trust Doctrine; Riparian Areas; Water Law.

BIBLIOGRAPHY. David Getches, *Water Law in a Nutshell* (West Publishing, 1997); David Gillilan and Thomas Brown, *Instream Flow Protection* (Island Press, 1997); Mark Reisner, *Cadillac Desert: the American West and its Disappearing Water* (Penguin Books, 1993); Joseph Sax et al., eds., *Legal Control of Water Resources: Cases and Materials* (West Publishing, 1991); Charles Wilkinson, *Crossing the Next Meridian: Land, Water and the Future of the West* (Island Press, 1992).

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Risk, Perception, Assessment, and Communication

RISK PERCEPTION IS the subjective judgment that people make about exposure to a hazard, the probability of occurrence and producing harm, and the dimensions of the event in a context of limited knowledge. That hazard may be of a natural, technological, environmental, or health nature. Each person has to live with risk and resolve in a situation of limited rationality because information is assumed to be costly, incomplete, and uncertain. All humans are exposed to risk because every human activity involves some degree of risk as a part of everyday life and, therefore, individuals seek to minimize it guided by their particular perception. This is very important but is not the only determining factor of human behavior; perception does not necessarily correlate with the actual risk dimensions because other personal, social, and political factors are intervening in the shaping of the individual and social understanding of risk. Experts are predisposed to think of risk assessment and management as objective and rational processes, but experts, scientists, and decision makers are still influenced by their perceptions as individuals. Although the term *risk perception* has a wide acceptance, some authors prefer the concept *risk judgment*.

The principal factors that affect the perception and determine acceptability of risk, level of concern, and ultimately risk-taking are: the characteristics of the hazard, the characteristics of the individual, and how the information is communicated.

HAZARD CHARACTERISTICS

Given that different types of risk generate different behavioral reactions, identifying their nature facilitates the comprehension of the relationship. Individuals overestimate the risk associated with unusual hazards, such as a meteorite fall, and novel hazards, such as SARS, while they tend to accept more common risks that are regarded as an inevitable part of everyday life, such as driving, and those that add value to life, such as practicing high risk sports—scuba diving, skiing, rock climbing, etc. Low frequency hazards induce some individuals to ignore the risk and to not take actions to minimize their exposure but, on the contrary, to increase it. This is linked to cost judgment—if individual benefits are perceived to be lower than mitigation costs, then inaction occurs, and people maintain or increase vulnerability.

A risk taken under the personal control and responsibility of an individual—a voluntary exposure—is more readily accepted than an involuntary risk, which is outside the control of the individual, such as driving a car versus flying. There is more concern about hazards which, despite having a low frequency, are associated with a low survival rate. There is less concern about those that are frequent and have more victims, and are associated with a high survival rate, i.e., plane crashes versus car accidents.

Risk derived from technological hazards is commonly less accepted than risk associated to natural hazards, due to its associated interference with nature. People feel the threat has originated from a supposedly inappropriate individual or company action, and social costs are estimated to be higher, the result of social inequity and greater exposure of the less favored, like in the big industrial disasters of Bhopal or Chernobyl. New technologies generate a certain level of perception that is an early indicator of some of the associated potential risks that have to be successfully addressed in risk communication before implementing the new development to avoid having the perception remain strongly rooted. High frequency exposure leads to a low risk perception as opposed to low frequency and more catastrophic events. Situations are perceived as more risky if they have delayed or long term effects; if they are difficult to understand; or if alternative options do not exhibit demonstrable benefits or advantages. Delayed effects, low frequency, unintelligibility, or novelty bring uncertainty, an undesirable state.

INDIVIDUAL PERCEPTION

Perception of a risk comprises both cognitive and affective components, and risk communication should focus on the two, as decisions are driven by both components. Affection, which relies on images and associations and materializes as concern, is often assumed to be post-cognitive because it is a manifestation of the experiential system, which enabled human beings to survive before the complete development of the rational system. But perceptions based on affection are not necessarily inadequate. Affective reactions to risk occur involuntarily, rapidly, and sometimes drive immediate actions. Both the rational and emotional systems work in parallel and depend on each other. People base their judgment not only on what they think about it but also on what they feel about it, jointly shaping individual perception.

Optimistic bias (also known as unrealistic optimism) is a phenomenon observed in some individuals consisting on the tendency to believe that they are less exposed or less likely than other people to suffer the effects of a hazard, and more likely to experience benefits. This perception is based on an absence of motivation to admit vulnerability, or on cognitive reasons, such as the failure to comprehend or apply probabilistic principles. Optimistic bias generally comes up in situations when risk is perceived to be under individual control rather than under unmanageable conditions.

Risk perception is socially and individually constructed as the result of knowledge, education, experience, and values. Individuals, on the basis of gender, age, income, disabilities, and other characteristics, have a unique perception of their environment and experiences associated with those individual-level factors. Gender differences relate to hazard magnitude and risk awareness. It has been observed that women tend to judge risks as greater than do men. Men with similar educational levels have been found to consider themselves more knowledgeable of hazard, risk, and eventual outcomes than women. Age seems to principally determine variation in the sensibility to the type of hazard. Religion affects individual values because it offers an elaborated interpretation of reality, adjusting behavior to predetermined patterns, although the level of literacy tunes the function of this variable.

It has been observed that certain communities ignore warnings of a hazard or disregard risk response because they consider these to be Western points of view. The level of knowledge gained has an effect on the degree of uncertainty experienced and the subsequent behavior, adjusting risk memory. The sources of information may be both risk information or earlier personal experience with risk. Nevertheless, less-educated people are more likely to misinterpret information and to deny evidence gained from scientific analysis and observation in favor of religious values of divine destiny. This suggests that risk communication strategies need to be adapted to local conditions every time.

The effects and magnitude of an event or condition are emphasized over the probability. People find it difficult to interpret percentages or rates alike, tend to interpret risk in binary terms of occurrence or nonoccurrence, and to emphasize those potential effects which are, apart from negative, unknown, as opposed to the positive outcomes of risk. Decisions made are a trade-off between losses and benefits, however, gains are most commonly ignored or considered less important.

In 1969 it was proposed that voluntary risks are more acceptable to people than imposed risks.

Attitudes are the result of a rational integration of expectancies and values in consideration of certain outcomes from a behavior. So behavior is the manifestation of an attitude, although various behaviors may result from the same attitude for the intervention of other expectancies.

Risk taking is the attitude with respect to exposure to a hazard and the assumption of the effects of an event, and is primarily associated with perception of returns and risk. There are two identifiable basic attitudes with respect to risk: Risk averse and risk seeking. An individual does not steadily have the same attitude at different times in the same context.

The field of finance explains this attitude in the framework of risk-return. Within this framework, the preference for risk is the result of a trade off between an expected benefit and estimated loss, in the context of a perceived risk. Those subjects who seem to have a preference for and appear to take big risks have an optimistic perception. They seem to recognize the differences between a situation of uncertainty and uncontrollable factors and a situation where management helps to reduce uncertainty by means of information availability and mitigation. What appears to be a risk seeking attitude is translated into a managed low risk situation.

Perceptual differences of risk among experts, policy makers, and laypersons often lead to conflict and mistrust. Science is seen in the double perspective of source of knowledge and source of risk. Some technologies are perceived as a threat, such as nuclear power or genetically modified food, and a decline in public trust in technology has been observed. In the same way, knowledge brings certainties, but distrust in science partly originates in the scientific method, which constantly questions standard science as new observations are made to develop new understanding.

Distrust also stems from questioning the limits of scientific knowledge, in the conviction that science cannot explain everything. Accordingly, people perform a metajudgment process, a judgment of what to believe of what experts say. The two rival rationalities collide and where scientists see opportunities, lay people recognize uncertainties and extend distrust to the whole scientific community.

In order to increase the influence of science in shaping public attitudes to risk and gaining public support for increased research, the gap between the scientific community and society should be broken by approaching the people, improving communication and using comprehensible language. Nevertheless, experts and nonexperts alike are prone to misinterpretation of facts. The expert's knowledge and perception of risk is not value-free but built subject to the same cognitive, affective, and cultural constraints, though he or she commonly perceives a lower risk level.

TRUST

Trust is the expectation that an individual, group or institution will predictably act appropriately and favorably and will be reliable in responding to prevention, response, and recovery situations. It is the basis for gaining support in decision making, but its effect on perception seems to be fairly small. Public trust is a fragile condition, difficult to maintain and hard to restore when lost, so decision makers should address the reinforcement of trust in risk assessment and in their capacity to manage risk. Conversely, risk perception and judgment is not easy to change, so a policy option is to seek modifying community perception of risk management and reach a level of tolerance of certain risks in return for an effectiveness of risk preparedness and response.

Administrators take their measure of public perceptions into account to make decisions, and it has been found that people and the politicians they elect share risk perception and priorities. Furthermore, they are predisposed to side with the public in their reluctance to trust scientific understanding. However, their beliefs do not fully correspond to public opinion for it is partly shaped by the mass media and the more active and concerned citizens, stakeholders who effectively communicate their own perceptions. Also, elites from administration, media, and the scientific community show more influence from ideological thinking than lay people do. The study of risk perception has occasionally been seen as a threat by experts and politicians, because it may increase the role of the people in the process of decision. Thus, public participation in risk assessment and management is debated, because it seems not to increase trust in risk management. Still, the complexity derived from the intervention of psychological factors and the need for gaining public acceptance and support in implementing decisions makes public participation in governance necessary.

THE PRECAUTIONARY PRINCIPLE

When concern about a specific process challenges current policy practice, additional measures based on the precautionary principle are usually invoked. In this sense public participation may be seen as an application of the precautionary principle. The application of the precautionary principle at an early stage of a hazard emergence may be operative and functional as a political option under uncertainty and as a response to public concern. However, it should not replace risk assessment, nor become a basis for political inaction. There is not sufficient agreement in regard to the application of the precautionary principle as a risk management strategy in risk perception. Critics maintain that action should only be based on scientific evidence, because public perception can be easily manipulated toward spurious interests.

The precautionary principle maintains that action should be taken, regardless of the likelihood of a risk, to mitigate and prevent the impact from a hazard by adopting various courses of action. The most immediate strategies are eliminating the risk source or minimizing exposure. The precautionary principle applies when there is a high degree of scientific uncertainty or when probability is not being understood by decision makers or the public. In these cases political decision makers may take action to handle public fears. However, two contrasting results may result from this action. While some authors claim precautionary measures will increase trust in risk management and a decrease in risk perception, others maintain the adoption of these measures will produce risk amplification, by reinforcing the perception that a risk is real in spite of the scientific uncertainty.

RISK COMMUNICATION

A basic statement is that with information accessible, people can make informed—not better—decisions. Also, information availability does not mean more knowledgeable decisions, or full understanding of the dimensions of risk, for the intervention of cognitive processes and attitude. Sometimes it happens that the more information there is about the hazard, the more resistance there will be toward accepting the source of risk, because undesirable components are identified in the process. The role of decision makers is to contribute to adjusting the discrepancies—on the one hand, between non-perceived and substantial risks and, on the other, between perceived and unsubstantial risks. Information on risk is critical, but the impact on perception seems to be very sensitive to how it is transmitted.

Risk communication is a process-related measure, like public participation, with a substantial influence on people's risk perception since it favors more fully informed and rational decisions. The process of communication involves both conveying and interpreting information on the dimensions of the hazard, and the relationship between the source and the probability of the event. The presentation of the information has a notable influence on risk interpretation and perception, because the same message can be framed positively or negatively. The effect is comparable to transmitting uncertainty; in the case of a low degree of scientific knowledge, the public interest is driven to the unknown instead of to the known facts. Positive framing, or highlighting ways to avoid the hazard or mitigate its effects, helps people to assume necessary risks, like in sessions of chemotherapy, strengthening the positive effects against those negative. With the use of negative framing communication the adoption of low cost protection measures while avoiding a high impact may be strengthened. This class of presentation has more effect on individualistic subjects than on cooperative subjects.

MASS MEDIA

People receive most information on hazards and risk management through the mass media. Its role in risk communication is decisive in changing community perception and in the definition of priorities of the public and administration, as has been observed when there have been changes in the amount of media coverage of an event. However, some media channels have drawbacks. The synchronicity between the news and coverage does not leave sufficient time to ponder how to process it, or to use qualified sources of information. The use of conventional or unconventional channels has a major impact, since they have various delay times. The journalist does not need to be a risk communication specialist and may interpret the information inadequately, like the other actors. The attitude of the receiver can have a major effect on the understanding and interpretation of the message. In turn, the attitude may be influenced by political, public, or media pressures. Public persuasion to accept a risk, challenging a rooted negative perception, may prove counterproductive if they feel intimidated to change their judgment.

MODELS OF RISK COMMUNICATION

A first model of risk communication, predominant since the early 1980s, understood the process as a one-way transfer of scientific information to increase people's knowledge, dismiss misconceptions, and support public policies of risk management. By the late 1990s, the dominant risk communication model shifted to conceive risk in its complexity and recognize its social dimension. From this perspective, science, politics, and social actors interact, negotiating their interests and perceptions in the public arena. Risk communication becomes an imperative instrument to improving governance by gaining and maintaining public confidence and trust in public institutions. It seeks to identify the critical gaps and misconstructions in risk knowledge by analyzing the level of understanding of hazard, risk, mitigation and response, in order to improve the efficiency of the communication effort.

Disciplines within the social sciences have developed several approaches and theories to explain the roles and interactions between psychological, social, and economic factors in the construction of risk, as the natural sciences do in the study of the dimensions of hazard. Three major theories have been elaborated to approach the study of risk perception: The psychometric paradigm, the social theory of risk, and the cultural theory.

Preliminary research and earlier theory was completed by Chauncey Starr who in 1969 published a paper in *Science* titled, "Social Benefit versus Technological Risk," identifying that human acceptability of a certain technological risk condition is the result of a balance through trial and error between the accepted level of risk and social benefits. According to this, the more benefits gained the more risk accepted, until reaching a sort of climax. He also found that voluntary risks are more acceptable than imposed risks, even if the former are larger. In his study Starr applied the revealed preference method, based on the assumption that decisions are based on their intent to maximize their utility.

THE PSYCHOMETRIC PARADIGM

Although the psychometric paradigm was elaborated by Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein in the 1980s, earlier studies were performed by Daniel Kahneman and Amos Tversky in the 1970s. They formulated concepts that broadly influenced the social sciences, such as the cognitive processes underlying the formation of preference and belief and problem framing in communication, and gave rise to the new field of behavioral economics. According to these authors people are guided by heuristics to interpret risk information. When individuals face a complex problem or do not have sufficient information they tend to simplify it, relying on heuristics, an approach for problem-solving or finding explanations. Heuristics are often very useful and yield valuable solutions but sometimes lead to erroneous judgments. Amos Tversky and Daniel Kahneman have identified three important heuristics employed when making judgments under uncertainty: Representativeness, adjustment, and availability.

Representativeness is used to assess the probability of an event by finding a comparable event, with similar features or generating process, assuming that the probabilities will be similar. Anchoring and adjustment, considered the most important for understanding risk perception, is used to assess an outcome on the basis of incomplete information as a starting point and then adjust it to make an estimation. In the light of new information a new assessment is accomplished. Availability is used to assess the likelihood of an event or an outcome on the basis of the accessibility to other associated events in the memory. Easily recalled events, which had a major public impact in media, are considered to be more probable than scientific evidences. The gain-loss asymmetry indicates that individuals are conservative when offered gains and adventurous when faced with loss because this threat has a greater impact than an equivalent gain. This heuristics is the basis for insurance.

The theory behind the psychological perspective argues that public perception of risk is psychologically determined, driven by emotional reactions, and its subjective nature can be measured by qualitative risk characteristics. Risk perception measurement is done by using any of the two general approaches elaborated. With an objective approach the individual is asked to evaluate prescribed levels of risk for different situations; with a subjective approach the individual is asked to rate a situation according to their own levels. The attributes assessed may be global, ranking the hazard as a whole, or dimensional, differentiating some particular features. After surveying people's ratings the large sets of data are reduced to those few dimensions which capture most of the variability. The results identified three key predictors of people's perception: Familiarity with the risk, dread or impact potential, and exposure. While earlier psychological theories basically focused on cognitive processes, later ones put more emphasis on affect, taking the traditional concept of dread.

THE RISK SOCIETY

The publication of 1992's *Risk Society* by Ulrich Beck catalyzed the study of another dimension of risk. According to Beck, this is unquestionably a risk society, after the scale of environmental change turned global with climate change or biodiversity loss, and uncertainty is an intrinsic component of the political process. In this new stage technology had a key role in homogenizing risk; the former class society has been substituted by a society that does not distinguish among groups.

The role of technology is two-sided; it brings solutions to deal with the problems and reduce uncertainty but, at the same time, generates risk. To produce risk has the side effect of being exposed to it. There is no chance for the application of the precautionary principle to avoid uncertainty. It is more advantageous to gain control of uncertainty and integrate it in decision making than to try to eradicate it in vain. There should not be a priori rationalities of risk, but they should instead be elaborated as the result of social negotiation through the process from analysis to management and from assessment to decision making. The various actors provide different categories of what is risk and what is acceptable, in an examination where experts are just another stakeholder.

THE CULTURAL THEORY OF RISK

The cultural theory of risk is based on the work of anthropologist Mary Douglas and political scientist Aaron Wildavsky, published in 1982. This theory focuses on the dependent condition of individual risk perception on group membership over individual factors. Within this framework, culture biases individual perception. Risk perception becomes a group phenomenon where common concerns contribute to strengthen its own articulation. It assumes that individual preferences for ways of life are patterned in four scaled world views or cultural solidarities: Hierarchy, egalitarianism, individualism and fatalism, based on shared ideas about how society, individuals, and the real world relate.

Its scaled standpoint and effect on risk perception is still controversial, but the views have been correlated to variables of age, gender, income, political orientation, and educational level. The world views reflect the extent to which individuals are incorporated into archetypal social groups. As group perceptions and attitudes differ, risk information impact is target-group dependent, so risk information strategies need to be tuned and adapted to each audience.

Hierarchists are characterized by a reliance on authority and regulation, believe in the rightness of rules and structures, and are afraid of disruptions of the present social order. Egalitarians are willing to accept group decisions based on negotiation even if they conflict with their particular interests. They favor voluntary social connectedness and reject authority by virtue of its position. Individualists tend to prefer few controls, beyond those required to maintain property, respond to the logic of market competition and reject cooperation, beyond contingent circumstances. Fatalists tend to feel pessimistic about current social structures and fear the worst. An action would be always uncertain and even counterproductive, so they reject cooperation and are isolated.

SEE ALSO: Chemical Additives (to Food); Chernobyl Accident; Mad Cow Disease; Movements, Environmental; Religion; Risk Society; Three Mile Island Accident.

BIBLIOGRAPHY. Ulrich Beck, *Risk Society: Towards a New Modernity* (SAGE, 1992); Mary Douglas and Aaron Wildavsky, *Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers* (University of California Press, 1983); Daniel Kahneman, Paul Slovic, and Amos Tversky, eds., *Judgment under Uncertainty: Heuristics and Biases* (Cambridge University Press, 1982); Lennart Sjöberg, "Factors in Risk Perception," *Risk Analysis* (v. 20/1, 2000); Paul Slovic, *The Perception of Risk* (Earthscan, 2000); Chauncey Starr, 2003, "The Precautionary Principle Versus Risk Analysis," *Risk Analysis* (v.23/1, 2003); Aaron Wildavsky and Karl Dake, "Theories of Risk Perception: Who Fears What and Why?" *Daedalus* (v.119/4, 1990); Iain Wilkinson, "Social Theories of Risk Perception: At Once Indispensable and Insufficient," *Current Sociology* (v.49/1, 2001).

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Risk Society

THE *RISK SOCIETY* is a concept describing the emergence of a social order organized increasingly around the politics of risk; it originated in the work of German sociologist and public intellectual Ulrich Beck during the late 1980s. This transformation is reflected in a widening of the public sphere, and of conventional realms of policy and politics, to include a range of environmental, scientific, and technological issues once considered beyond the scope of democratic politics.

The risk society has its basis in a general critique of Enlightenment ideals of science, technology, and expertise, and their application as normative models in social and environmental governance. It is argued that "scientism," seen in Beck's 1992 book *Risk Society* as a quasi-religious cultural form which conflates the meaning of human and technological progress, has served to justify all manner of environmental health risks in the name of economic value, growth, and efficiency.

Technocratic forms of expertise, in this sense, have legitimated the re-creation of the world as an uncontrolled experiment, one wherein the ecological consequences of widespread social changes—from industrial transformations to new medical technologies to nuclear reactors—tend to be knowable only after they have been incorporated into the social landscape. Or, as Beck describes the role of expertise in the "industrial sub-politics" of technology policy, "decisions only reach the desks of politicians and the public sphere after being taken." Reworking and extending philosopher Jürgen Habermas's theory of the public sphere, Beck envisions in the risk society a world wherein such technocracies are being broken down and reconfigured across a range of social sites. Transformations in the ways that governments and civil societies deal with the risks that they produce are occurring through oppositional movements and through rifts and cleavages within the scientific and engineering communities.

The premise of the risk society, then, is that the production of new environmental and technological hazards in recent decades, though commonly rationalized as the unexpected or unavoidable byproducts of industrial society, has engendered, at least in embryonic form, a political response—what Beck calls a second or *reflexive* modernity—which challenges many of the core propositions of the first (or industrial) modernity.

Disastrous global warming scenarios, ionizing radiation, and new uses of genetic technologies thus exemplify the kinds of unconfined experiments with the human environment which characterize the risk society, a world in which "the very idea of controllability, certainty, or security—which is so fundamental in the first modernity—collapses." And yet despite its somewhat grim emphasis on risk and hazards, the model is remarkable for its optimism: With the inevitability of risk-sharing as a basis for community, there is the possibility (albeit one based on necessity) for opening new social sites for direct democratic politics in areas that have historically been closed to public participation, such as in law, environment and resource policy, medicine and health, and in the politics of science and technology. There are indeed many limited examples of such political achievements in risk politics and the sub-politics of risk definition, including historical and ongoing struggles over workplace health rights and regulations, new forms of public accountability in scientific and medical research, and in the successes of varied Green and environmental justice movements.

Beyond the immediate aims of those engaged in particular issue-oriented struggles, and even where those struggles may appear merely as the defense of *de facto* rights, these risk conflicts, when viewed with lenses ground in Beck's utopian theory, have at times served as "leveling effects" that have mobilized activists, legitimated new rights demands, and impelled the creations of new political subjects. He writes:

> To be sure, risk cannot be banned from modern life, but we can and indeed should achieve new institutional arrangements that can better cope with the risks we are presently facing; not with the idea that we might be able to regain full control, but much more with the idea in mind that we have to find ways to deal democratically with the ambivalences of modern life and decide democratically which risks we want to take.

First published in German in 1988 in the wake of the unprecedented 1986 Chernobyl nuclear disaster, which scattered radiation from Ukraine in the (former) Soviet Union across international boundaries in northern and western Europe and North America, the *Risk Society* also gained currency alongside the rise of the German Green Party during the 1990s. Beck continued to develop his risk society concept in a series of essays written throughout the decade, later collected in the 1999 *World Risk Society* volume, in which the global and transnational dimensions of risk production are emphasized. Beck also develops in the latter work a more nuanced critique of science, and the role of scientific uncertainty, in risk politics. It is still the scientific-technical products and by-products of industrial and military political economies that have figured so prominently in the generation of environmental and public health hazards.

What is more, this realm of risk production has historically been regulated, Beck argues, by a "technocracy of hazards" through which "the engineering sciences continue to administer the privilege handed down to them … the right to determine according to their own internal standards the global social question of the most intensely political nature: How safe is safe enough?" And yet this "received monopoly of interpretation," i.e., the use of internal, self-validated standards, has at times been successfully challenged, including challenges originating among other scientists and sciences. For Beck, "new knowledge can turn normality into hazards overnight. … It is the successes of science which sow the doubts as to its risk predictions."

As a critique of technocracy, the risk society can thus be read constructively, neither antiscience nor antitechnology per se. In a world in which global warming and other environmental crises occur cheek by jowl with ongoing globalization, industrialization, and urbanization, building survivable futures, Beck argues, will depend not only on the scientific work of monitoring and evaluating all manner of risks, but also on an active role for some scientists and engineers in explaining and debating scientific-technical issues for (and among) a wider audience of stakeholders, politicians, and public participants. Science is at once a cause of environmental and health hazards, a necessary medium of their definition, and a potential (though not exclusive) source of their amelioration.

Developed chiefly to explain the German and European context, the risk society theory has been criticized for its Euro-centrism, whereas the emergence of what might be called post-materialist environmental values may be further from occurring in the world's poorer countries, where healthy environments are still more likely to be rendered as luxuries beyond the grasp of those engaged in day-to-day survival, or as resources for elite state and corporate actors to exploit. Indeed, the effects of Hurricane Katrina in 2005 in New Orleans, Louisiana, strongly indicate that race- and class-based models of social vulnerability to environmental hazards remain central to risk politics, even in the world's richest country.

Still, the risk society remains an important theoretical intervention aimed at identifying new political dynamics and frameworks for rights demands which go beyond the norms of place-specific, NIMBY activism. How is it possible, Beck asks, to achieve a shift in the burden of proof over what counts as "safe *enough*," and under what conditions? By lodging a critique against Enlightenment ideals of a singular science as the only legitimate, modern form of expertise, Beck's model also raises critical questions, resonating with the notion of the "precautionary principle," about what kinds of knowledge, and what values, should inform our decision making in the politics of environmental transformation, including those environmental problems for which absolute consensus may be difficult or impossible to achieve.

SEE ALSO: Chemical Additives (to Food); Chernobyl Accident; Mad Cow Disease; Movements, Environmental; NIMBY; Religion; Risk, Perception, Assessment, and Communication; Three Mile Island Accident.

BIBLIOGRAPHY. B. Adam, U. Beck, and J. Van Loon, eds., *The Risk Society and Beyond* (SAGE, 2000); U. Beck, *Risk Society: Towards a New Modernity*, trans. M. Ritter (SAGE, 1992); U. Beck, *Ecological Politics in an Age of Risk*, trans. A. Weisz (Polity, 1995); U. Beck, *World Risk Society* (Polity, 1999); S. Lash and B. Wynne, "Introduction," in U. Beck, *Risk Society* (SAGE, 1992).

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Rivers

RIVERS, OR LARGE natural waterways, have been used by man since prehistoric times. Remains of early man, such as those found by Louis Leakey in Kenya, have often been located in or near what had been river beds, as have pieces of flints used by prehistoric man during the Stone Age. The river provided water and fish; it was also an ideal place to hunt for animals that came in search of water.

Early towns and cities seem to have arisen alongside rivers, with the civilizations of Sumer, Ancient Egypt, and Ancient China all being heavily connected with rivers. By this time, people were growing crops and water was necessary to properly irrigate fields. It was also needed to provide water for domesticated animals, and as these settlements grew, rivers became important to wash away effluent from a town or city.

In the ancient world, the civilization of Sumer used the land between the Euphrates and Tigris Rivers, with that of Ancient Egypt emerging on either side of the River Nile. Although it is likely that the Sumerians did construct many boats—the Norwegian adventurer Thor Heyerdahl proved that the Sumerians could have sailed down the east coast of Africa with his Tigris expedition—the Egyptians certainly had many ships. Indeed, the stones to make the Great Pyramid of Cheops would have had to be brought by river from the quarry to Luxor. In China, settlements started to appear along the Yellow River (or Huang Ho), and in India, the earliest civilization is called the Indus Valley after its location along the River Indus. By this time the rivers were being used for two more purposes. With the construction of boats, they provided a method of trading with nearby places, and eventually with other civilizations. They also formed a natural barrier for the city to defend itself from attack.

Gradually more and more major cities arose alongside rivers. Rome, on the River Tiber, was clearly a better location than some of the nearby Etruscan settlements. In Roman Britain, the original capital of Camulodunum (Colchester) was quickly supplanted by Londinium (London), owing to the easier accessibility of the latter along the River Thames, with the River Colne through Colchester being harder to navigate. Even many inland capitals, such as the Thai medieval capital of Ayudhya, were located on rivers. The city of Manaus in Brazil is largely an anomaly created from a small port on the River Amazon that happened to be the closest to the area where wild rubber could be cultivated from the 1890s until the 1910s.

Although rivers have provided access to cities from ancient times to the present day, they also often demarcate the borders between countries, provinces, or states. In the case of the Roman Empire, the River Rubicon marked the boundary between Cisalpine (Italian) Gaul and what was then defined as Italy. During the Roman Republic (509–27 B.C.E.), no Roman general was allowed to bring his forces south over the river. If one did so, they disobeyed the law Lex Cornelia Majestatis, and were directly challenging the authority of Rome. Thus, when Julius Caesar, in 49 B.C.E., decided to cross

Many early settlements depended on rivers for water, fish, and irrigation—and waste removal.

the river and attack Rome, it led to the term *crossing the Rubicon,* or passing the point of no return. The Romans also used the River Danube to mark the furthest north that their empire stretched. The Treaty of Versailles in 1919, at the end of World War I, included a clause that German troops could never be deployed on the west bank of the River Rhine, the "Rhineland," although Hitler did this in 1936. In 1954 at the Geneva Agreements on Indochina, Vietnam was partitioned into North Vietnam and South Vietnam along the Bei-Hai River.

Today, there are many countries that have borders delineated by rivers. In most cases, the river boundary means that either both countries or states have access to the river, or that it is divided down the middle. An interesting exception is the border between the Australian states of New South Wales and Victoria, with the entire Murray River being in New South Wales, meaning that fishermen, even if they are standing in Victoria, need to get a New South Wales fishing permit for the Murray as the fish they catch would be from another state. One geographical curiosity, in terms of rivers, is The Gambia, a West African country, formerly a British colony, that straddles both banks of the River Gambia.

As well as being natural barriers for defense, rivers have often been seen as an easy method of attack. During the War of 1812 the British used the Potomac River to attack Washington D.C. In the American Civil War, the Union forces spent much energy in capturing the city of Vicksburg on the Mississippi River and cutting the Confederacy into two. Curiously, Beijing is one of the few major cities in the world that is not located on a river. This helped protect it from naval attack, delaying European forces in 1860 and again in 1900.

In some countries and cultures, particular rivers mark very important symbolic and historical events. For India, the River Ganges is of great significance to all Hindus who bathe in it at particular times of the year. At the Partition of British India into India and Pakistan in 1947, some militant Hindus made claim to the River Indus, wanting it to be diverted through India. The Yalu River representing the boundary of North Korea with China has political significance to the North Koreans from the fighting along it during the Korean War. One of the causes of the Gulf War (1990–91) was that Iraq wanted greater access to the Persian Gulf, wanting to have enough land to establish a deep-water port at the mouth of the River Euphrates.

There are a number of countries that are named after their major rivers. Technically, India is named after the River Indus, although it is no longer in India. The others are Republic of the Congo; Democratic Republic of the Congo; The Gambia; Niger and Nigeria; Paraguay; and Senegal. In 1806 Napoleon created the Confederation of the Rhine, but it fell apart with Napoleon's abdication in 1814.

Although explorers and geographers have long debated which is the longest river in the world, it is now accepted that it is the River Nile (approximately 4,160 miles long), followed by the Amazon (3,920 miles), the Yangtze (3,900 miles), the Mississippi-Missouri (3,870 miles), the Yenisey-Angara (3,440 miles; in Siberia), the Yellow River (3,400 miles), the Ob-Irtysh (3,360 miles; in China and Siberia); and the Congo/Zaire (2,900 miles).

SEE ALSO: Chang Jiang (Yangtze) River; Congo River and Basin; Danube River; Ganges River; Huang (Yellow) River; Lakes; Nile River (and White Nile); Rhine River and Valley; Tigris-Euphrates River.

BIBLIOGRAPHY. *Great Rivers of the World* (National Geographic Society, 1984); S.M. Haslam, *The River Scene* (Cambridge University Press, 1997); *Rand McNally Encyclopedia of World Rivers* (Rand McNally, 1980); Claudia W. Sadoff, Dale Whittington, and David Grey, *Africa's International Rivers: An Economic Perspective* (World Bank, 2002); Stanley A. Schumm, *The Fluvial System* (Wiley, 1977).

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Rocky Flats Facility

BETWEEN 1952 AND 1988, the Atomic Energy Commission (AEC) was responsible for the operation of the Rocky Flats Plant. The Dow Chemical Company managed the facility on behalf of the AEC, producing nuclear material for atomic weapons. Located about 15 miles (24.13 kilometers) northwest of Denver, Colorado, the site was a windy plateau called Rocky Flats. The ground breaking for the facility was on July 10, 1951; in 1953 the plant began production of plutonium triggers, which were used in nuclear weapons assembled at the Pantex plant in Amarillo, Texas. Between 1953 and 1957 the construction of facilities at Rocky Flats continued. In 1957 there were 27 buildings when an industrial accident resulted in a fire in Building 71. After the fire Building 71 was found to be radioactive and an incinerator for eliminating plutonium waste was installed in the patched remains of Building 71, which began operation in 1958. In 1959 radioactive waste stored in barrels in an open field at Rocky Flats leaked. The public was not notified of the problem and radioactive materials were allowed to remain in the open, blowing in the wind. In 1969 another major fire produced the most expensive industrial accident in American history up to that time.

As the danger of radioactive contamination had increased, a larger buffer zone of 4,600 acres (18 square kilometers) was created in 1972. However, in 1973 tritium was detected in creeks and other areas in the vicinity of the Rocky Flats plant. In the late 1970s protests by pacifists and in turn by supporters of nuclear weapons increased. By the 1980s, peace activists were able to increase the size of their demonstrations. In 1985 Rocky Flats was able to receive industrial recognition for the safety of its operations. However, only three years later the Department of Energy (DOE) issued a scathing report on its safety failures. The EPA fined the plant for environmental violations. Safety issues became so charged that the Federal Bureau of Investigation (FBI) began receiving tips from employee whistle blowers about unsafe conditions at the plant. After an investigation, the FBI charged the DOE with violating federal antipollution laws. The case was resolved when Rockwell paid a small fine for the crimes.

In 1993 all of the Rocky Flats weapons grade nuclear material was transferred to other facilities. The next year, the name Rocky Flats was changed to Rocky Flats Environmental Technology Site. During the late 1990s and early 2000s massive clean up projects were instituted. In 2003, the cleanup was completed; however, some areas still remained radioactive. In 2006, a federal jury awarded $354 million to landowners downwind from Rocky Flats. Dow and Rockwell appealed the verdict because they believe that the radioactive releases were too small to cause harm.

SEE ALSO: Department of Energy (DOE) (U.S.); Environmental Protection Agency (EPA); Nuclear Weapons.

BIBLIOGRAPHY. Len Ackland, *Making a Real Killing: Rocky Flats and the Nuclear West* (University of New Mexico Press, 2002); Kim S. Cameron and Marc Levine, *Making the Impossible Possible: Leading Extraordinary Performance—the Rocky Flats Story* (Berrett-Koehler Publishers, 2006).

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Rocky Mountains

THE ROCKY MOUNTAINS of North America claim many conservation firsts. The U.S. Congress established Yellowstone as the world's first national park in 1872. Less than 20 years later, Canada designated its own first national park in Banff in 1887 (a small reservation for the "sanitary" mineral springs in the Banff town site had already been established in 1885). Canada would go on to establish the world's first governmental park agency in 1911. One of the first successful efforts to save an endangered species, the bison (*Bison bison*), occurred in the Rocky Mountains. Canada and the United States established the world's first "peace park" in 1932: The Waterton-Glacier International Peace Park.

As the major feature of the *Laramide orogeny*, a term geologists use to designate the period of mountain building in the West that lasted from the Cretaceous to the mid-Tertiary (80–35 million years ago), the Rocky Mountains are a familiar geological formation to most North Americans. Yet the geologic Rockies do not translate into a widely accepted geographical area. Some have defined the Rocky Mountains as extending from northern British Columbia south to New Mexico, while others see the Rockies as commencing in the Brooks Range of Alaska all the way through Mexico's Sierra Madre Occidental (although inclusion of this latter range is uncommon). Thus, the Rocky Mountains stretch between 3,000 kilometers to nearly 7,000 kilometers on a north-to-south arc across the continent.

Lack of agreement among geographers, scientists, and conservationists over the geographical expanse of the Rockies extends to the delineation of subregions (sometimes called "bioregions" or "ecoregions," although scientists have yet to adopt strict definitions for these terms). In addition to the "Arctic Rockies" (the aforementioned Brooks Range) and the Sierra Madre Occidental, other widely used designations include the Southern Rockies, the Central Rockies, and the Northern Rockies.

In an international context, however, this loose terminology has led to confusion. For example, the term "Northern Rockies" carries significantly different connotations in the United States than it does in Canada. Canadians think of the "Northern Rockies" as the mostly untouched and rugged terrain of northern British Columbia, while in the United States the term refers to the Rocky Mountains of Montana, Idaho, Wyoming, and northeastern Washington.

Conservationists have approached the region from a number of perspectives, including ecology, biogeography, human culture, and politics. Probably the most comprehensive conservation effort to parse the landscape of the Rockies has come under the aegis of the Wildlands Project, a conservation initiative whose mission is to maintain and restore a system of large, connected protected areas throughout the North American continent. Of these Rocky Mountain subregions, by far the largest in geographical extent is the Yellowstone to Yukon (or "Y2Y") region. Others include the "Heart of the West" (roughly southeast Idaho, southwest Wyoming, northwest Colorado, and northeast Utah), the "Southern Rockies Wildlands Network" (mostly the Colorado Rockies, extending north into Wyoming and south into New Mexico), the New Mexico Highlands, and the northern Sierra Madre.

Although the biological sciences have weighed heavily in these regional designations, they are ultimately heuristic and not the only approach. Cutting across ecosystems are watersheds. The Rocky

Mountains are home to the headwaters of North America's greatest rivers: the Porcupine/Yukon, the Columbia, the Fraser, the Missouri/Mississippi, the Colorado, and the Rio Grande. They link the Rockies and some species to the Pacific Ocean and Gulfs of Mexico and California. A watershed approach looks quite different than one with a terrestrial emphasis.

Many argue that broad regional approaches constitute the only means of protecting all native species—most notably wide-ranging species—as well as large-scale ecological processes. Without top predators and wildfire, for example, the landscape becomes impoverished over time. Conservation at this broad scale also entails the political benefits of generating networks among geographically dispersed conservationists, scientists, and concerned citizens. In some cases, such as Y2Y, the creation of a regional identity has increased financial support for conservation work.

At the same time that a broad regional approach is requested, hundreds of locally focused efforts are underway throughout the Rockies with the aim of protecting privately held land through direct ownership or conservation easements. In addition to these two mutually supportive conservation trends at the regional and local levels, traditional governmental regulation—be it through improvement in hunting regulations, or public land management practices—remains vital to the ecosystem health of the Rocky Mountains.

The Rockies arguably constitute North America's most intact landscape, holding out both tremendous conservation challenges and opportunities. The challenges range from invasive species, fire suppression, and roads to mining, overgrazing, and oil and gas exploration. Perhaps most ominously, large numbers of people are migrating to the region—degrading the very amenities that attract them. On the other side of the coin, the elevation and latitudinal gradients will also likely make the Rockies relatively resilient in the face of climate change, and thus the region may constitute the continent's best hope for long-term biodiversity conservation. Overall, species protection is much easier than restoration; with most native species still extant in significant parts of the Rocky Mountains, the prospect of long-term conservation is within reach.

SEE ALSO: Biodiversity; Mountains; National Parks; United States, Mountain West; Yellowstone National Park.

BIBLIOGRAPHY. Jill Baron, *Rocky Mountain Futures: An Ecological Perspective* (Island Press, 2002); Frank Clifford, *The Backbone of the World: A Portrait of a Vanishing Way of Life along the Continental Divide* (Broadway Books, 2002); Ben Gadd, *Handbook of the Canadian Rockies* (Corex Press, 1985); T.J. Stohlgren, "Rocky Mountains" in M.J. Mac, ed., *Status and Trends of the Nation's Biological Resources* (U.S. Department of the Interior U.S. Geological Survey, 1998).

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Romania

IN 1859, THE principalities of Wallachia and Moldavia united into what became the country of Romania. Although Romania joined the Allied Powers in World War I, the country opted to join the Axis Powers in World War II. After the war, Romania became part of the Soviet bloc of nations and came under the domination of the tyrannical Nicolae Ceausescu from 1965 until his overthrow and execution in 1989. Since that time, a state of widespread underdevelopment, in part a product of state capture by elites, has prevented Romania from prospering financially and from joining the European Union (EU).

Bordering on the Black Sea, Romania has 225 miles (362 kilometers) of coastline. The climate is temperate, with cold, cloudy, and snowy winters and foggy, sunny summers with frequent precipitation. One of the main topographical features of Romania's landscape is the Transylvanian Basin. On the east, the Carpathian Mountains, which cover 30 percent of Romania's land area, separate the basin from the Plain of Moldavia. In the south, the Transylvania Alps separate the Walachian Plain from the basin. Earthquakes are common in Romania, particularly in the south and southwest. The climate and geological structure also make Romania vulnerable to frequent landslides.

The country remains poor despite its rich natural resources. Almost 41 percent of Romania's land is arable, and 31.9 percent of the workforce are involved in the agricultural sector. Petroleum is also a major resource, but reserves are declining. Other natural resources include timber, natural gas, coal, iron ore, salt, and hydropower. With a per capita income of $8,300, Romania ranks 96th in income among nations of the world. Approximately 30 percent of the 22,329,977 people live below the poverty line. Some 43 percent of the population lack access to safe drinking water, and 49 percent do not have access to improved sanitation. The United Nations Development Programme Human Development Reports rank Romania 64th on general quality-of-life issues.

Environmentally, Romania suffers from soil erosion and degradation. Industrial effluents have led to significant levels of water and air pollution in the south, and the wetlands of the Danube delta are severely contaminated by hydrocarbons from refineries. In 1997, the Danube Pesticide Region Study revealed that Romania retained higher levels of DDT and lindane than any other country in the study. Due to high contamination of chlorinated pesticides in the Danube River Basin, Romania was identified as an environmental "hot spot."

Around 55 percent of Romanians live in urban areas, and there are 144 cars per 1,000 people. Outside of urban industrial areas, much of Romania is relatively pollution free. In a 2006 study conducted by Yale University, Romania ranked 90th among 132 nations on environmental performance, below both the relevant income and geographic group averages. The ratings were particularly low in air quality, sustainable energy, and biodiversity and habitat.

The problems endemic in the Romanian government have hampered the efforts of environmentalists since the Soviets left Romania with extensive environmental damage. One of the few active citizens' groups is working to prevent mining exploitation in Rosia Montana in the Apuseni Mountains. Since ancient times, gold and silver have been found in this village. Less than 5 percent of Romanian land is protected by the government. Of 83 mammal species endemic to Romania, 17 are endangered, and eight of 256 endemic bird species are threatened with extinction.

In the mid-1990s, the Ministry of Waters and Environmental Protection began working with the Danish Environmental Protection Agency and the National Research Development Institute for Environmental Protection to develop a National Environment Protection Strategy and a National Environment Action Plan. Subsequently the Romanian Parliament enacted the Law on Environmental Protection and the Law on Environmental Impact Assessment and a number of supplementary bills. Overall, 286 environmental projects were planned, and of these, 233 were designated as immediate priorities.

The Romanian government has expressed commitment to the global environment by participating in the following international agreements: Air Pollution, Air Pollution–Persistent Organic Pollutants, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Danube River; DDT; Drinking Water; Habitat Protection; Mining; Petroleum; Pollution, Air; Pollution, Water; Poverty; Soil Erosion.

BIBLIOGRAPHY. Central Intelligence Agency, "Romania," *The World Factbook,* www.cia.gov (cited April 2006); Economic Commission for Europe, "Environmental Performance Review of Romania, 2001," www.unece.org (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); United Nations Development Programme, "Human Development Reports: Romania," hdr.undp.org (cited April 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); David Wallace, *Environmental Policy and Industrial Innovation: Strategies in Europe, the United States, and Japan* (London: Earthscan, 1995); World Bank, "Romania," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Roosevelt, Theodore Administration

THEODORE ROOSEVELT (1858–1919) was the first American president (1901–09) to successfully promote conservation as an issue important to domestic politics. His passion for conservation grew from his lifelong interest in natural history and hunting. As a boy, he kept meticulous notebooks describing the natural world and collected specimens in order to make accurate observations about the physical characteristics of wildlife.

EARLY INFLUENCES

Roosevelt never outgrew his childhood interest in the natural world. From his ranch in North Dakota he wrote several books drawing on his experiences on the Western frontier. Among his writings are: *Hunting Trips of a Ranchman* (1885), *The Winning of the West* (1889–96) and *Ranch Life and the Hunting Trail* (1888). While living on the ranch Roosevelt became concerned over disappearing wildlife habitat, which he believed was the result of uncontrolled cattle grazing.

His fears about overgrazing were realized when a major drought occurred in the summer of 1886, followed by an unusually brutal winter that killed hundreds of thousands of livestock by starvation and exposure. This event, known as Great Die-Up of 1886–87, coupled with a lifetime of exploration and study of nature, fostered in Roosevelt a concern for the sustainable use and protection of natural resources that played a central role in the domestic policy of his presidency.

THREE PRINCIPLES

Roosevelt's concern over the environment was driven by three principles: conservation should serve as a utilitarian tool for sustained economic growth providing the greatest good for the greatest number; wilderness and frontier experiences played a critical role in shaping America's identity; and the nation's unique natural wealth should be protected for future generations. The challenge in balancing these views is illustrated in Roosevelt's 1903 speech on the forestry service. According to Roosevelt, the primary objective is:

> not to preserve forests because they are beautiful—though that is good in itself—not to preserve them because they are refuges for the wild creatures of the wilderness—though that too is good in itself—but the primary object of forest policy … is the making of prosperous homes, is part of the traditional policy of homemaking in our country.

Roosevelt's belief in the importance of natural resources for "homemaking" was reflected in his conviction that conservation should be a central element of a strong democracy. He believed that westward expansion and frontier life in the United States had created an identity for Americans that separated them from their European roots. And he hoped to provide the opportunity for modern Americans to experience the wilderness, where they could develop self-reliance and courage and experience the benefits of hard work, attributes that Roosevelt felt were central to a strong democracy.

But Roosevelt worried that the nation's dependency on natural resources could become a weakness if these resources were overexploited. In 1907, in his Seventh Annual Message to Congress, Roosevelt declared:

> there must be a realization of the fact that to waste, to destroy our natural resources, to skin and exhaust the land …, will result in undermining in the days of our children the very prosperity which we ought by right to hand down to them amplified and developed.

It was a blending of Roosevelt's utilitarian ethic, his conviction that conservation strengthens democracy, and his romantic notion that the transcendent qualities of nature enriched mankind's spirit that inspired him to create the first of many protected areas. In 1903, Roosevelt visited Pelican Island in Florida, a nesting ground for shorebirds. Current fashion had driven a demand for plumes for women's hats that was decimating shorebird populations. To counter the possibility of massive extinction, Roosevelt created Pelican Island Bird Reservation, the first of over 50 bird refuges that he established during his presidency.

Roosevelt's conservation agenda was also an important component of his Progressive era politics for political and economic reform. Ultimately he believed democratic reform and conservation would produce better living and working conditions for Americans. His land policies promoted a democratic view of greater land distribution and access to resource for the lower socioeconomic classes by opening up the National Forest lands suitable for agriculture to small farmers and by challenging the exclusive grazing rights of large ranchers on the public lands of the West. In 1907, in his message to Congress, he spoke about the need for the federal government to take control over the range and end the current abuse of the land by large ranchers. Drawing on his progressive roots, he wrote:

> The government should part with its title only to the actual homemaker, not to the profit-maker who does not care to make a home. Our prime object is to secure the rights and guard the interests of the small ranchmen, the man who ploughs and pitches hay for himself. It is this small ranchman, this actual settler and homemaker, who in the long run is most hurt by permitting theft of public lands.

WISE USE VERSUS PRESERVATION

The conservation legacy of Roosevelt's presidency encapsulates many of the environmental debates that continue today. During his presidency Roosevelt was bracketed by two opposing views of conservation: Sustainable or "wise" use versus preservation. Gifford Pinchot, as chief forester for the U.S. Forest Service under Roosevelt, believed that conservation should be achieved by the highest possible sustainable use of natural resources. John Muir, who came to represent the preservationist view of conservation, disagreed with Pinchot's sustainable use approach to conservation. Roosevelt, while politically committed to utilitarian perspectives of resource conservation, deeply respected Muir's transcendental reverence for the natural world. While Roosevelt had to navigate this internal conflict with conservationists, his conservation polices were also opposed by laissez-faire capitalists who felt that conservation limited individual rights. George L. Knapp, a fervent opponent to conservation, wrote in 1910 that conservation was driven by "zealots [wanting] to install themselves as official prophets and saviors of the future." For Knapp, conservation would result in "mining discouraged, homesteading brought to a practical standstill, power development fined as criminal, and worst of all, a Federal bureaucracy arrogantly meddling with every public question."

The tensions in the conservation movement came into sharp relief in the Hetch Hetchy dam debate. The proposed dam, which would provide water and electricity to the arid San Francisco region by damming portions of Yosemite Valley, became a landmark case for the fragmented conservation movement and forced Roosevelt to choose between creating a reservoir for the benefit of people or protecting the wilderness area. In 1907, with grave reservations, Roosevelt supported the proposed Hetch Hetchy dam. John Muir and other preservationists launched an aggressive campaign and argued that Yosemite National Park, including the valley that would be flooded by the dam, was an important "public playground." The campaign proved temporarily successful and Roosevelt retreated from his endorsement of the reservoir. The dam was approved under Woodrow Wilson's administration in 1913.

Roosevelt's legacy to conservation includes 51 Federal Bird Reservations, five National Parks, 18 National Monuments, four National Game Preserves, and 21 Reclamation Projects. Altogether, in the seven and a half years he was in office, he provided federal protection for almost 230 million acres.

SEE ALSO: Conservation; Forest Service; Hetch Hetchy; Intergenerational Equity; Muir, John; National Monuments; National Parks; Overgrazing; Pinchot, Gifford; Preservation; Protected Areas; Timber Industry; Wise Use Movement; Yosemite National Park.

BIBLIOGRAPHY. Daniel Filler, "Theodore Roosevelt: Conservation as the Guardian of Democracy," pantheon .cis.yale.edu (cited May 2006); George L. Knapp, "The Other Side of Conservation," *North American Review* (v.191, 1910), reprinted in Carolyn Merchant, ed., *Major Problems in American Environmental History,* 2nd ed. (Houghton Mifflin, 2005); Curt Meine, "Roosevelt, Conservation and the Revival of Democracy," *Conservation Biology* (v.15/4, 2001); Roderick Nash, *Wilderness and the American Mind* (Yale University, 2001);

"New Perspectives on the West: Theodore Roosevelt (1858–1919)," www.pbs.org (cited May 2006); Theodore Roosevelt, "Bird Reserves at the Mouth of the Mississippi," *A Book Lover's Holiday in the Open,* www.bartleby.com (cited May 2006); Theodore Roosevelt, "Opening Address by the President," *Proceedings of a Conference of Governors in the White House,* reprinted in Carolyn Merchant, ed., *Major Problems in American History,* 2nd ed. (Houghton Mifflin, 2005); Theodore Roosevelt, "Seventh Annual Message to Congress," December 1907, www.pbs.org (cited May 2006).

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Rousseau, Jean Jacques (1712–78)

THE GENEVA-BORN PHILOSOPHER of the Enlightenment, Jean Jacques Rousseau is considered to be one of the founders of modern political thought and political science. Together with Thomas Hobbes and John Locke—and despite the radical differences in their work as well as the different historical circumstances in which they developed their philosophy—Rousseau was one of the most important philosophers of the "social contract." His famous book, *The Social Contract, Or Principles of Political Right* (1762), influenced not only the declarations of the French Revolution (1789), but also the development of political liberalism, the theory of human rights, government, and modern democracy. Also, because of his critique of the idea of individual property and wealth, Rousseau is often considered as a harbinger of socialist thought and social democracy.

For the humanist Swiss-Franc philosopher, "nature" and the "state of nature" were of paramount importance. The concept of "nature" is dialectically opposed to that of "civil society." Civil society expresses for Rousseau the ways by which social members are coexisting in the organized, collective society. By their birth, and in the frame of their "state of nature," individuals are characterized by primitiveness and virtue, although not by specific forms of immorality or morality. Individuals obtain their identity through their entrance to the rule-based civil society. In order to avoid the dangers of corruption caused by greed, and competition for wealth and violence, individuals inevitably have to abandon their initial state of nature. By entering society, they are forced to compromise with the other members of society for the achievement of social order and the establishment of a "social contract," which in turn, is the fundamental basis of every organized society.

In Rousseau's naturalist perception, civil society is far from being an ideal social formation. On the contrary, it is a society of inequality, for individuals are not equal with regard to property, civil rights, and freedom. Freedom is for him a utopian ideal and a kind of a pre-human, pre-social state of existence, while civil society is the space of inequality, plutocracy, exploitation and corruption. Whilst for John Locke, civil society is an important condition for the support of the property rights and the security of the individuals subordinated to the political power of government, for Rousseau it is the inevitable social formation in which people have to coexist since they are forced to abandon their state of nature.

Although he is critical of civil society, he does understand it as the main option for the achievement of social coherence and peaceful coexistence. The bridging between the state of nature and the civil society (namely the reconciliation of the individual with the broader society) will occur through the building of a mutual social contract. The basic task of government is, therefore, to guarantee through fair implementation of law, that the differences and inequalities that characterize individuals by their birth and state of nature will be diminished by effective governance and by law.

Government should respect and serve the "general will," but, because for Rousseau the expression of general will requires also that citizens are well aware of public issues and participate equally in decision making, he underlined the importance of education to the creation of general will and emphasized the role of mutual commitments in the maintenance of the social contract. The task of government is not only the minimization of social inequality caused by economic exploitation, but also the interference of government in general economic issues in order to protect citizens from economic irresponsibility.

SEE ALSO: Human Nature; Nature, Social Construction of.

BIBLIOGRAPHY. Martin Carnoy, *The State and Political Theory* (Princeton University Press, 1984); Jean Jacques Rousseau, *The Social Contract* (Penguin, 1953); Frederick Watkins, ed., *Jean Jacques Rousseau: Political Writings* (University of Wisconsin Press, 1986).

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Rubber

RUBBER IS A naturally occurring hydrocarbon polymer with elastic properties. In its natural state, rubber, also known as latex, is tapped from several different types of trees the most important being *Hevea brasiliensis*, the major commercial source of natural rubber. This tree is native to the Amazon Basin in Brazil. It grows best at temperatures of 20–28 degrees C with a well-distributed annual rainfall of 1,800–2,000 millimeters.

Its prime growing area, between 10-degree latitudes on either side of the equator, is restricted by its required temperature and rainfall. Other plants containing latex include figs (*Ficus elastica*), euphorbias, and the common dandelion. Before 1910, most rubber was harvested from "wild trees" growing in the Amazon Basin and to a lesser extent from other natural sources of natural rubber such as *Ficus elastica* growing wild in the Congo Basin of Africa.

In 1876, Henry Wickham gathered over 70,000 seeds from the Brazilian rubber-bearing tree, *Hevea brasiliensis,* which he then smuggled to Kew Gardens in England. From there, *Hevea* was introduced to British colonial possessions in Sri Lanka, Singapore, and Malaysia by the British Colonial Office, where it was grown experimentally and later on plantations. Henry Wickham is accredited with having contributed greatly to the rubber plantation industry. Cultivation of rubber then spread throughout the tropics to Vietnam, Cambodia, Indonesia, and Thailand in Southeast Asia, and subsequently to Liberia, Nigeria, and Cote d'Ivoire in Africa. Initially, cultivation took place on plantations, but smallholders rapidly adopted it as a source of income.

Although many people think that rubber originated in 19th-century Europe, the truth is that the ancient Mayan people used latex to make rubber balls, hollow human figures, temporary shoes, water-resistant cloth, and as bindings to secure axe heads to their handles. The Mayans learned to mix the rubber sap with the juice from morning glory vines so that it became more durable and elastic and less brittle. Both the rubber tree and the morning glory were important plants to the Mayan people—the latter being a hallucinogen as well as a healing herb. The rubber balls were used in an important ritual game and weighed as much as 15 pounds. The Spanish conquistadors were so astounded by the vigorous bouncing of the rubber balls of the Aztecs that they wondered if evil spirits enchanted the balls.

In the modern world, latex is collected from rubber trees by making incisions into the bark of the rubber tree and tying a container to the tree to allow the latex to drip into it overnight. Then the latex from the trees is poured into flat pans and mixed with formic acid as a coagulant. The sheets are then wrung out by putting them through a press before transportation to factories for vulcanization and further processing. The process of vulcanization entails the heating of the latex and the addition of sulfur and peroxide or Bisphenol to improve resilience and elasticity. From the 1830s on, vulcanization made rubber a very useful commodity by increasing its durability. Vulcanized rubber proved to be resistant to water and chemical interactions and did not conduct electricity, which made it an excellent candidate for the production of many products. Charles Goodyear is credited with discovering the process of vulcanization.

The unique physical and chemical characteristics exhibited by vulcanized rubber have made it an indispensable commodity in the modern world. The process of making rubber has improved with time, and now various chemicals are added before the mix is poured into molds, heated, and cured under pressure. For example, in the manufacturing of rubber destined for tires, carbon black is often added to rubber to further improve its strength.

New discoveries have resulted in the production of synthetic rubber made from crude oil. World War

Edmund Dene Morel

A British journalist who managed to reveal the truth about the rubber industry in the Congo Free State, Edmund Dene Morel was born Georges Eduard Pierre Achille Morel de Ville in 1873 in Paris. His father died when he was four, and after a family feud, his mother took him to Britain. However, his mother fell ill when he was fifteen, and he had to leave school to take up a position as a bank clerk and then as a clerk with Elder Dempster, a shipping firm in Liverpool. It was at this point that Morel anglicized his name.

In 1893, Morel started to write newspaper articles critical of the European treatment of Africans and supporting decolonization movements in Africa. It was during this time that Elder Dempster gained a shipping contract between Antwerp and Boma in the Congo Free State, Belgium's possession in Central Africa—strictly speaking the personal property of the king of Belgium. Gradually, Morel came to see the true nature of Belgian rule over Congo and its use of forced labor to find wild rubber, with tens of thousands of Africans dying during this exploitation.

When Morel started writing about what he had discovered, he formed the Congo Reform Association. He gained the support of many writers, including Joseph Conrad, who was to write about the Congo in *Heart of Darkness* (1902). Arthur Conan Doyle's *The Crime of the Congo* (1908) was also influential. With the outbreak of World War I, Morel was controversial for his opposition to supporting Belgium. He ran a pacifist group and was accused of supporting the Germans. In the 1922 general election in Britain, Morel defeated Winston Churchill, becoming a member of parliament for the Independent Labour Party. He died two years later.

II cut off Germany and the United States from traditional sources of natural rubber supplies, which propelled the production of synthetic rubber. Synthetic rubber accounts for 50 percent of rubber supplies worldwide.

Over 90 percent of natural rubber production today takes place in Southeast Asia, notably Malaysia, Thailand, and Indonesia. However, due to competition from synthetic rubber, the price of natural rubber has remained at levels below that which will sustain the industry. Output of natural rubber production in Malaysia has declined markedly in recent years, as cultivators have switched to other crops such as palm oil.

SEE ALSO: Brazil; Malaysia; Mendes, Chico; Nontimber Forest Products; Petroleum.

BIBLIOGRAPHY. Warren Dean, *Brazil and the Struggle for Rubber: A Study in Environmental History* (Cambridge University Press, 2002); Vernon Herbert, *Synthetic Rubber: A Project That Had to Succeed* (Greenwood Press, 1985); John Loadman, *Tears of the Tree: The Story of Rubber—A Modern Marvel* (Oxford University Press, 2005); R.G. Unny, *The Indian Rubber Economy: History, Analysis, and Policy Perspectives* (Manohar Publishers & Distributors, 1995).

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Runoff

SURFACE RUNOFF, OR overland flow, is that part of precipitation that is left after inception or wetting of plants and other surfaces, infiltration into the topsoil, and surface storage in little pits and rills. *Runoff* refers to the water leaving an area of drainage and flowing across the surface to points of lower elevation. Runoff means that rainfall intensity exceeds the soil's infiltration rate; a thin water layer forms on the surface that begins to move because of the influence of slope and gravity; flowing water accumulates in depressions, and forms small rills, which merge to form larger streams and rivers.

Surface runoff is a main cause of water erosion, after heavy raindrops have already caused the de-

Agriculture is the source of more than 50 percent of the nutrient load in European rivers.

tachment of soil particles (splash erosion). The amount of surface runoff, and thus of erosion, is determined by the infiltration of water into the soil. The higher the infiltration from a single storm, the less surface runoff occurs. Infiltration is hindered by compacted or sealed surfaces. Therefore, high rainfall intensities often result in high runoff rates. A dense vegetation cover is the best protection against compacting and accelerates infiltration. Intensive cultivation combined with insufficient provision of organic matter can leave soil prone to crusting and compaction, and consequently to erosion. Heavy machinery and poor timing of agricultural operations often cause soil compaction.

Unsaturated overland flow is common in dry lands, where rainfall intensities are high and the soil infiltration capacity is reduced. Runoff can detach and transport large amounts of soil, as well as nutrients, phosphates, and pesticides. Erosion is one of the most serious consequences of runoff, particularly on agricultural land and other areas with low vegetation density. Land cover change and intensive land use lead to a decline of physical and hydrological soil properties, making the soil even more susceptible to erosion. With runoff it is possible that significant amounts of fertilizers and pesticides reach rivers or leach into groundwater. Nutrient and phosphorus pollution originating from agricultural operations are the main causes of water quality decline in lakes and rivers, adding up to more than 50 percent of the nutrient load in European rivers.

In urbanized watersheds, the infiltration capacity of the soil is greatly reduced because of impervious surfaces, such as pavements, streets, and buildings. Thus, runoff with higher peaks and larger volumes occurs, which in turn reduces groundwater recharge, thus lowering the water table. This can lead to the worsening of droughts because of low groundwater recharge and low dry season flows in rivers, and floods, which are particularly critical for agriculture.

In 2006, one in six people worldwide lived in the potential path of a 100-year flood, or roughly one billion people. That number is expected to double by 2050 due to climate change, deforestation, rising sea levels, and population growth in flood-prone areas. For example, in 2002, monsoon rains resulted in floods that submerged half of Bangladesh. Floods transport sediment and silt, which affect homes and crops. Floodwaters gave way to outbreaks of water-borne diseases that affect the most vulnerable groups—those already living below the poverty line. Poor people loose their basis of living in such events and often become dependent on humanitarian assistance.

SEE ALSO: Eutrophication; Floods and Flood Control; Pollution, Water; Water; Water Quality; Watershed Management.

BIBLIOGRAPHY. D.B. Beagle and L.E. Lanyon, "Nutrient Management Legislation in Pennsylvania," *Journal* *of Soil and Water Conservation* (v.49/2, 1994); D.J. Eldridge, "Trampling of Microphytic Crusts on Calcareous Soils, and Its Impact on Erosion under Rain-Impacted Flow," *Catena* (v.33, 1998); M. Gayer and M.A. Connolly, "Communicable Disease Control After Disasters," in J.M. Schultz and E.K. Noji, *Public Health Consequences of Disasters* (Oxford University Press, 2005); A. Mando, "Soil-dwelling Termites and Mulches Improve Nutrient Release and Crop Performance on Sahelian Crusted Soil," *Arid Soil Research and Rehabilitation* (v.12, 1998); G. Zeleke and H. Hurni, "Implications of Land Use and Land Cover Dynamics for Mountain Resource Degradation in the Northwestern Ethiopian Highlands," *Mountain Research and Development* (v.21, 2001).

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Rural Gentrification

LIKE ITS URBAN counterpart, *rural gentrification* refers to processes of social replacement and displacement that are the outcome of changing investment strategies, economic restructuring, and changing government policy. Together, these pressures both produce and foster continuing migrations of people to and from rural places. Many of the areas that experience rural gentrification have historically been characterized by extraction-based or subsistence-oriented economies and land uses, such as activities related to hunting, the gathering of foods and fiber, agriculture, cattle ranching, timber production, or different forms of mining. Researchers have described this process and its social and environmental impacts in several parts of North America (particularly the American West) and Europe (mainly Great Britain), but it is likely more widespread.

Although the processes that drive rural gentrification are debated, the global restructuring of key extractive industries, such as agriculture and forestry, seems to have contributed to a wave of new real estate investment in rural places that have generally met two basic criteria. First, these rural places are home to cultural and natural landscapes that offer attributes valued for their "quality of life" or "amenities": spectacular scenery or vistas; relaxed or easy-going lifestyles; small-town or rural feel and perceived safety; and easy access to large open spaces, including wilderness areas and/or other recreational opportunities. Second, these areas are within relatively easy commuting distance. Importantly, commuting may be defined either by proximity to nearby metropolitan areas and adequate road, rail, or air infrastructure to facilitate physical commuting and/or characterized by adequate telecommunications infrastructure that facilitates telecommuting.

In such places, landowners engaged in extractive activities often cannot compete with the falling commodity prices on world markets (vertical competition) and the financial pressures created by the increased property values that come with real estate investment and often mounting property tax pressures (horizontal competition). As a result, some landowners sell land for development thereby reinforcing the cycle: An influx of new residents, predominantly affluent urbanites, further invest in real estate, shift centers of economic power, and influence local politics in ways that all too often lead to cultural and environmental conflicts.

Unlike urban gentrification, rural gentrification may or may not lead to an exodus of rural peoples who can no longer afford to live in the area. Indeed, many people in gentrifying areas appear to stay in their communities. By contrast, replacement and displacement often centers on the valorization of the landscapes for their aesthetic, ecosystem-related, and recreational qualities instead of their productive capacity. These shifting values often lead to the marginalization of local culture and traditions by many, but not all, of the newly arrived residents.

Often, this marginalization results in the real or perceived loss of valued ways of life or economic activities, including declines in jobs related to extraction and their replacement with service-related jobs; declines in access to, or the use of, local natural resources for social reproduction through activities (e.g., hunting, fishing, or gathering); and a general increase in the privatization of resources (e.g., posting of areas to prevent trespassing). For example, although urbanites often seek out rural places for their abundant natural amenities, their "small-town feel," "sense of place," or "sense of community," long-time locals complain that new residents fence off traditional swimming and fishing areas, other areas historically used for recreation or local travel, and sites historically available for resource collection by the community.

The changing economies and cultures of gentrifying rural places are also accompanied by changing ecologies, which may exacerbate feelings of displacement or replacement. Scientists, planners, and many locals—both newcomers and long-time residents—are increasingly concerned about the ecological impacts that accompany rural gentrification and associated residential and commercial development.

A growing literature describes the ecological change created by new landowners who want to live on large parcels, but that are typically much smaller than previous land uses. Sometimes referred to as "rural sprawl," this emerging low-density pattern is characterized by the conversion of habitats, forests, and farmland to new uses and quite likely contributes directly to loss and fragmentation of habitat for a variety of wildlife species, a variety of natural resources, and productive farmland. Although a number of conservation strategies have emerged to address these ecological impacts, such as the creation of habitat protection areas or conservation easements that help maintain agricultural areas, these efforts have sometimes led to heightened tensions in gentrifying rural communities if perceived by long-time locals as a form of "gatekeeping" designed to control their social practices.

SEE ALSO: Habitat Protection; Land Degradation; Land Use; Land Use Policy and Planning; Livelihood; Nature, Social Construction of; Preservation; Quality of Life; Sustainable Development; Tourism.

BIBLIOGRAPHY. Eliza Darling, "The City in the Country: Wilderness Gentrification and the Rent Gap," *Environment and Planning A* (v.37, 2005); Rina Ghose, "Big Sky or Big Sprawl? Rural Gentrification and the Changing Cultural Landscape of Missoula, Montana," *Urban Geography* (v.25, 2004); Terry Marsden, Phillip Lowe, and Sarah Whatmore, *Rural Restructuring: Global Processes and Their Responses* (David Fulton Publishing, 1990); J. Todd Nesbitt and Daniel Weiner, "Conflicting Environmental Imaginaries and the Politics of Nature in Central Appalachia," *Geoforum* (v.32, 2001); Martin Phillips, "Other Geographies of Gentrification," *Progress in Human Geography* (v.28, 2004); Peter Walker and Louise Fortmann, "Whose Landscape? A Political Ecology of the 'Exurban' Sierra Nevada," *Cultural Geographies* (v.10, 2003).

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Rural versus Urban

THE DIFFERENCES BETWEEN urban and rural appear to be as simple as day and night, yet there are also similarities between the two areas. Contrasts between urban and rural manifest themselves in a number of different ways; the most striking are the landscape, people, and economy. The similarities emerge at the interface of the urban-rural fringe.

The definition of urban and rural according to the U.S. Census Bureau is stated in terms of metropolitan and non-metropolitan areas. The U.S. Census Bureau defines metropolitan areas as an urban nucleus with 50,000 or more people and a population density of 1,000 persons per square mile and may contain adjacent territory with at least 500 persons per square mile. Nonmetropolitan areas are outside the boundaries of metropolitan areas. Overall, approximately 79 percent of the U.S. population live in metropolitan areas (222.4 million) and the remaining 21 percent (59 million) live in non-metropolitan areas.

The county or its equivalent, however, is the general unit of measurement for the U.S. Census Bureau. Of the 3,141 counties in the United States, metropolitan counties total 1,099 (35 percent) with non-metropolitan counties the remaining 2,042 (65 percent). The most striking difference is the amount of land in each category. Metropolitan counties account for 897,094 square miles (25 percent) of the land area in the United States, while nonmetropolitan counties cover 2,640,344 square miles, or 75 percent of the land. Thus, nonmetropolitan or rural areas dominate the landscape, even though they only contain 21 percent of the population.

LANDSCAPE

The U.S. Department of Agriculture conducts a study of land use across the United States every five years. The most recent study for 2002 identified six major land uses: Forest (28.8 percent), grassland pasture and range land (25.9 percent), cropland (19.5 percent), special-uses parkland and wilderness areas (13.1 percent), miscellaneous lands (10.1 percent) and urban lands (2.6 percent). These statistics provide more detail as to the use of land than the metropolitan/non-metropolitan county difference. Within a metropolitan county there can be forests and croplands along with high density residential. Thus, the urban lands may be a small subset of the metropolitan county.

Some combination of forest, grassland, cropland, special uses, and the miscellaneous lands will generally dominate the rural areas of the United States. The predominate type of land use will vary based on topography, climate, and economic activity in the United States; croplands in the Midwest and eastern Great Plains, forest lands in the east, Rocky Mountains, and northwest, and grasslands in the western Great Plains and southwest. The rural landscape will also have residential, commercial, and industrial activities, but also very small land partitions. Rural landscapes provide the majority of the habitat for biological resources preserving genetic diversity; this includes wildlife, plants, and microbes.

The urban areas of the United States are concentrated in the region east of the Mississippi River along the coastal regions of the northeast and southeast, the upper Midwest, and along the major river systems. In the western United States, southern California and the Pacific northwest are the major areas of urban concentration, along with the front range of the Rocky Mountains and the desert in the southwest. Urban areas are generally composed of residential, commercial, industrial and transportation land uses, with a mix of parks, open space, and river/coastal corridors. The proportions of the different land uses will vary across the urbanized area, with less residential near commercial and industrial centers, but with an increase in transportation access. Residential lands will have some commercial to meet local demands, but generally will not have industrial activities. The downtown business district will be the focal point for commercial and financial businesses, and also the center for the performing arts and cultural exhibitions.

PEOPLE

The urban-rural dichotomy is most obvious when examining the concentration of people. Urban areas are defined by a concentration of 1,000 people or more per square mile. Urban centers with high-rise apartments, however, can produce densities as high as 69,873 people per square mile. In rural areas, the number of persons per square mile can be as low as zero in wilderness areas. These are the extremes, however; the average in metropolitan counties is 558 persons per square mile, and in the non-metropolitan counties the average is only 18.5 persons per square mile. For the entire United States, the average population density is only 79.6 persons per square mile; however, the population is not evenly distributed. The highest population concentrations are east of the Mississippi River and along the California coast. The lowest population densities are in the western United States and Alaska.

There are two major "megapolitan" areas in the United States, one on the East Coast and another on the West Coast. Along the eastern seaboard the urban area stretches from Boston to Washington, D.C., including the metropolitan areas of New York, Philadelphia, and Baltimore. A similar urban concentration is developing from San Diego northward to Santa Barbara, California. Adjacent counties to these urban concentrations are influenced by the synergies generated by the high density of people, economy, and social activity.

ECONOMY

Historically, urban areas focused on manufacturing, finance, retail, and service sectors of the economy. In contrast, the rural economy emphasized natural resources, agricultural, recreation/tourism, and cottage industry activities. Two major changes over the last three decades have altered urban and rural economics: Technology and the expansion of transportation networks. Advances in electronic communication have made it possible for corporations to decentralize their manufacturing operations, diffusing their plants across the globe and into rural areas, and freeing workers to live away from their employment center. Advances in agriculture have forced small-scale agricultural operations to become large-scale operations, ending the era of the family farm and beginning the era of the corporate farm. Expanded transportation networks have allowed workers to commute to their employment and at the same time allowed businesses to migrate away from urban centers. These two phenomena have changed the historical employment base to a less manufacturing focus and to a more diverse service configuration in urban areas and a corporate culture in the rural areas.

The rural economy is still dominated by agriculture, natural resources, recreation/tourism, and cottage industries, but the employment structure has changed. Fewer workers are dependent on employment in these activities, and because of the expanded transportation network, are becoming commuters to adjacent urban centers. No longer are rural citizens totally dependent on agriculture. Agricultural-oriented counties are currently defined as those counties with at least 20 percent of the income from agriculture. Agriculture is not the sole income generator for rural America.

Urban centers are becoming less dependent on manufacturing but more dependent on production services and the use of electronic communication for business transactions. In a recent survey more than one-half of employment in major cities is production service oriented. The concentration of retail and manufacturing has become decentralized and has moved to suburban and rural areas, while only management and financial activities have remained in central business districts. The movement of employment and subsequently workers to the urban-suburban fringe has increased the interaction between urban and rural.

SIMILARITIES

Three trends are making urban and rural areas similar, producing housing densities, open-space conservation and expansion, and agricultural preservation. Rural areas have low population densities, but a growing philosophy is to increase residential density by using cluster developments to preserve open space and wildlife habitats. Cluster developments are not approaching urban densities for large areas, but they do approach them in small areas of 10–160 acres. Within small areas, they can average 200–500 persons per square mile.

Similarly, in urban areas, the importance of open space is being integrated into the redevelopment of abandoned industrial sites. Instead of creating just single family units, cities are increasing density by utilizing mixed density residential units with the intent to provide open space adjacent to the housing without forfeiting the needed housing units.

Finally, agricultural preservation policies in both rural and urban areas have increased over the last decade. The use of zoning, tax incentives, conservation easements, and land trusts have created strategies for local government to protect and preserve agricultural activities in rural and urban-rural fringe areas.

SEE ALSO: Land Use Policy and Planning; New Urbanism; Rural Gentrification; Suburbs; Urbanization.

BIBLIOGRAPHY. R.E. Heimlich and W.D. Anderson, “Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land,” *Agricultural Economic Report* (no. 803, 2001); E.J. Kaiser, D.R. Godschalk, and F.S. Chapin, *Urban Land Use Planning* (University of Illinois Press, 1995); R.N. Lubowski et al., “Major Uses of Land in the United States, 2002,” *Economic Information Bulletin* (no. 14, 2005); J. Ratcliffe and M. Stubbs, *Urban Planning and Real Estate Development* (UCL Press, 1996); U.S. Department of Agriculture, “Measuring Rurality: What is Rural?” www.ers.usda.gov (cited April 2006).

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Russia (and the Soviet Union)

RUSSIA FORMS AN arc around much of the North Pole, extending east to west half way across the globe, and stretching 2,500 miles north to south. Following the collapse of the Soviet Union, Russia still remains by far the largest country on earth, spanning 11 time zones. Encompassing most of north Asia, Russia has 14 international land borders, second only to China (15).

CLIMATE AND POPULATION

Because only a small part of Russia lies south of 50 degrees north latitude, and the majority of the country lies above the line of 60 degrees north, much of Russia experiences six months of snow cover every year. Mountain chains along its southern and eastern borders block the effect of moderating temperatures from the Indian and Pacific oceans. The lack of such topographical features on its northern frontiers, however, leaves Russia exposed to the effects of cold winds from the North Atlantic and Arctic oceans.

Isotherms, or lines of constant temperature, move west to east across the Eurasian landmass, in contrast with north to south in North America. Thus, while in North America temperatures tend to contrast from north to south, north Asia experiences far greater temperature contrasts, ranging warmer to colder from west to east. A massive winter high-pressure system creates winds blowing from the south and southwest across all of the Russian landmass except for its Pacific zone. During the summer months, a low-pressure system produces winds blowing from the north and northwest. Thus, cities located at approximately the same latitude have increasingly cold average temperatures as one moves west to east: Average January temperatures are –8 degrees C for St. Petersburg, –27 degrees C in the West Siberian Plain, and –43 degrees C for Yakutsk, located in eastern Siberia.

Despite its size, much of Russia is not conducive to agriculture; it is either too cold or dry. This is due to Russia's continental climate and the fact that much of its landmass is more than 250 miles from an ocean or sea. While parts of northwestern Russia near the Baltic Sea receive an average annual rainfall of 23.6 inches, the amount of precipitation decreases to the southeast further from the sea. Moscow, therefore, receives only 20.6 inches annually. Parts of Russia also experience desert conditions: Along sections of its border with Kazakhstan, 0.787 inches, and parts of coastal Arctic Siberia, as little as 0.590 inches annually. This explains why a country as large as Russia has only 7.17 percent arable land.

It is estimated (1996) that Russia has a population of 150,000 million, with 82 percent ethnic Russians and more than 100 other ethnic groups. Much of Russia's population (75 percent) lives in only one-fourth of its territory lying to the west of the Ural Mountains (European Russia). Much of Russia's natural resources (coal, natural gas, oil, timber, diamonds, gold, and furs) are found in regions of low population density, such as the sub-Arctic and Arctic zones and the area located to the east of the Urals, Siberia. A major theme of the last century of Russia's history, therefore, has been that European Russia's energy consumption outpaces that which can be produced by its thinly populated far northern and eastern territories.

RECENT HISTORY

In the early 18th century, Peter the Great (1682–1725) inherited a massive empire that lagged far behind Europe technologically and culturally. He reoriented Russia to the West by visiting and studying in Western Europe, inviting Western specialists to work in Russia, expanding Russia's educational institutions, and modernizing its military. Since a modern European empire required a warm-water port providing access to European markets, Peter spent much of his reign fighting, and eventually winning, the Great Northern War (1700–21) against Sweden, in which Russia gained control over much of the eastern Baltic. There, Peter built a new, Western-style capital city, St. Petersburg.

Russia's modernizing and expansionist trend continued under Catherine the Great (1762–96), under whose reign Russia acquired large parts of Poland, the Ukrainian steppe lands, the Crimean Peninsula, and Georgia. Russia continued its eastward expansion by organizing the Russian-American Company (1799), with bases established in Alaska and northern California (Fort Ross). Following the Napoleonic Wars, Russia also gained Bessarabia (Moldova) and Finland.

Having established itself as a major European power, Russia concentrated its foreign policy on securing influence in the weakening Ottoman Empire. While Russia possessed warm-water ports in the Baltic, it lacked an outlet to the Mediterranean Sea. Russia's claim to a protectorship over Christians and pilgrimage sites in the Ottoman Empire was challenged by an alliance of France, England, and Ottomans during the Crimean War (1853–55), which Russia lost in part due to its comparatively undeveloped industrial complex. During the next half century, as Russia engaged in large-scale military, social, and economic reforms, which included the emancipation of the serfs in 1861, it focused its expansion efforts on the Caucasus and Central Asia. Russia easily annexed Turkestan (1865), the Emirate of Bukhara, Samarkand (1867), the Amu-Darya and Ferghana regions, and the Transcaspian region (1881–85). Russian Turkestan played an especially important role in the Russian economy through the cultivation of cotton, which helped meet the demands of the world market as the production of American cotton plummeted in the immediate post–Civil War period.

Despite Russia's successful conquests in Central Asia, and expanding sphere of influence in the Balkans, Russia's industrial development and transportation network were far outpaced by that of the other European empires. Russia lost the Crimean War in large part because of the delays imposed by lack of rail lines in provisioning its army. While other European states had expansive railroad networks by 1850, Russia had only recently completed its first line connecting Moscow with St. Petersburg.

Sergei Witte, finance minister from 1892 to 1902, played a large role in orchestrating Russia's rapid industrialization. He encouraged foreign investment, put Russia on the gold standard, and, as transport minister, oversaw the building of the Trans-Siberian railroad. Witte, along with Pyotr Stolypin and his agrarian reforms, also encouraged the migration of the peasantry to Siberia from central Russia's overpopulated agricultural regions. Peasants were offered free land and transportation west of the Urals on the Trans-Siberian railroad; between 1890 and 1914, four to 10 million people (estimates vary widely) made the journey, an estimated 750,000 by foot. This migration more than doubled the Siberian population.

The Russian Empire ended in 1917 with the Bolshevik Revolution led by Vladimir Lenin (d.1924). Poorly managed reforms, lagging industrialization, and gross mismanagement of Russia's army in World War I were all contributing factors. The Treaty of Brest-Litovsk (1918), concluded by the Bolsheviks and the Central Powers, led to the independence of Poland, Finland and, until they were forcibly re-annexed by the Soviets following World War II, the Baltic States (Estonia, Latvia, and Lithuania). The early results of the Revolution were promising. During the Civil War (1918–22), the Soviets practiced War Communism, which involved the requisitioning of grain from all farmers. In 1921, however, they began to implement the New Economic Policy by which farmers were permitted to sell part of their surplus yields. Agricultural activity increased and the economy slowly recovered and, by 1928, agricultural and industrial output had returned to their 1913 (pre–World War I) levels.

AGRICULTURAL COLLECTIVIZATION

Joseph Stalin, the Soviet Premier from the mid 1920s to 1953, dismantled NEP, beginning in 1929 a program of agricultural collectivization and rapid industrialization. In the collective (*kolhoz*) and state (*sovkhoz*) farms, peasants shared equipment and received a dividend check from the state-purchased proceeds of their harvest. When peasants did not join voluntarily, they were forcibly collectivized. Forced collectivization resulted in famine, such as that which occurred in 1932–33 in Ukraine (Holodomor) and the Kuban region. Famine occurred in other regions of the Soviet Union as well, resulting in the starvation deaths of an estimated five to 10 million people. At the time, the Soviets were also exporting grain in a show of the success of socialism to the capitalist powers.

THE RAPID INDUSTRIALIZATION PLAN

At the forefront of Stalin's rapid industrialization plan was the construction of a massive iron and steel works in the southern Urals near a substantial deposit of iron ore. The town and factory, Magnitogorsk, produced more than one-half of Soviet tanks and one-third of its projectile weapons during World War II. By 1933, the results of Stalin's plans were mixed: agricultural production had actually dropped below late 1920s levels, and industrial growth is now measured to have been negligible: 2.9 percent to 5.8 percent.

The disappointing results of collectivization and industrialization were blamed on middle- and upper-class peasants and the educated elite. These and other groups were sent to prison camps in Siberia, known as the Gulag, a Russian acronym for the Main Camp Administration. The growth of the forced labor camps, many of which were in remote, thinly populated areas of Siberia, coincides with Soviet industrialization. In 1931–32, for example, the Soviet prison camp population consisted of 200,000. After World War II, the number rose to 2.5 million, 1.7 million of which were in camps, while the remainder lived in Siberian colonies. Many of the camps had an economic purpose, such as the exploitation of natural resources (timber, gold, iron) or the building of enormous infrastructure facilities. An example is the canal linking the Baltic and White seas, the Belomorkanal. This was the first major construction built completely by forced labor (1931–33). Over 100,000 prisoners died due to poor working conditions. Although praised as a success, the canal received only light traffic because it was only 12 feet deep.

ENVIRONMENTAL EFFECTS

The Soviets enlisted the natural physical environment in their industrialization as well. Dams and hydroelectric stations were built on the Dnepr, Volkhov, and Yenisei rivers to provide energy for heavy industry. Extensive canals were dug to connect Moscow with the Baltic, White, Caspian, Black, and Aral seas (such as the Moscow-Volga and Volga-Don canals). In the Virgin Lands Campaign, thousands of acres of land in the Kazakh and Altay steppe were plowed and, in 1955, more than 300,000 Ukrainians were moved there to plant wheat. After an initial remarkable harvest, the land became depleted of nutrients for wheat and, by the 1960s, the soil disappeared due to wind erosion. A few years after the first boom harvests, the Soviet government had to import grain from Canada. Poor planning is also evinced in the production of cotton in central Asia. Not only did these areas become monocultures, highly dependent upon imports, but also the Soviets, in diverting the Amu Darya and Syr Darya rivers to irrigate the fields, contributed to the desiccation of the Sea of Azov.

SIBERIAN DEVELOPMENT

During the 1960s through the 1980s, the Soviets concentrated on the exploitation of mineral rich territories in the far north of European Russia and Siberia. Siberia alone contained a large part of the world's mineral wealth: 40 percent of world natural gas reserves, 25 percent of the world's coal, 30 percent of its aluminum and timber, six percent of global oil, and an as yet undetermined amount of diamonds, gold, and nickel. Significantly higher wages, longer vacations, and improved housing were offered to workers as incentives to move to harsher climates. The Soviet-planned economy helped to mask the astronomical production costs for these industries. For example, standard equipment such as trucks break down three to five times more frequently than in more moderate temperatures, and standard rotary and excavation equipment can only be used three to four months out of the year in the northern Siberian tin and gold mines.

The human labor cost is also greater than in moderate climates. There is a noticeable drop in human productivity when temperatures drop below 32 degrees F. When temperatures dip below –4 degrees F, a 10-minute warm up break is imposed per hour for a seven-hour work shift, which results in an estimated work loss of up to 73 percent. In Siberia and the extreme north, therefore, more people are needed in order to perform the same task. It has been estimated that 10 support people, such as family and various categories of support personnel, are needed for each worker.

Even though the gains were negligible, the Soviet government continued to develop Siberia. Today, Russia has 70 towns of over 50,000 people dependent on only one industry. The town of Vorkuta, for example, located north of the Arctic Circle in the Komi Peninsula, was built around its coal mines. Today, many of the mines have closed and much of the population is unemployed.

With the collapse of the Soviet Union in 1991, the territory controlled by Moscow shrank considerably. The Baltic States, Belarus, Ukraine, Moldova, and the Central Asian and several of the Caucasian republics gained independence. For Russia, this meant the loss of industry and ports in the Baltic, heavy industry and agriculture in Ukraine, and the oil fields of the Caucasus and Central Asia. Russia's dependence on Siberia, therefore, is now magnified by these losses. For the time being, the mineral rich autonomous republics such as Yakutia (Sakha Republic) in the Far East, which produces 99 percent of Russia's diamonds, remains dependent on Russia. Whether Russia can maintain its territorial breadth and retain its status as a world power is a question now being addressed by politicians and economists.

SEE ALSO: Belarus; Communism; Kazakhstan; Kyrgyzstan; Peasants; Turkmenistan; Ural Mountains; Uzbekistan; Volga River.

BIBLIOGRAPHY. G.L. Freeze, ed., *Russia: A History* (Oxford University Press, 2002); Fiona Hill and C.G. Gaddy, *The Siberian Curse: How Communist Planners Left Russia Out in the Cold* (The Brookings Institution Press, 2003); J.P. Ledonne, *The Russian Empire and the World 1700–1917: The Geopolitics of Expansion and Containment* (Oxford University Press, 1997); J.R. Miller, ed., *Encyclopedia of Russian History* (Macmillan, 2004); D.J.B. Shaw, *Russia in the Modern World: A New Geography* (Blackwell, 1999); "Special Section: Russia," *The Economist* (July 12, 1997).

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Rwanda

THE REPUBLIC OF Rwanda has had one of the bloodiest histories of any modern nation. Under administration by a harsh Belgian colonial authority in the early 20th century, a minority ethnic Tutsi population was kept in place to rule over a majority ethnic Hutu (and lower class Tutsi) population. In 1959, the Hutus overthrew the ruling Tutsi king, setting off a slaughter that resulted in the deaths of several thousand Tutsis and forcing another 150,000 thousand into exile. Rwanda's independence from Belgium in 1962 did little to check the ethnic cleansing. In 1990 the children of exiled Rwandans formed the Rwandan Patriotic Front and launched the country into civil war. Some 800,000 Tutsis and moderate Hutus became the victims of genocide in April 1994.

Although the ethnic cleansing was technically over by July of that year, some two million Hutus fled to Burundi, Tanzania, Uganda, and what was then Zaire. Although most refugees have returned to Rwanda, which is the most densely populated country in Africa, around 10,000 Rwandans remain in open rebellion in the Democratic Republic of the Congo. Open elections have created a new government that has instituted political reform, and Rwanda has received substantial assistance from the international community, including acceptance into the Heavily Indebted Poor Country program. Nevertheless, the situation in Rwanda remains volatile.

More than 40 percent of Rwandan land area is arable, and 90 percent of the population is engaged in agriculture, generally subsistence, with coffee and tea providing most foreign exchange revenue. Most families farm about two-and-a-half acres each and have learned to use a number of methods to make the land as productive as possible. Natural resources include gold, tin ore, tungsten ore, methane, and hydropower; but these resources are not capable of making Rwanda economically sufficient. Women were particularly affected by the war, and the population as a whole is still suffering. With a per capita income of $1,300, Rwanda is ranked 201 of 232 countries in world incomes. Sixty percent of Rwandans live below the poverty line. The United Nations Development Progamme's Human Development Reports rank Rwanda 159 of 232 countries on overall quality-of-life issues.

Rwanda is a landlocked country with 1,390 square kilometers of inland water resources. The terrain is mostly savanna with grassy uplands and hills that give way to mountains. Elevations range from 950 meters at the Rusizi River to 4,519 meters at Volcan Karisimbi. The climate is temperate with two distinct rainy seasons from February to April and from November to January. While temperatures tend to be mild in the mountains, frost and snow are possible. The entire country is subject to periodic droughts. The Virunga mountain chain, which is located in northwestern Rwanda along the border with the Democratic Republic of the Congo, is volcanic.

One of the major reasons for the fragility of Rwanda's population of 8,648,248 is the susceptibility to preventable diseases. Rwanda has a 5.1 percent HIV/AIDS adult prevalence rate, and 250,000 Rwandans are living with this disease that had killed 22,000 people by 2003. Recent studies have estimated that 8.6 percent of urban working-age women have developed HIV. Some 23 percent of Rwandans do not have sustained access to safe drinking water, and 59 percent do not have access to improved sanitation. As a result, the population has a very high risk of contracting food and waterborne diseases such as bacterial diarrhea, hepatitis A, and typhoid fever as well as malaria, a vector-borne disease. Consequently, Rwandans experience a lower-than-expected life span (47.3 years) and growth rate (2.43 percent), and a higher-than-expected infant mortality (89.61 deaths per 1,000 live births) and death rate (16.09 deaths per 1,000/population). Rwandan women produce an average of 5.7 children each. While literacy rates are higher than those of the poorest African countries, 35.3 percent of adult females and 23.7 percent of adult males are illiterate.

Because land is at such a premium in Rwanda, the poor have made their homes in forests, destroying ecosystems and indiscriminately cutting down trees to use as fuel. Deforestation is occurring at a rate of 3.9 percent each year. Agricultural mismanagement has led to overgrazing, soil exhaustion, and soil erosion. The country is also experiencing an energy shortage. The loss of wetlands has made land areas more vulnerable to flooding and sedimentation and has adversely affected biodiversity.

Even though the government has protected 6.2 percent of land area, the encroaching human population and widespread poaching pose great threats to Rwandan wildlife. In the Nyungwe National Forest Reserve, for instance, the buffalo and forest antelopes have disappeared, and only six elephants are left. In all of Rwanda, nine of 151 identified mammal species are endangered, as are nine of 200 bird species. In 2006, a study by scientists at Yale University ranked Rwanda 89 of 132 countries on environmental performance, above the comparable income and geographic groups. The overall score was reduced because of the poor showing in environmental health.

The Ministry of Lands, Environment, Forestry, Water, and Natural Resources has the responsibility under the Organic Law on Environment Protection and Management to develop policies and strategies, oversee environmental impact assessments, and implement and monitor all environmental laws and regulations. In 2005, the government announced the creation of the Rwanda Environmental Management Authority to take on major responsibility for environmental protection. Sustainable development through poverty reduction was identified as the number one goal of a new program that targeted women and young people as major participants in instilling environmental responsibility.

Rwanda participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, and Ozone Layer Protection. The agreement on the Law of the Sea has been signed but not ratified.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Colonialism; Deforestation; Poaching; Wars.

BIBLIOGRAPHY. Central Intelligence Agency, "Rwanda," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); Rwanda Development Gateway, "Environment," www.rwandagateway.org (cited April 2006); United Nations Development Programme, "Human Development Report: Rwanda," hdr.undp.org (cited April 2006); World Bank, "Rwanda," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Sachs, Wolfgang (1946–)

WOLFGANG SACHS STUDIED sociology and Catholic theology at Berkeley and in Munich and Tubingen, Germany. As an assistant professor in Berlin from 1975–84, he conducted the 1980–84 research project "Energy and Society." After stints in Italy, the United States, and elsewhere, in 1993 he began working at the Wuppertal-Institute in Germany where he acts as chairman for the interdisciplinary project "Globalization and Sustainability." He has been the chairman of the supervisory board for Greenpeace since 1994 and is a member of the Club of Rome.

Sachs has devoted his academic work to studying the questions of sustainability, global, social, and environmental justice, and, in recent years, more and more to globalization and its economic and electronic consequences. He has analyzed the impact of Western lifestyles and globalization on poverty, ecological destruction, social exclusion, and the deformation of viable communities in developing countries. His ironic and sometimes sarcastic presentation has earned him a reputation as one of the most thoughtful, and perhaps notorious, intellectuals to deal with the crisis of the Western world's relations with nature and social justice.

He explores the ambivalences and controversies that pervade the terrain of global environmental politics in detail. Presenting at both the Rio Conference in 1992 and the World Summit for Sustainability in 2002, his inquiries turned around one nagging hypothesis: The Western development model is at odds with both the quest for justice among the world's people and the aspiration to reconcile humanity and nature. According to Sachs, it is not possible for all citizens of the world to share in the fossil fuel-based, money-driven development model that has come to hold sway in the world today; the biosphere, eventually, may give in. In the case of mid-19th century America, Sachs, therefore, denounced fixation on the idea that the development of the North was obsolete and a disservice to the South, since development could no longer be separated from ecology.

On ecological development, his criticism remains sharp; he asks if ecological policies are just means of establishing a "clean" economy that does not simultaneously change lifestyles toward higher social sensitivity and inclusion. He also demystifies conventional distinctions between North and South as diplomatic artifacts, since the real divide goes through every society between the globalized rich and the localized poor. He views poverty mainly as a lack of power, and, therefore, advocates for reinforcing the rights of the poor and of poor communities.

Sachs suggests ways to leave conventional modernity behind by creating sophisticated but moderate-impact technologies, redirecting relentless accumulation, and appreciating ways of living that are simpler in means but richer in ends. Finally, he advocates for a so-called "leap-frog" into a solar age, for abandoning large-scale energy-intensive industrial economies that waste clean water, virgin land, and fresh air, and for decentralized smaller-scaled production patterns that are more considerate of nature and require more labor and intelligence.

SEE ALSO: Globalization; Justice; Policy, Environmental; Poverty; Sustainability.

BIBLIOGRAPHY. Wolfgang Sachs, ed., *Global Ecology: A New Arena of Political Conflict* (Zed Books, 1993); Wolfgang Sachs, "Ecology, Justice, and the End of Development," *Development* (v.40/2, 1997); Wolfgang Sachs, "Wasting Time is an Ecological Virtue," *New Perspectives Quarterly* (v.1, 1997); Wolfgang Sachs, *Planet Dialectics: Explorations in Environment and Development* (Zed Books, 1999); Wolfgang Sachs, "Rich in Things, Poor in Time: Poverty of Time Degrades the Wealth of Goods," *Resurgence* (v.196, 1999); Wolfgang Sachs, "Being and Buying: The Power of Limits—An Inquiry into New Models of Wealth," *New Perspectives Quarterly* (v.17/4, 2000); Wolfgang Sachs, Reinhard Loske, and Manfred Linz, *Greening the North: A Post-Industrial Blueprint for Ecology and Equity* (Zed Books, 1998).

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Safaris

IN KISWAHILI, a language derived from Arabic and Bantu interactions, the word *safari* refers to a journey, voyage, or expedition, with *kusafiri* being the infinitive verb form. The command *safiri salama* means "travel with peace" or "safe journey," and is a blessing for someone going away. Safaris can transpire on foot or by animal, wheeled vehicle, plane, or boat. Despite the generality of the term in Kiswahili, to most non-Kiswahili speakers, *safari* is synonymous with wildlife tourism in Africa. One can participate in such safaris through organized walks or even by hot air balloon, but by far the most common today involve short-term visits during which tourists travel with safari guides in minivans or Land Rovers.

The term *safari* entered the English language in the late 19th century, the era during which the British claimed east Africa as a protectorate. Prior to that, east African trade safaris—large-scale caravans (also known as *misafara*) organized by African and Arab traders—moved goods (including wildlife products) and people between the interior and the Indian Ocean coast. The structure of the trade safaris served as the organizational basis for big game safaris, the latter of which also built upon the colonial penchant for hunting.

Elite game hunters found east Africa a veritable paradise. The savannas teemed with game, and white hunters could rely on African caravans to porter fallen game and transport luxury supplies. U.S. President Theodore Roosevelt and his son Kermit's 1909 romp through British East Africa serves as iconic representation of the romance and excess of this kind of safari. While the Roosevelts bagged over 500 game animals between them, accompanying personnel killed over 11,000 mammals, birds, amphibians, and reptiles for scientific purposes. All the while, they hobnobbed with colonial elites and other wealthy visitors, and consumed fine food and drink.

The adventures, as covered by media and the Roosevelts themselves, coupled with the material representation of seemingly infinite, magnificent animals, secured Kenya as the ideal destination for wealthy hunter tourists and made the phrase "going on safari" one of social distinction. Millionaires and royalty from Europe, India, and elsewhere "went on safari," which came to index a series of elite social events interspersed with exciting hunting expeditions. Hemingway's writings on the subject further etched this ideal of safari into popular imaginings. The business of big game safaris also secured the high status niche for a select group of settlers acting as professional white hunters and hosts, although the vast majority of work undertaken during any safari was done by African employees, who

Today's safari-going tourists generally travel through wildlife areas in minivans or Land Rovers.

were rarely acknowledged. Safari firms cropped up and began to advertise overseas, and the decadence of big game safaris lasted until the interruption of World War II.

The post–World War II boom in adventure travel saw a widening range of safari options catering not only to extremely wealthy sport hunters, but also to middle-class adventure-seekers. Increases in numbers of international flights and decreases in ticket prices allowed Europeans and Americans to book short-term east African safaris, which allowed travelers to taste some of the romance and luxury associated with the earlier big game safaris. Photographic safaris also increased in popularity during this time.

By the 1960s, east Africa's crown colonies had been reconfigured into independent states. The land within those political entities had been divided according to a variety of uses, including more formalized national parks and reserves set aside as wildlife habitats. These changes came about in part due to a recognition that wild animal populations had dwindled dramatically over the preceding decades. The creation and management of parks, reserves, and wildlife populations occurred within a historical context in which a series of policies alienated large numbers of Africans from lands, and thus subsistence practices, in pursuit of foreign revenue.

By 1977, sport hunting ceased in Kenya due to presidential decree. The Kenyan government did so to further enhance tourism as a revenue stream, as short-term photographic safaris were anticipated to prove more lucrative than hunting, while also protecting that which tourists paid to see. Tanzania, however, still permits sport hunting (as do several southern African countries). Debates continue about how best to conduct and capitalize on safaris.

Now, throughout the world, tourist and ecotourist businesses form the very basis of local economies in many biodiversity hotspots and serve as important foreign revenue earners for states. The term *safari* has been popularized in a number of ways, still maintaining its symbolic links to those set out previously. For example, the term *safari* has come to refer to visiting any exotic locale or undertaking something that is (or should be, according to the speaker) viewed as wild and/or perhaps even dangerous.

SEE ALSO: Ecotourism; Hunting; Kenya; National Parks; Roosevelt (Theodore) Administration; Tanzania; Tourism; Wildlife.

BIBLIOGRAPHY: Elspeth Huxley, *White Man's Country* (Chatto and Windus Ltd., 1935); John MacKenzie, *The Empire of Nature: Hunting, Conservation, and British Imperialism* (Manchester University Press, 1988); Edward I. Steinhart, *Black Poachers, White Hunters: A Social History of Hunting in Colonial Kenya* (Ohio University Press, 2006).

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Safe Drinking Water Act (SDWA)

THE SAFE DRINKING Water Act (SDWA) of 1974 is the primary U.S. federal law regulating the nation's drinking water supply. SDWA applies to all public water systems. The SDWA is implemented through the U.S. Environmental Protection Agency (EPA) but enforcement is mostly delegated to individual states. SDWA sets thresholds or Maximum Contaminant Levels (MCLs) for known and suspected drinking water contaminants. Additionally, SDWA put into place measures to assure that clean groundwater supplies remained uncontaminated. The original SDWA set MCLs for 21 contaminants but through subsequent revisions, the list has grown to over 80. Regulated contaminants include organic contaminants, pesticides, biological contaminants, inorganic compounds, and radionuclides.

SDWA rode the tide of major federal environmental legislation passed during the first half of the 1970s that began with President Nixon's New Year's Day signing of the National Environmental Policy Act in 1970 and, later that year, the establishment of the EPA. Public awareness of chemical toxins had been on the rise since the 1950s and by the 1970s, the American public was even more galvanized in its demands for regulations as synthetic toxins were increasingly linked to cancer. Nixon rode these existing public sentiments as he proclaimed the 1970s the "environmental decade" and later declared a national "war on cancer." The link between toxins and drinking water came to the forefront after a 1972 federal study found 36 chemicals present in drinking water drawn from the Mississippi River in Louisiana.

The SDWA received major amendments in 1986 and 1996. In addition to adding dozens of new contaminants to the list of those regulated via MCLs, the 1986 amendments required disinfection of all public water supplies, added filtration requirements for all drinking water drawn from surface water sources, added new regulations to protect existing groundwater supplies from contamination, banned lead in water delivery system pipes and solder repairs, and laid out "best available technology" for treating each listed contaminant. The 1996 amendments streamlined the effectiveness of SDWA by establishing a method for setting priorities for contaminant regulations "based on data about the adverse health effects of the contaminant, the occurrence of the contaminant in public water systems, and the estimated reduction in health risk that would result from regulation." The 1996 amendments also gave states greater flexibility in deciding how to meet the minimum standards set by the SDWA and established a loan program for infrastructural improvements targeting small water systems.

SDWA is often touted as an environmental policy success story as, for example, the percent of people served by water suppliers with zero SDWA violations approached 90 by the end of the 1990s. The SDWA is not, of course, without its critics. Many public health advocates and environmentalists, for example, advocate for a more precautionary approach that would set lower MCLs for contaminants for which hard data on adverse human health effects has been difficult to establish.

SEE ALSO: Drinking Water; Environmental Protection Agency (EPA); Nixon, Richard Administration; Pollution, Water.

BIBLIOGRAPHY. Richard N.L. Andrews, *Managing the Environment, Managing Ourselves: A History of American Environmental Policy* (Yale University, 2006); Robert W. Collin, *The Environmental Protection Agency: Cleaning Up America's Act* (Greenwood Press, 2006); U.S. Environmental Protection Agency, *25 Years of the Safe Drinking Water Act: History and Trends* (U.S. EPA Office of Water, 1999).

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Sagebrush Rebellion

THE SAGEBRUSH REBELLION refers to a movement that gained momentum in the western United States where states sought to assert their individual rights over federal public land within their boundaries. The rebellion had its roots in historical events spanning four previous resistance movements in the west dating back to the 1880s, with each movement coalescing around natural resource issues. This resistance was also in opposition to the placement of land under federal jurisdiction following the passage of federal legislation and creation of federal agencies to manage public land. As the rebellion gained strength throughout the 1970s, it turned into a populist campaign for states' rights united in opposition to federal land management policies.

The term specifically came into being in 1979 with the passage in the Nevada State Legislature of Assembly Bill 413, entitled the Sagebrush Rebellion Bill. The rebellion was particularly strong in Nevada, where 87 percent of all land was federally managed. The bill sought to create a review board and provide for state control of certain lands within the state boundaries under the administration of the Federal Bureau of Land Management. The bill was the result of previous failed attempts by the State of Nevada during the 1970s to receive federal land grants. Ultimately, 10 other states joined the rebellion, with four of them (Arizona, New Mexico, Utah, and Wyoming) passing similar legislation. Western states felt that too much of their land was being placed under federal jurisdiction. Driven by the sheer size of the federal estate and angered by what they perceived as a land-grab of state land by the federal government, the western states sought to control the resource and recreational use of public lands that they deemed essential to their state economies. The rebel states claimed that federal land within their boundaries was rightfully theirs, and that they could better utilize the land through resource extraction.

In addition to actual legislation, the Sagebrush Rebellion represented a general attitude of frustration and hostility with federal management of land in western states. The "rebels," representing various interest groups (including timber, grazing, mining, water, hunting, and fishing interests), believed that federal policies affecting the west were made without regard for conditions and concerns there. The western states felt that this treatment by the federal government would worsen, as the 1977 energy crisis indicated that the west could be called upon to satisfy national energy needs. Rebel states also believed that the environmental movement, which rebels saw as hostile to their interests, unduly influenced federal government policies. For this reason, the rebellion is sometimes characterized as an antienvironmental movement.

During the Sagebrush Convention in Salt Lake City, Utah in 1980, President Ronald Reagan sent rebels a message saying that he would "… work toward a 'sagebrush solution.' " With the appointment of James Watt as Interior Secretary in 1981, the rebellion felt they had the support in Washington that they needed to succeed. Watt was from Wyoming; one of the "rebel" states, and having a westerner in charge of the Department of the Interior seemed advantageous since this agency primarily dealt with the administration of western lands. However, the rebellion lost momentum when Reagan failed to push the cause and with Watt's resignation in 1983, the rebellion was essentially dead in Washington. The main cause of the defeat of the Sagebrush Rebellion was the inability of states to establish the basic legal claim that the public domain truly belonged to the states. The Supremacy Clause (Article VI) of the U.S. Constitution made this legal case more difficult, stating that federal laws (and treaties) are the supreme law of the land, and that judges in every state are bound to those laws.

SEE ALSO: Department of the Interior (U.S.); Reagan, Ronald Administration; United States, Mountain West; United States, Southwest.

BIBLIOGRAPHY. R. McGreggor Cawley, *Federal Land, Western Anger: The Sagebrush Rebellion and Environmental Politics* (University Press of Kansas, 1993); William W. Coons, *The Sagebrush Rebellion: Legitimate Assertion of States Rights or Retrograde Land Grab?* (Vance Bibliographies, 1981); William L. Graf, *Wilderness Preservation and the Sagebrush Rebellions* (Rowman & Littlefield Publishers, 1990).

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Sahara Desert

THE SAHARA IS the world's largest desert. Whether the desert is increasing or decreasing is a point of constant debate. The Sahara's northern boundary runs from the Atlas Mountains in Morocco to the Suez Canal. The southern boundary stretches from a point in Mauritania to the Red Sea in Sudan or Eritrea. These borders create an area of approximately 9,000,000 square kilometers. This area was not always a desert. As recently as 8,000 years ago, much of it was temperate, making the climate hospitable to fishing and farming. The area then quickly turned to a desert, most likely due to a shift in the earth's axis.

This change in climate had a substantial impact on human society. It is proposed that grazing for sustenance became difficult, forcing many Saharan people to cultivate food and to eventually move to the Nile River valley. Some theorists further hypothesize that these new developments led to civilizations. There is contention over this grand theory, especially concerning dates, in part because of difficulty in carbon dating objects in an arid area that lacks many carbon based organisms.

Despite the arid conditions, the Sahara is a populated area, where the environs have played a primary role in the distributions of people, the construction of their political systems, and the development of their culture. Environmental conditions, combined with the aspirations of foreign empires, led to the current Arab, Moor, Berber, and Tuba societies. The desert prevented many empires from expanding, but the Arabs managed to establish themselves in Egypt. With the desert as a hurdle, Arab life and customs later collided with various Moor, Berber, and Tuba communities established in the desert, resulting in distinct cultures among these societies.

In 2002, there were approximately two million people living in the Sahara, with two-thirds living in cities, oases, and the highlands, and one third living a nomadic life. Availability of water is central to the distribution of people, although recently political leaders such as Muammar al-Qadhafi have begun tapping the Sahara's subterranean water sources for agricultural pursuits. Water was pivotal to the traditional mainstays of the Saharan economy, trade, and farming. Caravans composed of non-native camels, which were introduced by Arabs, carried slaves, salt, and gold between the Mediterranean and the Shale. Today, only salt is still traded this way.

With new forms of society come new ecological issues and challenges. Shifting sands can easily destroy settlements. Increases in population and resource use are fueling localized desertification and resource degradation among oases and previously border areas. Attempts to access new water sources raise questions concerning the water tables' ability to regenerate. Further, it is uncertain what affects climate change will have on the Sahara.

SEE ALSO: Climate, Arid and Semiarid; Desert; Desertification.

BIBLIOGRAPHY. Lloyd Cabot Briggs, *Tribes of the Sahara* (Harvard University Press, 1960); Marq de Villiers and Sheila Hirtle, *Sahara: A Natural History* (Walker and Company, 2002); Compton Tucker et al., "Expansion and Contraction of the Sahara Desert from 1980 to 1990," *Science* (v.253, 1991).

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Sahel

THE SAHEL IS the semiarid zone forming the southern margin of the Sahara Desert, stretching 4,500 kilometers across Africa. It includes parts of Senegal, Mauritania, The Gambia, Mali, Burkina Faso, Northern Nigeria, Niger, Chad, and the Sudan, and commonly includes parts of the Cape Verde Islands. The word means "shore" or "border" in Arabic. The Sahelian countries are some of the world's poorest. In addition, the Sahel has a rapidly increasing population of over 50 million people. It has been important as a region of settlement and movement for millennia, but it was the environmental emergency of droughts and famine in the 1970s and 1980s that has brought it to the world's attention.

The Sahel usually receives more than 150 millimeters and less than 500–700 millimeters of rain per year, restricted to three summer months, and has been one of the world's hottest regions for over two millennia. The Sahelian climate is "perhaps the most dramatic example of climatic variability that we have quantitatively measured anywhere in the world," according to Hulme, and the future impacts of climate change are uncertain. Biomass and rainfall are already subject to extreme non-equilibrial variations; therefore the Sahel's geographical limits fluctuate significantly. Moving north, Acacia savanna changes to grassland. Three major droughts have occurred this century, in 1910–16, 1941–45, and below average rainfall (termed "desiccation") began in the late-1960s and continued, with some interruptions, into the 1980s. The latter was especially hard for many Sahelian farmers and pastoralists, causing widespread loss of life.

The Sahel has frequently confounded science. The term *desertification* was misapplied by European scientists in the early 20th century to describe the presumed overexploitation of land and vegetation by local people. However, history shows exogenous drivers such as fire, insect attack, and rainfall have a far greater effect on the local ecology than human actions, except in areas of highly intensive land use. Most researchers now support a variant of this state-and-transition model, and identify a complex landscape, one constantly transformed by human actions, rather than monotonal desertification. The droughts also helped initiate some longer-term externally aided projects that might not otherwise have been supported. There are now thousands of farmer cooperatives, small-scale NGO projects, internationally funded development projects, and programs involved in environmental rehabilitation, soil and water conservation, social development, and other forms of support to rural people.

Around 65 percent of the Sahel's population is rural, and most draw part of their living from natural resources. Sahelian populations are accustomed to drought and the hardships of aridity. Hunter gathering began over 10,000 years ago, but pastoralism is now the dominant productive activity in the northern Sahel. Mobility is vital to maintain access to water and fodder. Herders have benefited from modern technologies like boreholes and veterinary support, but livelihoods are often precarious unless herd sizes are large and markets for meat and hides are reliable. Pastoral and agro-pastoral groups often compete for resources with farmers, who are usually of different ethnicity, and serious land and water conflicts plague the transition zone. Farming dates back 4,000–5,000 years, latterly assisted by iron tools, but not by wheeled transport. Millet and sorghum are the staples, alongside groundnuts. Cotton is commercially competitive, but Sahelian farmers are disadvantaged on the world market. Agriculture is almost entirely reliant on summer rainfall, except along the banks of the major rivers, lakes, and other seasonal watercourses. Households pursue handicrafts alongside livestock rearing, business, and informal labor (particularly in the long dry season), with individuals sometimes migrating for long or short periods to tap into these alternative income streams. Migration to new regions has allowed Sahelian populations relief when they are faced with drought, land pressures, and poor soil quality. There is a huge Sahelian diaspora stretching from the west African coast to Europe and North America, linked by mobile phones, banking systems, and the internet.

Geographer Mike Mortimore's research demonstrates that farmers and herders adapt to the risks posed by drought and hazards. He disputes the Sahelian crisis image through empirical illustrations of agricultural intensification without modern inputs. Several areas of the Sahel have in fact seen greening in recent years, also due to extensive soil and water conservation and the irregular rains. But others argue that Sahelian households are mining soil nutrients, intensifying farming onto less suitable soils and exacerbating land degradation. Farming rarely benefits from public support or subsidies. The African variant of the Green Revolution failed to generate more reliable yields for Sahelian staples.

Cities are vital to the region's economy. Some, like Dakar, Bamako, Ouagadougou, Niamey, and Kano predate the colonial period. Major roads and several railways link cities. Urban jobs, however, are concentrated in the informal sector and in the civil service and aid agencies. There is little hope of import substitution, given lingering colonial interests and the cheapness of imports. Nonetheless, there are increasing opportunities for urban speculators to invest in trade, communications, livestock, and farming, and growing linkages between cities and their hinterlands.

Political control of the region has changed hands many times. Camels and horses, introduced by Arab traders, permitted central military control and trading (particularly of gold, salt, and slaves) by the kingdom of Ghana for 300 years, until the 11th century. Saharan Berbers defeated the kingdom of Ghana. The Mali Empire peaked in the 1350s, and the huge Songhai Empire, with elaborate governance structure and a sizeable army, dominated the Sahel until defeated by Moroccans in 1591. Timbuktu, on the banks of the Niger, was its capital and the site of the Islamic university of Sankore. The pastoral Fulani organized and eventually subdued the Hausa and much of the eastern Sahel by the early 1800s, creating a new state that persisted until colonial conquest, alongside the smaller kingdoms like Kanem-Bornu (Nigeria) and the Mossi (Burkina Faso).

Although Portugal, France, the Netherlands, and Britain had long maintained outposts on the west Africa coast for slavery and trading, it was not until 1850 that France extended its control eastwards from the Senegal coast, overrunning the existing ethno-linguistic communities and organized states. France colonized all of the Sahel by the turn of the 20th century, with the exception of Northern Nigeria, The Gambia, and the Cape Verde islands. Because the Sahelian territories had few exploitable resources other than livestock, cotton, and limited minerals, France extracted value through monetary taxation and human labor. Thousands of Sahelians were deployed in plantation agriculture in cotton-growing areas or elsewhere in west Africa, and harsh legal codes were applied in the early years. The colonies were uneconomic, and decolonization occurred swiftly from the mid 1950s.

In the postcolonial period, the record of governments has been mixed. Power was passed to a handful of independence leaders, mostly unelected. Military coups have been frequent, as tensions are played out from religious and ethnic differences and colonial policy. Today's leaderships are still crippled by persistent national poverty and negative trade balances, and each country has high indebtedness and large international aid contributions. The modern Sahel is experimenting with the devolution of state power, particularly in Mali, Burkina Faso, and Senegal. Decentralization is progressing slowly, largely because of the unwillingness of governments to fully devolve powers, and the limited revenue-raising capacity in rural areas. Since the 1970s, when markets were depressed, the Sahelian nations have witnessed an economic transformation, not all of it positive, involving increases in migration and more international trade. Fearing aid dependence, many aid donations are couched as partnership, and debt cancellation is strongly on the agenda.

In summary, the response to the Sahelian droughts of the 1970s and 1980s provoked many changes and substantial investment. However, challenges remain, including persistent poverty, limited access to employment, poor health, social and resource conflicts, land tenure insecurity, and variance in resource entitlements by gender and status. At the national level, the record of governments is checkered, and devolution of state powers is still difficult. The Sahel is seeing a profound transformation in how its people relate to their environment and to each other. Aid, economic adjustment, and modernity and development, though they may transform the Sahel, still coexist with important local traditions and knowledge.

SEE ALSO: Climate, Arid and Semiarid; Colonialism; Desert; Desertification; Overgrazing; Postcolonialism; Sahara Desert.

BIBLIOGRAPHY. *Land Tenure and Resource Access in West Africa: Issues and Opportunities for the Next Twenty Five Years* (International Institute for Environment and Development, 1999); T.A. Benjaminsen and C. Lund, eds., *Politics, Property and Production in the West African Sahel: Approaches to Natural Resources Management* (Nordic Africa Institute/Transaction Publishers, 2001); J. Henao and C. Baanante, *Agricultural Production and Soil Nutrient Mining in Africa: Implications for Resource Conservation and Policy Development* (International Center for Soil Fertility and Agricultural Development, 2006); M. Hulme, "Climatic Perspectives on Sahelian Desiccation: 1973–1998," *Global Environmental Change* (v.11/1, 2001); M.J. Mortimore and W.M. Adams, *Working the Sahel: Environment and Society in Northern Nigeria* (Routledge, 1999); F. Van der Pol, *Soil Mining: An Unseen Contributor to Farm Income in Southern Mali* (Koninklijk Instituut Voor De Tropen, 1994); A. Warren, "The Policy Implications of Sahelian Change," *Journal of Arid Environments* (v.63/3, 2005).

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Sailing

FROM EARLY IN human history, people have put boats into water to transport goods and people. Until the late 19th century, the main source of power for seagoing vessels was the wind captured by sails. This was also the source of power used by most coastal cruisers carrying goods and people along riparian or sea shores. From the voyages of Christopher Columbus and Ferdinand Magellan, to the clipper ships trading with Asia, sailing ships were the means of transportation.

The advent of coal, oil, and nuclear powered vessels led to the almost total abandonment of sailing vessels. Even pleasure boats came to be motorizes. However, especially after World War II, sailing for pleasure or sport became increasingly popular. Today, virtually every harbor or marina in the world is filled with sailboats.

The advent of fossil fuel–powered motorboats led to the near abandonment of sailboats.

Sailing is an interaction of the vessel with the wind and waves. Because local conditions vary so widely from one coastal area to another, many ships were developed that could be easily handled in all kinds of weather among the rocks, currents, and hazards of a coast. When sailing vessels were abandoned for motorized vessels, many designs were also abandoned. However, as sailing as a sport and recreation activity grew, many of these designs were adopted to by recreational sailors. In fact, many of the original boats used for racing or for cruising were simply refurbished working sailboats.

All sailboats have a hull, a rudder, a keel, a mast, sails, ropes, and connecting links. What makes them different are their number of hulls, the type of keel, rudder, the number of masts, and the kinds of sails. Sailboats can be monohulls or multihulls like catamarans. The design of a hull and its associated keel depends upon whether it will be a racing vessel or a cruising vessel. The keel provides stability against the sideways force of the wind. Racing sailboats are designed to glide at fast speeds and usually have a long narrow design. The sailboats that cruise in coastal waters or that sail the oceans are usually wider in design.

Sails used are generally of two types. Square sails, which were made of cotton canvas in earlier times, were used for cruising before steady winds, especially the trade winds. The Yankee Clipper ships were powered mainly by square rigging. However, to handle shifting winds, triangular sails are used either fore or aft. Today, sails are usually made of a lightweight material such as rayon. Sloops, yawls, cutters, schooners and ketches use mainly rig sails. In all cases the power of a boat is directly related to the area of sail it can carry without capsizing.

Those who sail experience the wind and water very closely. It is imperative for sailors to be skilled at reading the signs of changing weather patterns. Their safety depends upon their ability to sail in stormy conditions as well as in fair weather. Radios, medical kits, weather and GPS devices, and other equipment have increased the safety of sailing. Besides regattas and races such as the America's Cup, many have sailed alone or with a small crew around the world or on ocean voyages. Others sail on ecology or environmental voyages.

SEE ALSO: Ecotourism; Fossil Fuels; Law of the Sea; Marine Pollution; Recreation and Recreationists.

BIBLIOGRAPHY. Bob Bond, *The Handbook of Sailing* (Alfred A. Knopf, 2005); Michael L. Frankel, *Voyage of SABRA: An Ecological Cruise through the Caribbean* (W. W. Norton, 1990); Joshua Slocum, *Phoenix: Sailing Alone Around the World* (Phoenix Press, 2001); Roger

D. Stone, *Voyage of the Sanderling: Exploring the Ecology of the Atlantic Coast from Maine to Rio* (Random House, 1997).

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Salinization

SALINIZATION IS THE process by which excessive salts build up on land, especially agricultural land, making it unfit for use. The most common cause of salinization is insufficient drainage, which leads to water evaporating from the soil and leaving dissolved salts. This frequently occurs when irrigation has been used to increase the yields of agricultural land, but the irrigation is insufficiently drained. Improving the drainage, consequently, can help to rectify the problem. However, where there is insufficient water to provide drainage, the salinization can become a wide-scale problem. This has occurred in the Nile Delta, the Aral Sea, and the southwest United States. Salinization is an example of nonsustainable use of land.

Although salinization is assumed to be a phenomenon primarily affecting arid and semiarid zones of the world, it affects all climatic zones. More than 100 countries have been affected to date, and the number will rise as global warming places more pressure on already limited fresh water resources.

The most common salts are sodium, although in some parts of the world calcium, iron, and magnesium salts have also been found. The salts derive from a variety of sources, including rainfall, aeolian deposits, and mineral weathering. The process can be intensified with acid rain. The chemical composition of the soil and the way in which it is husbanded determines the importance and relevance of the presence of salts in particular locations.

Salinization reduces the fertility of the land and requires forcible migration to other locations, and has a number of negative impacts on the local environment. Since agriculturalists are likely to pursue similar methods in new lands that are settled, then the area suffering from salinization will spread along with migration. Since animals and plants may also be dependent on the water resources of an area, salinization can reduce their ability to survive, and may be responsible for desertification, in which the land becomes almost completely uninhabitable on a permanent basis.

Salinization disproportionately affects the poor people of the world, since the poor are much more likely to be involved in agriculture and are less likely to farm the most fertile land. Globally, around 30 million hectares of land suffer from salinization or waterlogging. There is a considerable need for improvements in the ways that water is managed and recycled throughout the world. This should be part of an integrated approach to water management that includes attention to irrigation, watershed restoration, recycled water usage, and rainwater harvesting. Technology will be necessary in this effort, since a great deal of affected land is not sufficiently well mapped or charted.

Scientific analysis of soil is also necessary to identify optimal methods of desalinization and to make recommendations for future husbandry. Such analysis can also identify when only comparatively small portions of land have been affected by salinization, and if selective leaching of the land is an option. Such technology is rarely found in the poorer parts of the world.

SEE ALSO: Desertification; Irrigation; Salt; Waterlogging; Watershed Management.

BIBLIOGRAPHY. *Agriculture and Rural Development, Shaping the Future of Water for Agriculture: A Sourcebook for Investment in Agricultural Water Management* (World Bank, 2005); Seth G. Pritchard and Jeffrey S. Amthor, *Crops and Environmental Change: An Introduction to Effects of Global Warming, Increasing Atmospheric CO_2 and O_3 Concentrations, and Soil Salinization on Crop Physiology and Yield* (Haworth Press, 2005); Pichu Rengasamy, “World Salinization with Emphasis on Australia,” *Journal of Experimental Botany* (v.57/5, 2006); W.D. Williams, “Salinization of Rivers and Streams: An Important Environmental Hazard,” *Ambio AMBOCX* (v.16/4, 1987).

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Salmon

SALMON, ALSO KNOWN as salmonids, are anadromous fish renowned for their unique life cycle and precise migrations: They are born in fresh water, spend much of adulthood in the open ocean, and return to the same stream to spawn. Salmon found along the northern Pacific Rim of North America, Russian Siberia, and Japan belong to the genus *Oncorhynchus* (cherry, chinook, chum, coho, pink, sockeye, and cutthroat and steelhead trout species) and belong to the family Salmonidae. Those found in the Atlantic Ocean belong to the genus *Salmo* (Atlantic, brown trout, and land-locked species). Salmonids are found in discrete breeding populations known as spawning stocks.

Salmon are species of conservation concern with hundreds of spawning stocks at risk and several already extinct. Healthy populations of salmon require gravel for spawning, proper flow regimes, and unobstructed migration passages, all parameters that are degraded by the presence of dams. Several populations of chum, steelhead trout, and chinook salmon in the U.S. Pacific northwest have been proposed for federal listing under the Endangered Species Act by its implementing agency for marine species, the National Marine Fisheries Service (NMFS).

Of concerns cited by NMFS is the extensive presence of large hydroelectric projects in the Pacific northwest, notably on the Snake and Columbia Rivers where "save the dammed salmon" campaigns (and bumper stickers) have attracted widespread public attention. Other considerations include overfishing and the introduction of disease through salmon aquaculture, and water pollution from nonpoint sources in urban centers and ranching.

Historian Richard White attributes salmon declines in the immediate postwar years to the early policies of the Washington Department of Fisheries, the Oregon Fish Commission, the U.S. Fish and Wildlife Service, and the Bureau of Indian Affairs. Today over $1.4 billion is used on dam mitigation costs such as hatcheries, fish ways, and mitigating pollution from timber harvests and ranching.

Salmon are a food resource for local populations. Indigenous populations used weirs to direct the salmon to platforms manned by individuals with spears. Trollers, gill nets, and traps were widely used by the beginning of the 20th century. The salmon industry catch was soon depleting the stocks of spawning fish, leading to some population crashes in the 1900s. Ocean trollers became the most productive commercial fishers by the 1960s. However, new restrictions in the U.S. Fisheries Conservation and Management Act of 1976 redistributed the salmon catch back to the river. In the large salmon fisheries in Alaska, much salmon fishing is done by independent fishers who own and operate their equipment as a result of favorable terms set out by the Alaska licensing system and constitutional framework.

Worldwide aquaculture production has doubled from 1995 to 2005, and grown twenty-fold in revenues since 1975.

Salmon fisheries have historically been vulnerable to overfishing. Many rural commercial fishing jobs, dependent on healthy salmon fisheries and the fresh market for salmon, have been lost in recent years. Another factor in the decline of fishing jobs is the explosive growth of the salmon aquaculture industry producing farmed salmon.

Salmon aquaculture uses net pens that are suspended in the open seas. They have been controversial on several environmental grounds. First, because most salmon aquaculture off the Pacific Coast uses Atlantic salmon, they are considered a potential source of invasive species. This has been particularly noteworthy because of several escapes due to storms, tidal surges, and breaks in containment nets.

Pacific and Atlantic salmon are sexually compatible, raising long-term consequences to the fitness of future generations of salmon. Escaped Atlantic salmon have been documented to breed in Pacific streams and rivers. One salmon produced through genetic engineering has been controversial because it produces growth hormone throughout its grow-out phase, reaching maturity far sooner than its conventionally-bred counterparts.

Environmentalists argue that under the Clean Water Act, pollution discharge permits should be required for net pen aquaculture facilities, with non-native salmon as the effluent under regulation. Environmentalists assert that net pen aquaculture causes sea lice outbreaks and suggest these sea lice have spread to juvenile wild salmon. The application of antibiotics and pesticides directly into the water to treat sea lice, necessary because of the close confines of net pen aquaculture, is questioned for negative impacts on water quality and the potential for disease resistance.

Similarly the excrement from net pen and excess food has been shown to affect dissolved oxygen levels and cause algal blooms. Because the food used to feed the carnivorous Salmonids is taken from a higher point in the feed chain, farmed fish have been shown to contain higher levels of mercury and dioxin, ostensibly through processes known as bioaccumulation and biomagnification. Another concern is the culling of marine mammals like otters and sea lions that are known to harm aquaculture species, or the use of high frequency signals broadcast from net pens as a deterrent, which has been shown to disrupt whale communications and migration patterns.

The shift from fishing to aquaculture has been greatly affected by consumer expectations of fish quality. Aquaculture can deliver year-round, high quality fish at low prices shaped by economies of scale. Wild caught salmon production fluctuates with the seasons and is subject to variable fish and cosmetic blemishes from handling. Worldwide aquaculture production has doubled from 1995 to 2005, and grown twenty-fold in revenues since 1975.

First Nations and other indigenous peoples of the Pacific northwest have long influenced fisheries policies in the Pacific northwest. The Yakima have long asserted the significance of salmon as a cultural talisman in opposition to some of the Columbia's water projects. The significance of salmon as food is captured by the names given to it by the Yurok (*nepu*, "that which is eaten") and the Ainu (*stripe*, "the real thing we eat").

SEE ALSO: Aquaculture; Dams; Fisheries.

BIBLIOGRAPHY. Richard A. Cooley, *Politics and Conservation: The Decline of the Alaska Salmon* (Harper & Row, 1963); Rik Scarse, *Fishy Business, Salmon, Biology, and the Social Construction of Nature* (Temple University Press, 1999); Joseph Taylor, *Making Salmon: An Environmental History of the Northwest Fisheries Crisis* (University of Washington Press, 2001).

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Salt

SALT IS A compound of sodium and chlorine (NaCl) that is an essential ingredient for human life. The human body has to maintain a saline solution in the blood in order to be healthy. If the level of salt is too high, death from extreme thirst can occur. On the other hand, if the level is too low, the body is unable to absorb water and death may occur. The oceans of the earth are all salty and contain a salt solution that is similar to that of the human body. This has led many to conclude that it is likely that life began in the sea.

Salt is a colorless crystalline substance that is brittle. Its chemical name is halide and its crystalline structure is cubic. If it has a color, such as pink, it is a result of the admixture of one or more impurities. Common table salt comes from two major sources. Rock salt is dug from underground deposits that were formed by geologic forces that created salt lakes like the Great Salt Lake in Utah or the Dead Sea between Israel and Jordan. Salt mines can yield tremendous quantities of impure salt that can be used for industrial purposes. The other major source is saltpans, where salt water or seawater is collected into shallow pools. The sun evaporates the water, allowing the salt to be left behind.

All salt originated as salty water or brine. Originally, the rock salt formations found in many places were brine that collected with the evaporation of a lake or a shallow sea. Numerous lakes around the world are salty. and serve as sources for salt production.

Besides common table salt, there are other salts formed by other elements. The chemistry is complex, but essentially, a salt is produced from the combination of an acid with a basic compound. These numerous compounds of salt are of great importance in the manufacture of many products. Salts that are not sodium chloride include calcium chloride (CaCl), calcium carbonate ($CaCO_3$), and sodium bisulfate ($NaHSO_4.H_2O$).

Potassium chloride (KCl) is a salt. It is sold as "light salt" to flavor food for people who are afflicted with hypertension, as table salt can aggravate their blood pressure and contribute to a cardiovascular incident or stroke. It is also used in executions by lethal injection. Salt compounds, especially sodium chloride, are used extensively by the chemical industry in the manufacture of chemicals. Much of the chlorine used by industry comes from salt.

It has been estimated that modern medicine would be powerless without the many drug molecules that are developed from salts in at least one stage of the manufacturing process. Probably half of all drugs are either developed or delivered to the cells in the body by means of a salt. Salt is also important in livestock production. Blocks of salt are made available for cattle or other animals to eat along with their natural feed. In nature, many animals will seek out sources of salt as an aid to their diet.

Salinity can be a severe problem for farmers who use irrigation. The evaporation of water brought to fields for crop irrigation can cause the accumulation of salts. The salt left by evaporation reduces the fertility of the soil. Eventually, the land will be rendered infertile by the salt. The use of salt to make modern highways passable during times of ice and snow consumes great quantities of salt. The practice causes vehicle corrosion and saline pollution in areas where the road salt dissolves and enters into the surrounding land or streams.

Throughout human history, salt has been of great importance to people; Roman soldiers at one period were paid in salt. The word *salary* is derived from the Latin word for salt. In ancient times, an enormous trade in slaves for salt was conducted.

Sea salt has the additional benefit that it often carries iodine, which is needed by the thyroid glands. Without iodine, goiter develops, with devastating effects. The Kiwanis Club International has a global program to eradicate goiter by funding salt factories in a number of poverty-stricken areas of the world. These manufacturing plants add iodine to the salt that will be consumed by local populations in areas remote from the sea.

Salt has been used as a preservative from near the beginning of human history. Pickles, sauerkraut, and other foods are preserved by means of salt. The salt prevents the growth of bacteria or fungi or other microbes. It also retards the oxidation of fats that cause meats or nuts to become rancid. Salt adds flavor to numerous foods and is consequently an important ingredient in cooking.

Many religions have used or still use salt in their rituals. For example, Buddhists have used salt to repel evil spirits; when the 13th Dalai Lama died in 1933 he was buried on a bed of salt to ward off evil spirits. The Pueblo Indians of the American southwest worshipped the Salt Mother. Among the Hebrews and Israelites, salt was used in the Salt Covenant. The New Testament relates that Jesus called his disciples "the salt of the earth" because of their power to create a divine sense among people that resembled the flavoring of a dish with salt.

SEE ALSO: Lakes; Oceans; Salinization.

BIBLIOGRAPHY. Rene Ashley, *Salt* (University of Wisconsin Press, 1991); Robert Froman and A.M. Jauss, *The Science of Salt: An Informal Introduction to Some of the Fundamentals of Chemistry and the Chemical Industry* (D. McKay Co., 1967); Mark Kurlansky, *Salt: A World History* (Penguin Group, 2002); P.H. Stahl and C.G. Wermuth, eds., *Pharmaceutical Salts: Properties, Selection and Use* (John Wiley & Sons, 2002).

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Samoa

SAMOA IS MADE up of two principal islands, Upolu (1,100 square kilometers) and Savai'i (1,800 square kilometers), and six islets in the South Pacific Ocean. Both of the main islands are volcanic and mountainous; the last significant eruption occurred in 1911. The interiors are densely forested and more fertile land and soils can be found along coastlines. However, prime agricultural land only accounts for 14 percent of total land area. Of the two islands, Savai'i has poorer quality stony soils with less agricultural diversity and opportunity, while Upolu, home of almost 70 percent of the population, is more suitable for both agricultural development and settlement.

Samoa's climate is typically hot and humid with a pronounced wet season from November through March and dry season between April and October. Rainfall is variable, typically ranging between 2,500 and 5,000 millimeters annually. Though uncommon, Samoa lies in the path of cyclones, particularly in El Niño periods. The country faced two catastrophic cyclones, Ofa (the most devastating in over a century) and Val in 1990 and 1991, which destroyed buildings, forests, food sources, export crops and entire villages, with high seas instigating serious coastal damage and erosion. The impact was so great that many agricultural crops did not recover for a decade. The damage from Cyclone Val alone was estimated to be U.S. $368 million.

Though secondary industry exists and plays an increasingly important role in productivity and employment, Samoa's economy remains centered around agriculture. While coconuts, fishing, and manufactured products account for a great proportion of exports, taro, yams, coconuts, and other crops continue to play an important role in meeting the subsistence needs of many Samoans. Fishing, forestry, and cattle are also significant to the national economy.

Over 70 percent of the country's 200,000 people work and live in rural areas, but population is increasingly concentrated on the main island of Upolu and particularly along the northwest coast where the capital, Apia (population 40,000), is located. Though moderate by international standards, the concentration of population on northern Upolu is placing demands on land, infrastructure, and services as well as impacting on the quality of inshore water and fisheries.

A key feature in environmental use and management is that the nation of Samoa is made up of villages through which councils (*fono*) and traditional authorities (*Matai*) exercise authority over the use of land. Customary stewardship of land essentially acts as a check on commercial exploitation. Nevertheless, customary land tenure may also permit exploitation of resources and degradation of public goods, such as watersheds. This interface of formal/state institutions and traditional forms of governance will continue to be important in the future management of Samoa's environmental resources.

SEE ALSO: Hurricanes; New Zealand; Pacific Ocean.

BIBLIOGRAPHY. Central Intelligence Agency, "Samoa," *World Factbook,* www.cia.gov (cited April 2006); R. Gerard Ward and Paul Ashcroft, *Samoa: Mapping the Diversity* (Institute of Pacific Studies, 1998); World Bank, "Samoa," lnweb18.worldbank.org (cited April 2006).

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Satellites

A SATELLITE IS an airborne autonomous platform that carries a set of sensors to capture information on the surface of the earth, including vegetation, water masses, ice, and the atmosphere. The scientific and technological field dealing with the conception, design, and control of satellites as well as processing and interpretation of space imaging is remote sensing.

The sensor of the satellite captures energy—electromagnetic radiation—of a certain wavelength and geographical area, producing a scene or image. The sensors capturing the energy reflected or emitted are called "passive," while those that send the energy that will be returned by the surface and thereafter captured are termed "active," like in satellites Radarsat or ERS-2. Active sensors operate in the region of microwave length, which allows them to capture information in almost any atmospheric condition, while passive sensors experience strong limitations with cloud coverage.

The resolution of the satellite determines the accuracy of the information provided and ultimately the field of application. There are four resolutions of interest: spatial, spectral, temporal, and radiometric. The spatial resolution resolves the smallest spatial feature represented (or the size of the image pixel). Spatial resolution is, in turn, conditioned by the IFOV (Instantaneous Field of View), the angle corresponding to a certain ground area of the earth surface captured at a certain moment.

The spectral resolution refers to the number of bands and the width of the bands captured by the sensor, expressing the capability of resolving features or phenomena at various wavelengths. Sensors are commonly multi-spectral, capturing various bands of the spectrum for the same area at the same time. Hyperspectral sensors register information in numerous (up to several hundred), very narrow, contiguous spectral bands along the spectrum. The temporal resolution is the frequency, or repeat time, with which a satellite passes over the same geographical area. The radiometric resolution indicates the capability of distinguishing between coverages with close response.

The regions of the electromagnetic energy spectrum operated are ultraviolet (UV), a wavelength in the range of three nanometers to 0.4 micrometers; visible (0.4–0.7 micrometers); infrared (IR), in the range of 0.7–1,000 micrometers; and microwave (one millimeter to one meter). Within the visible region blue, green, and red bands are differentiated; within the IR region near-, mid-, and thermal-infrared are distinguished.

There are various types of satellites for different mission objectives. Military satellites are deployed to accomplish restricted national defense goals of reconnaissance and surveillance, although images from some older decommissioned ones have been made public.

Meteorological observation has been one of the first civil applications, with a focus on weather prediction. Geostationary Operational Environmental Satellite (GOES) covers the hemisphere, including North and South America. European Meteosat, Japanese GMS, or Indian Insat serve similar purposes. Ocean monitoring and other atmospheric observation satellites are Seasat, Nimbus or SeaWiFS.

Earth observation, however, has been the more developed application. Landsat, a pioneering program initiated in 1967, continues today with Landsat-7. This mid-resolution satellite has long maintained Thematic Mapper as a sensor, allowing it to monitor long-term processes. The first SPOT was launched by France in 1986 with a revisit time of 26 days and five spectral bands—from visible to mid-infrared—and a spatial resolution of 10 meters in panchromatic mode and 20 meters in multi-spectral. The satellite Terra integrates multiple sensors with multiple objectives, which makes it adequate for multiple applications. NOAA satellite series have addressed these same objectives with a single sensor (AVHRR).

Earliest initiatives responded to national schemes with durable scientific programs, such as NOAA, Landsat, SPOT, or IRS, but soon other countries sought to guarantee control over information about their resources and environmental monitoring by launching their own programs. Private initiatives started in 1999 with Ikonos-2, followed by Quickbird-2 and Orbview-3. Their commercial perspective led to reducing spectral resolution and increasing spatial and temporal resolution.

SEE ALSO: Geographic Information Science; Global Positioning Systems (GPS); Maps; Remote Sensing; Topographic Maps.

BIBLIOGRAPHY. James B. Campbell, *Introduction to Remote Sensing* (Guilford Press, 2002); John R. Jensen, *Remote Sensing of the Environment: An Earth Resource Perspective* (Prentice Hall, 2000); Thomas M. Lillesand, Ralph W. Kiefer, and Jonathan W. Chipman, *Remote Sensing and Image Interpretation* (John Wiley & Sons, 2003); Gareth Rees, *Physical Principles of Remote Sensing* (Cambridge University Press, 2001); Floyd F. Sabins, *Remote Sensing: Principles and Interpretations* (W.H. Freeman, 1996).

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Saudi Arabia

EFFORTS TO UNIFY the Arabian Peninsula began in 1902 under the ancestors of the current ruling family of Saudi Arabia. Eventually covering 80 percent of the peninsula, the Kingdom of Saudi Arabia was formally established in 1932. The population of Saudi Arabia rapidly expanded in 1990 when 400,000 Kuwaitis sought refuge after the Iraqi invasion of their homeland. The following year, Saudi Arabia proved the strongest ally when Western troops liberated Kuwait. By 2003, virtually all American forces had relocated to Qatar, easing tensions between the royal family and the Saudi people. The current population figure of 26,417,599 includes approximately 5,576,076 non-nationals.

Bordering the Persian Gulf and the Red Sea, the Saudi coastline runs for 1,637 miles (2,640 kilometers). Saudi Arabia shares borders with seven other Middle Eastern nations: Iraq, Jordan, Kuwait, Oman, Qatar, the United Arab Emirates, and Yemen. The 1,960,582 square miles (756,981 square kilometers) that make up Saudi Arabia are mostly uninhabited desert, with mountains in the west and broad plains in the east. Because of the extensive desert, Saudi Arabia experiences harsh temperature extremes with frequent dust and sand storms. Elevations range from sea level at the Persian Gulf to 10,279 feet (3,133 meters) at Jabal Sawda in the southwestern corner of the country.

The 212,355-square-mile (550,000-square-kilometer) Rub'-al Khali is the world's largest quartz-sand desert, and the smaller Great Nafud continues to defy explanation; no one can find the reason for its unique horseshoe shape.

With a fourth of the world's petroleum reserves, Saudi Arabia is the largest petroleum exporter in the world and the major force in the Organization of the Petroleum Exporting Countries (OPEC). Petroleum and natural gas provide around three-fourths of Saudi budget revenues and 90 percent of export earnings, contributing 45 percent of the Gross Domestic Product (GDP). Saudi Arabia also has deposits of iron ore, gold, and copper. Even though Saudi Arabia has a per capita income of $12,900 and is the 74th-richest nation in the world, women do not lead economically or politically viable lives. The fertility rate remains high at more than four children per female, and over a fourth of adult females are illiterate. Women are denied basic political and social rights. Officially, the unemployment rate for Saudi males is 13 percent, but it may be as high as 25 percent.

The major environmental problem for the Saudi government is a lack of freshwater resources since there are no rivers or navigable waters within the country. In order to deal with this problem, a wide network of desalination facilities has been erected. Climatic conditions have contributed to extensive desertification. Saudi Arabia is also still in the process of recovering from damage caused by Iraqi forces during the Persian Gulf War of 1991, when approximately eight million barrels of oil were dumped directly into the Gulf. Scientists have identified oil residues as high as 7 percent in sediments along the Saudi coast, the normal feeding grounds for birds and breeding grounds for fish.

Because the war-related damage has affected the entire shallow-water ecosystem, the economic consequences have been substantial. For instance, pollution at the industrial facilities of Al Jubayl endangered essential supplies of potable water. Northward, damage was even more extensive, killing off wildlife that included cormorants, grebes, and auks. To promote biodiversity, the Saudi government has protected over 38 percent of the land area. Of 77 endemic mammal species, eight are endangered, as are 15 of 125 endemic bird species.

Less than 2 percent of Saudi land area is arable, but 12 percent of the workforce is engaged in agriculture. Approximately 88 percent of Saudis live in urban areas where heavy industry and vehicles contribute to poor air quality. Saudi Arabia produces 1.6 percent of the world's share of carbon dioxide emissions. Due to increased attention to air pollution, however, carbon dioxide emissions per capita in metric tons rose only 0.1 percent between 1980 and 2002.

Air pollution in Saudi Arabia was significantly increased by the exploding and burning of 700 oil wells in Kuwait during the Gulf War. The United Nations Environmental Program (UNEP) warned the Saudis that human lives were in danger from eating livestock that had grazed in contaminated areas. Long-term effects of the contamination left by Iraqi forces, including approximately 52.8 million gallons (200 million liters) of untreated sewage, are still being determined. In 2006, scientists at Yale University ranked Saudi Arabia 59th of 132 countries on environmental performance, below the comparable geographic group and considerably below the comparable income group. The lowest scores were achieved in the categories of air quality and sustainable energy.

The Ministerial Committee on the Environment (MCE) is the Saudi body charged with making environmental policy. The ministry works in concert with other ministries such as Agriculture and Water, which bears the responsibility for overseeing water resources, wildlife, and national parks. MCE is focused on the formulation and implementation of policy and on monitoring compliance with environmental laws and regulations. Under Article 32 of the Basic Rule of Governance, the Meteorology and Environmental Protection Administration, founded in 1980, implements preventive measures and conducts environmental impact assessments. Specific environmental goals include ensuring that air, water, and food are free of pollutants, managing natural resources, and promoting sustainable development.

Saudi Arabia has expressed commitment to global environmentalism by participating in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Desertification; Natural Gas; Oil Spills; Organization of the Petroleum Exporting Countries (OPEC); Petroleum; Pollution, Air; Wars.

BIBLIOGRAPHY. Central Intelligence Agency, "Saudi Arabia," *The World Factbook*, www.cia.gov (cited May 2006); Country Studies, "Saudi Arabia: Environment," www.country-studies.com (cited May 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); David E. Long, *Culture and Customs of Saudi Arabia* (Greenwood, 2005); United Nations, "Institutional Aspects of Sustainable Development in Saudi Arabia," www.un.org (cited May 2006); United Nations Development Programme, "Human Development Report: Saudi Arabia," hdr.undp.org (cited May 2006); World Bank, "Saudi Arabia," *Little Green Data Book,* lnweb18.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu (cited May 2006).

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Sauer, Carl (1889–1975)

CARL ORTWIN SAUER was an influential American geographer and has been characterized as the father of cultural geography. He received his doctorate in Geography from the University of Chicago in 1915. Prior to this he worked as a geologist with the Illinois Geological Survey, a map editor for Rand McNally, and as a teacher in Massachusetts. Sauer developed a great appreciation for the work of the French geographer Paul Vidal de la Blache and others in France who espoused the importance of regions to geographical analysis.

Sauer contended that all regions have their unique landscapes that reflect the social processes and physical modifications within them over time. One of Sauer's most important writings is "The Morphology of Landscape," in which he presents a model of the derivation of a cultural landscape. Sauer insisted that the occupying culture group makes its distinctive imprint on the natural landscape of the region. The cultural landscape, Sauer contended, is fashioned from a natural landscape by the culture group. This article not only set the concept of the cultural landscape squarely in the center of the geographical arena, but also effectively ended the dominance of environmental determinism.

Sauer served on the geography faculty at the University of Michigan from 1915 to 1923 before relocating to the University of California, Berkeley, where he spent the remainder of his career. His work on the cultural landscape drew heavily on anthropological theories put forward by Alfred Kroeber and Robert Lowie, Sauer's colleagues at Berkeley, and the integration of ideas from the Kulterkreise

School in Europe. His program centering on cultural landscape and human impact on the environment later evolved into cultural ecology.

Sauer was a dedicated and enthusiastic field worker. He believed strongly in the immersion of the geographical analyst. Observation of the environment and holding discussions with occupants of the region were invaluable, Sauer contended, in gaining insights about the land and people. In his article, "The Education of a Geographer," Sauer reflected on his approach to fieldwork: "Locomotion should be slow, the slower the better; and should be often interrupted by leisurely halts to sit on vantage points and stop at question marks." He was also an outspoken critic of governmental efforts to destroy wilderness areas. Sauer advocated against the forest industry practice of clearcutting, and he wanted a system in place to inventory valuable resources and to ensure their wise use.

Sauer's work on agricultural origins was highly regarded. He theorized that southeast Asia was a likely center for agricultural development because of its extensive inventory of plant life. He also suggested that the cultivation of plants occurred in a number of different regions. This idea ran counter to the prevailing argument, which favored the notion of a single source region for particular plants. Sauer wrote on urban places too, and suggested that they were also cultural landscapes and reflected human society's response to the natural landscape. His research on one occasion extended to the study of gerrymandering and the reapportionment of an unusual congressional district in Missouri. Sauer was the recipient of numerous awards, including the Alexander von Humboldt Medal from the Berlin Geographical Society in 1959, and the Victoria Medal from the Royal Geographical Society, London, in 1975, the year of his death.

SEE ALSO: Cultural Ecology; Geographic Information Science; Geography.

BIBLIOGRAPHY. Carl O. Sauer, "The Morphology of Landscape," *University of California Publications in Geography* (v.2/2, 1925); Carl O. Sauer, *Agricultural Origins and Dispersals* (American Geographical Society, 1952); Carl O. Sauer, "The Education of a Geographer," *Annals of the Association of American Geographers* (v.46, 1956); Carl O. Sauer and John Barger Leighly, *Land and Life: A Selection from the Writings of Carl Ortwin Sauer* (University of California Press, 1963).

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Savanna (or Tropical Grassland)

THE SAVANNA ECOSYSTEM is one of the largest terrestrial biomes in the world with a remarkable expanse throughout tropical environments of South America, Africa, Asia, and Australia. It is estimated that throughout the world savannas cover a total land area of about 12.7 million square miles (33 million square kilometers). The term *savanna* is of Amerindian origin used in Haiti and Cuba to denote a treeless plain. This term was later incorporated into Spanish. Although there is no agreement on a single definition for this biome, the term is broadly used to describe all tropical and subtropical ecosystems characterized by continuous herbaceous cover of heliophilous grasses that show seasonality related to water and temperature and in which woody species are significant but do not form a closed canopy or continuous cover. As such, savannas contain a continuous cover of perennial grasses of three to six feet in height interspersed with shrubs or open canopy trees that are drought, fire, and browse resistant.

Several classifications have been identified dependent upon the composition of the flora, for example the savanna woodland, savanna parkland, savanna grassland, low tree, and shrub savannas. The classification may also involve the use of the dominant tree layer, for example, palm savannas, pine savannas, acacia savannas, brachystegia-julbernadia savannas, and so on.

The savanna biome is generally located between the tropical rain forest belt and the desert biome to the north or south of the equator. Not enough rain falls in this biome to support tropical rain forests. Precipitation is estimated at 30 to 50 inches of rainfall per annum with mean monthly temperatures of about 65 degrees F. The soils are often lateritic oxisols resulting in their low fertility. Our ecological knowledge of this biome comes from research that has been conducted largely in Africa and Australia. In southern and eastern Africa, the vernacular term for savanna is *miombo* woodlands. This is the primary woodland ecosystem in this region and is dominated by the tree species of the genera *Brachystegia, Julbernardia,* and/or *Isoberlina*, all of the legume family Fabaceae, subfamily Caesalpinioideae.

The *miombo* woodland biome in eastern and southern Africa covers almost 1.5 million square miles (2.7 million square kilometers) containing over half of Africa's tropical dry forests stretching over a number of countries such as Kenya, Tanzania, Zimbabwe, Botswana, South Africa, Malawi, Mozambique, Zambia, and Namibia. Elsewhere in the world, the llanos of the Orinoco basin of Venezuela and Colombia are grass savannas maintained by the annual flooding and long periods of standing water, which inhibit the growth of trees. In Brazil, the cerrado is open woodland that is extremely rich in species and second only to the tropical rain forest in fauna and flora diversity. The tropical savanna of northern Australia is one of the largest in the world, with dense grass inter-spaced with scattered eucalyptus trees providing a home to many animals including several species of kangaroos. Savanna woodlands are also found in large areas of India.

In spite of the fact that savannas are found throughout the world, the savannas many people are most familiar with are the east African savannas covered with acacia trees. This is probably because the largest chunk of savanna woodlands (about 40 percent) is found in Africa. The famous game parks of Kenya, Zimbabwe, Botswana, South Africa, and Tanzania such as the Serengeti Plains of Tanzania are located in this biome. Here, one finds animals such as lions, zebras, elephants, and giraffes, and many types of ungulates (animals with hooves) graze and hunt. The diversity of species is remarkable, with a large range of highly specialized plants and animals that depend on each other to keep the environment in balance. It is estimated that there are over 40 different species of herbivore mammals that live on the savannas of Africa. The variety of these herbivores provides a wide range of food for carnivores, like leopards, cheetahs, hyenas, lions, and jackals.

However, an ever-expanding human population is putting pressure on the savanna biome. Large areas of the savanna are under stress and disturbance from human activities such as grazing, fuel wood, and timber collection and land clearing for cultivation. Threats to African savanna from intense human activity have received little attention in comparison to those affecting tropical rain forests. Yet Africa's savanna habitants are being degraded rapidly. Poaching for ivory to satisfy the international market has also resulted in the decimation of the elephant and rhinoceros to the point of near extinction. Deforestation is another major threat to the survival of the savanna environment in Africa. Research is currently shading important knowledge about the fragility of the savanna ecosystem. Once the vegetation is cleared either due to overgrazing or deforestation, the savanna quickly converts to semiarid or desert environment.

SEE ALSO: Australia; Biome; Botswana; Grasslands; Kenya; Rain Forests; South Africa; Tanzania; Wildlife.

BIBLIOGRAPHY. Martin E. Adams, "Savanna Environments," in William M. Adams, Andrew S. Goudie, and Antony R. Orme, eds., *The Physical Geography of Africa* (Oxford University Press, 1996); David J. Beerling and Colin P. Osborne, "Opinion: The Origin of the Savanna Biome," *Global Change Biology* (v.12/11, 2006); Elisabeth Benders-Hyde and Karl Nelson, "Savanna," www.blueplanetbiomes.org (cited December 2006); James Fairhead and Melissa Leach, *Misreading the African Landscape: Society and Ecology in a Forest-Savanna Mosaic* (Cambridge University Press, 1996); David R. Harris, *Human Ecology in Savanna Environments* (Academic Press, 1980); Mark Owens and Delia Owens, *Secrets of the Savanna: Twenty-Three Years in the African Wilderness Unraveling the Mysteries of Elephants and People* (Houghton Mifflin, 2006).

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Save the Whales Movement

DURING THE LATE 19th and early 20th centuries, the modernization of whaling methods, such as the invention of the explosive harpoon, powered catching vessels, and factory ships led to an explosion of commercial whaling activity. As the numbers of whales killed grew and species of whales declined, the public began to take an interest in these animals. Starting in the 1940s, articles and pictures appeared in popular magazines on whales and their unique appearance and behaviors. The whaling nations noted that whale numbers were starting to decline and concerns about the impacts of this on the industry and a need to manage catches led to the establishment of the Convention on the Regulation of Whaling in 1931, and the International Whaling Commission in 1946.

Some nongovernmental organizations (such as the Humane Society of the United States and Friends of the Earth) began actively advocating for the conservation of whales and calling for the cessation of commercial whaling as early as the 1950s and 1960s. But it was not until the 1970s that this advocacy reached a peak with the initiation in 1971 of the Animal Welfare Institute's and the Fund for Animals's "Save the Whales" campaign. One aspect of their campaigning was a call for a boycott of goods from Japan (the main whaling nation).

In 1975, the relatively new environmental group Greenpeace expanded its scope from campaigning against nuclear activities to opposing whaling, and promoted its Project Ahab program. The media attention gained by Greenpeace's filming and publicizing of commercial whale hunts led to international public concern and protest, and helped to galvanize the "Save the Whales" movement, with more nongovernmental organizations, such as the National Audubon Society, joining the movement.

Also during the 1970s, national governments began expressing concern about the impacts of whaling activities. For example, in 1972, the Nixon administration in the United States passed the Marine Mammal Protection Act, which among other actions prohibited whaling and the sale of whale products. Moreover, at the United Nations Conference on the Human Environment in Stockholm in 1972, the U.S. government proposed a 10-year ban or moratorium on commercial whaling, which passed 53 votes to zero (with three abstentions). The resolution was the initiative of, and spearheaded by, the nongovernmental organization (NGO) Project Jonah.

A major development at the International Whaling Commission was an allowance in 1970 for NGO observers to attend the IWC meetings. These NGOs encouraged conservation-minded countries to press for a ban on commercial whaling. Finally, in 1982 the necessary three-quarters majority of IWC member countries voted in favor of a moratorium on commercial whaling, which was implemented in 1986.

The moratorium was considered a victory for the "Save the Whales" movement. However, despite this, countries continue to hunt whales. Norway filed a formal objection to the ban and returned to commercial whaling in 1993. Japan and Iceland hunt whales under a provision that allows killing of whales for scientific research. The quotas and the diversity of species taken under both commercial and scientific whaling have increased, so that now over 2000 whales are being targeted each year. However, the media attention that accompanied the original enactment of the moratorium has led a large proportion of the public to believe that whales are no longer threatened by commercial whaling, i.e., that whales have been saved. In an effort to counteract this misconception, some nongovernmental organizations are starting to develop renewed advocacy programs. According to public surveys in some countries, awareness of the continued existence of whaling and opposition to whaling appear to be increasing.

SEE ALSO: Audubon Society; Dolphins; Greenpeace; Nixon, Richard Administration; Whales and Whaling.

BIBLIOGRAPHY. R. Ellis; *Men and Whales* (Afred A. Knopf, 1991); Save the Whales Again Campaign, www.savethewhalesagain.com (cited December 2006); N. Scott and E.C.M. Parsons, "A Survey of Public Opinion in South-west Scotland on Cetacean Conservation Issues," *Aquatic Conservation* (v.15, 2005).

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Scale, Problems of

A LARGE DIVIDE exists between natural and social scientists across the disciplines in terms of how they understand scale in studies of the environment and society. This divide has led to disparate conceptions and uses of scale and few attempts at bridging the divide (even within disciplines). On one side is an understanding of scale that is derived largely from the physical sciences. On the other are conceptions of scale that are a part of traditions within geography and related disciplines that are influenced by critical social theory.

PHYSICAL SCIENCE CONCEPTIONS

Physical science traditions consider three basic types of scale: Process scale, observation scale, and model or conceptual scale. To characterize fully each type of scale, one must specify the following: (1) support (the spatial/temporal coverage (i.e., resolution) of an individual observation or manifestation of a process), (2) spacing (the spatial/temporal distance between observations or areas in which a process occurs) and (3) extent (the total coverage encompassing the total area in which observations are made or a process occurs). It is important to note that scale is not an active thing. Processes occur across a range of scales some of which are arbitrarily delimited and ascribed more significance. However, the scale itself is not the important feature, the importance is how the particular process under examination is manifested at the scale. In short, processes do not create scales, they are only manifested at some scales and not at others.

The scale problem is how to take an observation collected at a local scale and determine how the process would be observed at some other scale (e.g., regional). This problem ultimately incorporates scaling of each support, spacing, and extent. Depending on the process being examined, some of these translations are relatively simple, e.g., downscaling the observational extent is trivial in that it only means ignoring some of the data. The most difficult component is upscaling or downscaling the support. This is analogous to changing the pixel size of a remotely sensed image or deciding whether to use census tracts, counties, or states as the spatial unit of analysis. Given some observation of a process in a one meter square pixel, what would be the observation at 100 square kilometers? However, scaling of the conceptual understanding is even more problematic since we are attempting to ascertain some mapping between some observations collected at a particular scale to determine the outcome of a process at that scale. Ultimately we want our conceptual framework to allow us to take the same mapping with the same variables collected at a different scale to give us the representation of the process at the new scale. Thus, we are seeking a proper weighting of, for example, the small scale input variables to determine the larger scale manifestation of the process. In a trivial case where the weighing is linear and the larger scale manifestation is solely determined by the process at small scales, the larger scale is simply the mean of the small scale.

However, many processes occurring in the real world are highly nonlinear, and not all scales are equally relevant to manifestation. Here it is important to keep in mind the relationships among the process, observation, and model or conceptual scale. The ultimate goal of all research is to obtain some understanding of the process being examined. We observe some manifestation of the process, and our understanding of the process is to some amount determined by the support, spacing and extent of our observations. These observations are used to develop or confirm our conceptual framework (i.e., hypothesis testing and theory development). Our conceptual understanding is then scale dependent, in that it is derived from specific observations gathered at some scale. For example, the dominant mechanism responsible for the observation of some process at a large scale may have very little to do with the individual small-scale manifestations—what is observed at the large-scale is not simply determined by the aggregation of that observed at the small scale. In this case, the issue is complicated by the fact that our conceptual understanding (i.e., the hypothesis that the larger scale process would be observed as the aggregation of the small scale realizations) is wrong, and thus the conceptual scale does not mesh with the actual process.

The issue is further complicated when we do not have observations at different levels of support. Thus we must attempt to ascertain how the larger scale manifestation of the process relates to the small scale without having any actual observations on which to base our understanding. Thus, we must use our conceptual understanding to derive hypotheses that can ultimately be tested to ascertain what the observations at larger scales would be. This is ultimately the scale problem, regardless of what the actual process being examined, and it applies equally to both studies of society and the environment.

SOCIAL SCIENCE CONCEPTIONS

The above discussion is derived largely from a physical science perspective. A very different idea of scale can be found in research influenced by critical social theory where scale is discussed in terms of "geographical scale," the "production of scale," and the "politics of scale." A common conception of scale in this realm of research is that scale is socially constructed, and that the active scaling of human activity can be subjected to critical analysis. The argument here is that one should not take scales such as the urban, regional, national, or local as having some *a priori* essence. Rather we should examine how different processes of human organization came to be manifested at such scales in the first place.

Scales and their interrelationships are produced by political-economic struggles among different groups with different interests. At different points in history, particular scalar hegemonies can emerge. For example, the national scale has long been a dominant scale at which states, economies, language, culture, and citizenship are organized. However, that hegemony is currently being challenged by a wide ranging process of "glocalization" by which political and economic organization at local and global scales is becoming increasingly important. For example, the rise of regional economic clusters has called into question the former coherence of national economies, and the emergence of supranational state forms like the European Union has undermined the notion that state sovereignty should exist only at the national scale.

Researchers encounter problems when they assume the particular qualities of a given scale are natural; they should instead critically analyze the social processes through which that scale came to be associated with those qualities. A common example is in development studies when researchers call for localization of power in development planning and implementation in order to achieve goals of sustainable development. Such goals may or may not be achieved by localization. It is not the scale of organization that produces the development outcome; outcomes are produced by social actors pursuing particular agendas. Localization is always merely a strategy used by people who benefit from organization at that scale. Believing a particular outcome will automatically result from a particular scale of human organization, without full consideration or knowledge of the processes operating at and on that scale, leads to what we call a "scalar trap." Thus, since scales are socially produced, when we observe a process of marked rescaling, our first instinct should be to look at how power has shifted from one group of people to another.

Bridging these two approaches to scale is a difficult task. One possible way is to suggest that physical science conceptions are really not that different from those in social science, and that the terms of the social-science side can be translated into the terms of the physical science tradition. In this light, all physical and human political and economic processes potentially exist at all possible scales.

When geographers critically analyze the national scale and the current challenges to its hegemony, we must first be specific about the particular process(es) that are in question, for example economic policy making. To say that the national scale was "created" or "forged" is to say that economic policy making became manifested at some point in history primarily at the national scale (the support of the economic policy process scale). This process scale has, therefore, partially determined the observational scale; e.g., we now use national economic statistics in studies of the effect of economic policies on wealth disparity across the globe. When national economic policy making is "re-scaled" to global entities, this is similar to saying that the dominant level of support for the policy process scale is being changed from a national to a global level of support.

Finally, we enter a "scalar trap" when the support of the economic policy conceptual scale (how we believe it operates) is applied uncritically without regard to the support of the economic policy process scale (the process that is actually occurring). Developing a common language like this is one way to create cross environment-society understanding of problems of scale. No matter the research, when scale becomes merely a stand-in or shorthand for the human and physical processes we are studying, then we are narrowing our vision of what the world is and how to study it.

SEE ALSO: Geographic Information Science; Geography; Regions; Remote Sensing.

BIBLIOGRAPHY. Michael J. Bradshaw, George W. White, Joseph Dymond, and Dydia DeLyser, *Contemporary World Regional Geography: Global Connections, Local Voices* (McGraw Hill, 2004); M. Crang, *Cultural Geography* (Routledge, 1998); D. Gregory, *Geographical Imaginations* (Blackwell, 1994); D.A. Quattrochi, S.J. Walsh, J.R. Jensen, and M.K. Ridd, "Remote Sensing: Prospects, Challenges, and Emergent Opportunities," in G.L. Gaile and C.J. Willmott, eds., *Geography in America at the Dawn of the 21st Century* (Oxford University Press, 2004).

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Scarcity

SCARCITY IS A concept fundamental to economics with important ramifications concerning human use of natural resources. Before the rise of classical economics, the term was primarily used to refer to times or situations of hardship; for example, there was a scarcity of food if people were starving; if people had plenty of food and other amenities, there was abundance. Classical economics redefined *scarcity* based on the claim that all humans (not just greedy ones) have unlimited needs and wants. Hence, any desirable resources that exist in finite quantities are considered scarce in the sense that there are less of them than people desire, and scarcity prevails even among the richest people in the most affluent societies.

This universal condition of scarcity is used to justify the need for everlasting economic growth in all countries, regardless of their wealth or poverty. Economic growth typically entails increased consumption of natural resources, whether they are located in the same or a different country than where final consumption takes place, raising the specter of absolute resource scarcity.

Early critics pointed out that economic or population growth would be limited by absolute scarcity of physical resources. The most well known critic of this kind was Thomas Malthus, who argued that population would grow exponentially while the productivity of agricultural land would only grow in a linear fashion, leading to scarcity of food as population growth outpaced growth in food production. The results would include famine, pestilence, and war. Modern-day neo-Malthusians (e.g., Garret Hardin or Paul Ehrlich) posit that scarcity in food and other resources appears once human population exceeds a more or less constant regional or global carrying capacity, a concept derived from the study of animal populations. Their main advice to avoid this kind of scarcity is to stop population growth. Hardin's "lifeboat ethics" goes further, arguing that resource scarcity demands that the well-off let starving people die.

Other critics of growth-oriented economics see population growth as only one form of problematic growth; they find trends of increasing per capita consumption of natural resources equally or more worrying. A path-breaking study of this kind was the Club of Rome's "Limits to Growth," which saw not only population growth, but also economic growth and resultant pollution as encountering limits, i.e., a scarcity of resources. Based on a similar logic, a few scholars have developed principles for an economy based on constant throughput of resources.

Defenders of capitalist growth-oriented strategies usually argue that new technologies will allow for continued economic and population growth despite any scarcities of natural resources. For example, Julian Simon argues that the "ultimate resource" is human ingenuity, which can substitute for any and all natural resources. Hence, any scarcity we encounter is due to the limitations of our own knowledge, and capitalist market incentives are the best method to stimulate the development of new technologies that eliminate scarcities.

Based on empirical studies she conducted in Africa, Ester Boserup made far less extreme claims, arguing that the pressure of population on land resources stimulated the development of more intensive forms of agriculture, which could in turn feed higher population densities. There is considerable empirical support for her thesis, as for example a recent study by Mary Tiffen and others in Kenya. In western Africa, various scholars have challenged claims that population pressure is leading to progressive natural resource degradation due to increasing scarcity, for example, by pointing out that local people are actively planting trees or otherwise enhancing local resources, and landscapes that appear degraded to some observers may actually have been improved. Such characterizations do not necessarily imply that capitalist markets are the solution, however, but instead point to a variety of relevant social institutions as being involved in finding solutions to increasing resource scarcity.

SCARCITY AND JUSTICE

Leftist critics of both growth-oriented economics and of Malthusianism in its various forms regard scarcity as resulting largely from social injustice. Thus, Frances Moore Lappé argues that there is more than enough food production in the world, but economic exploitation leaves the poor (even many farmers) without access to food. Political ecologists likewise usually stress the role of political-economic exploitation in marginalizing the poor, who are then forced to make use of marginal environments in unsustainable ways in order to try to make a living. For example, poor peasants may be forced to clear small plots of land on erosion-prone slopes in the mountains of countries ranging from the Philippines to Honduras, not because land as such is scarce but because the concentration of land holdings in the hands of a few has led to intense land scarcity.

MARKET FORCES

Some critics of the optimistic idea that resource scarcity will lead to adaptive technological change point out that perverse incentives may prevent such a positive outcome. For example, if a species is close to becoming extinct due to trophy hunting, the scarcity of trophies enhances their prestige value to buyers. Therefore, their market value increases, leading to redoubled hunting efforts to the point of extinction. In the realm of traffic, the use of personal cars increases congestion, energy demand, and pollution compared to public transport or to walking or cycling. However, even in congested conditions, the relative speed and comfort of the car provide an individual incentive not to use public transport. Only if perverse incentives of this kind can be removed will resource scarcity lead to adaptive changes; the removal of perverse incentives usually requires some kind of social and not just technological change.

Further critiques of the economic concept of scarcity challenge the idea that human wants and needs are unlimited. If, as argued by Ivan Illich, our wants and needs are indeed limited, then perpetual growth is only possible through the continued creation of needs. Mechanisms to create wants and needs include advertising, but also “radical monopolies” such as transport systems that force us to rely on cars, and health care systems that force us to rely on expensive medical treatments.

Based on such a critique, scarcity can be overcome if the institutions that create ever more new wants and needs are dismantled, or are at least challenged by “convivial institutions,” which help people to define their own needs and fulfill them in self-reliant and resource-conserving ways. This would allow the simultaneous pursuit of individual freedom, social equity, and environmental sustainability, which are usually regarded as being at odds with each other.

SEE ALSO: Boserup, Ester; Capitalism; Carrying Capacity; Club of Rome; Economics; Ehrlich, Paul and Anne; Famine; Hardin, Garrett; Malthus, Thomas Robert; Malthusianism; Tragedy of the Commons; Zero Population Growth.

BIBLIOGRAPHY. Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (Aldine, 1965); Ivan Illich, *Energy and Equity* (Harper and Row, 1974); Frances Moore Lappé and Joseph Collins, *Food First: Beyond the Myth of Scarcity* (Houghton Mifflin, 1977); Julian Simon, *The Ultimate Resource 2* (Princeton University Press, 1996); Mary Tiffen, Michael Mortimore, and Francis Gichuki, *More People, Less Erosion: Environ-*

mental Recovery in Kenya (John Wiley, 1994); Nicholas Xenos, *Scarcity and Modernity*, (Routledge, 1989).

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Schumacher, E.F. (1911–77)

ERNST FRIEDRICH SCHUMACHER is best known for his book *Small is Beautiful*, which argued for social and environmental sustainability as a radical critique of mass industrialization, the culture of consumerism, and the logic of globalization. Upon its release, Schumacher became an instant celebrity and a sort of guru of the burgeoning global environmental movement, which embraced his vision of human-scaled development, social decentralization, and the deployment of intermediate and appropriate technologies as alternatives to the destructive aspects of modern life.

Moving beyond orthodox economic thought, Schumacher outlines a "Buddhist economics" that rationally utilizes local resources for local needs and seeks dignified, meaningful, and creative work in the name of human development. Schumacher's later writings highlight the role that religion and spirituality play in fostering a more sustainable existence. Schumacher believed that humans are essentially *homo viator*, or beings created with the purpose of recognizing God, and that it was the failure to recognize this that led to the growth of social problems rooted in individual selfishness.

An economist by training and profession, notably as an early protégé of John Maynard Keynes and later, from 1950 onwards, as the chief economic adviser for Britain's National Coal Board and consultant to many international leaders and developing nations such as India, Burma, and Zambia, Schumacher brought an understanding of public policy to the matters that commanded his attention. Presciently, Schumacher perceived a growing energy crisis after World War II and he took a leading position against the adoption of a petroleum-based economy as the global standard. Schumacher foresaw the rise of oil cartels such as the Organization of Petroleum Exporting Countries (OPEC), and argued that because oil is a non-renewable resource that has many significant deposits located in the world's most politically destabilized regions, making oil the centerpiece of national energy platforms would prove short-sighted, costly, and non-facilitative of international peace. Additionally, Schumacher derided high-technological solutions to the energy crisis such as nuclear power, and while he initially promoted coal as a sensible long-term solution to the world's energy needs, his belief in the need for intermediate and appropriate technologies accords most directly with renewable forms of alternative energy such as wind, hydro, geothermal, and solar power.

In 1966 he co-founded the Intermediate Technology Development Group—now known as Practical Action—dedicated to fostering sustainable social solutions for the developing world. Schumacher recognized that technical changes often produce unexpected social, economic, and cultural transformations, and that the developing world thus required a middle path between cultural imperialism and indigenous technologies in order to combat growing poverty, environmental disasters, and the legacy of colonialism at the regional and community level. Such technologies, he felt, could decrease unemployment and raise efficiency by an order of magnitude, while building upon traditional knowledge and values that promote conservation of the environment.

Many organizations, such as those that comprise the Schumacher Circle, are dedicated to carrying on his legacy. Schumacher's philosophy has shaped key aspects of modern environmentalism, the global justice movement, and what has come to be called Post-development theory. Further, as information-communication, genetic modification, and other emergent technologies revolutionize global life, questions about their appropriateness for the developing world mount.

SEE ALSO: Colonialism; Renewable Energy; Sustainability.

BIBLIOGRAPHY. E.F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (Harper & Row, 1973); E.F. Schumacher, *A Guide for the Perplexed* (Harper & Row, 1977); Roli Varma, "E. F. Schumacher: Changing the Paradigm of Bigger is Better," *Bulletin of Science, Technology & Society* (v.23/2, 2003).

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Science and Technology Studies (STS)

ALTERNATELY REFERRED TO as "science studies" or "science, technology, and society," science and technology studies (STS) emerged relatively recently as an interdisciplinary conversation straddling the social and natural sciences. STS is commonly held to have originated with a critique of orthodox historical accounts of the Enlightenment, the Industrial Revolution, and similar epochal events, many of which depended on the idea that science works in a value-neutral fashion by accumulating knowledge obtained through direct observation. STS builds on an alternative depiction predicated on science and technology as thoroughly *social* phenomena. Supplementing its engagement with the history of science and technology, it gradually incorporated philosophical inquiry into scientific knowledge and the sociological study of technical practices and institutions.

Since the early 1960s, scholars and academic departments specifically engaged in those conversations have proliferated (beginning principally in the United States and the United Kingdom), becoming institutionalized in the 1970s in the form of a growing number of professional societies, journals, and state-supported research funding programs. By virtue of its interdisciplinary constituency, STS accepts a broad variety of approaches to research, a methodological and analytic amalgam drawn from across the humanities and social sciences that includes qualitative, quantitative, and hybrid forms.

Most recently, a broad movement within contemporary STS has sought to effect a conscious shift beyond the bounds of academe, newly engaging a variety of nongovernmental and grassroots organizations in the design of proposed technologies and environmental research programs, fostering a field of inquiry focused on the boundary between scholarship and advocacy and the role of scientific expertise in democratic societies.

STS AND ENVIRONMENTAL ISSUES

The field of STS bears strong relevance to contemporary issues of environment and society. Karl Marx was an early exponent of the fundamental interdependence of modern technology and nature, suggesting that the very objective of "industry" is to transform our environment in such a way as to make it more useful or accommodating to human societies. Many of the writings of Martin Heidegger develop a deep critique of this instrumentalist, anthropocentric relationship between human societies and nature. It should come as no surprise, then, that as a conversation on the social underpinnings and effects of scientific knowledge and technological development, STS is rife with concerns and questions also pivotal to inquiry into environment and society.

Social constructivism, for instance—a concept broadly adopted within STS in the 1970s—is an important example. This somewhat controversial term refers to the idea that technologies, systems of knowledge, theories, and even scientific "facts" are more appropriately thought of as actively constructed by social groups, in a process partially shaped by values and political forces, rather than through some neutral or "natural" process. One vein of STS research, begun in the late 1970s and usually referred to as "laboratory studies," shows how after-the-fact accounts of scientific work can be highly "sanitized" in comparison with the quite messy realities of how science is actually conducted.

By taking careful, firsthand account of the details of research practice, communication, and organization in situ—much as early anthropologists might have taken account of the details of life in, say, a Micronesian village—a more analytically useful depiction can be built, one that enables scientific research that more fully acknowledges its own social underpinnings. The relevance of this work for environmental issues rests on the prescription it provides for environmental science and engineering endeavors, be it the design of transportation infrastructure, the evaluation of genetically modified crops, or the determination of forest "health." Sound science and just, sustainable technologies require an understanding of the social and political forces intrinsic to them.

Another broad area of intersection between STS and environmental issues lies in the study of risk. Arguably, a hallmark of our modern relationship with the environment is the common acceptance (or imposition) of technologies that entail nontrivial risk. This includes risks to humans and/or their environment, overt or undisclosed risk, potential or empirically demonstrated risk, and everything from long-term, cumulative risk (e.g., low-level exposure to radiation, or the introduction of genetically modified crops into the food chain) to immediate, catastrophic risk (such as industrial accidents or oil spills). Many large-scale technological systems of the modern era—nuclear and hydroelectric power, fossil fuels, industrial manufacturing, crop monoculture—entail such risk. STS scholars have focused their efforts on recording and analyzing the ways in which that risk is understood and evaluated and the means by which those most susceptible are allowed to participate (or are prevented from participating) in decisions about risky technologies.

This relates to a final topic of specific relevance to issues of environment and society: The meaning and function of expertise. It has been argued that science is intrinsically democratic in that it is (ideally) blind to the social and political biases and backgrounds of either its practitioners or those who rely upon them. One undeniable aspect of science, however, is that it entails the bestowal of authority on specific individuals (scientists and engineers) and institutions (schools, laboratories). Today that authority is routinely marshaled in arguments for or against many decisions and initiatives with major social and environmental implications, in a variety of forums from scholarly journals to courtrooms, popular news media to global economic summits.

STS takes the view that the very process of developing and conferring scientific expertise is unavoidably imbued with the social and the political. "Green chemistry," for example, provides an alternative path for the education of chemical engineers by foregrounding the environmental life cycle of synthetic chemicals. Further, the dichotomy between "lay" and "expert" (or "user" and "designer") itself valorizes certain types of knowledge over others, sometimes subordinating or ignoring the less-formalized expertise of those who are often closest to the phenomena in question and whose local environment is the most subject to the possible side effects and by-products of science and technology. Some STS practitioners seek to articulate alternative modes of research and design that capitalize on the participation of a broader variety of stakeholders, while others document those cases in which scientific experts and institutions have abandoned the orthodoxy of "science neutrality" in favor of conducting research explicitly in support of social justice or underrepresented populations.

Given the ubiquity of (and unprecedented authority granted to) science and the patent benefits to human welfare often provided by technological development, it is perhaps not surprising that the critical perspectives espoused within STS have engendered no small measure of controversy. By placing an emphasis on the more democratic ideals of science and the egalitarian possibilities of technology, many of those in STS strive not to eliminate them wholesale (were such a course even possible), but to shape them radically and appropriately.

SEE ALSO: Anthropocentrism; Green Chemistry; Marx, Karl; Risk, Perception, Assessment, and Communication; Technology.

BIBLIOGRAPHY. Mario Biagioli, *The Science Studies Reader* (Routledge, 1999); European Association for the Study of Science and Technology, www.EASST.net (cited April 2006); David Hess, *Science Studies: An Advanced Introduction* (New York University Press, 1997); Sheila Jasanoff, Gerald E. Markle, James C. Peterson, Trevor J. Pinch, eds., *The Handbook of Science and Technology Studies* (SAGE Publications, 1995); *Science, Technology & Human Values: The Journal of the Society for Social Studies of Science* (SAGE Publications); *Science, Technology & Society: An International Journal Devoted to the Developing World* (SAGE Publications); Sergio Sismondo, *An Introduction to Science and Technology Studies* (Blackwell Publishing, 2004); Society for Social Studies of Science, www.4Sonline.org (cited April 2006).

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Scott, James C.

JAMES C. SCOTT is co-founder of the Program in Agrarian Studies at Yale University and the author of a series of influential monographs. These works are concerned with different aspects of power and resistance, especially in contexts related to nature, agriculture, development, and environmental planning. A political scientist and South Asianist originally working on Malaysian elites, his work spans anthropology, history and sociology. In the *The Moral Economy of the Peasant* (1976), a seminal text in peasant studies, Scott argues that the need to assure minimal livelihoods is central to subsistence peasants' morality and underlies patron-client relations and communal redistribution; but that this social fabric is eroded through the expansion of Western capitalism and the modern state in Southeast Asia.

For his next book, *Weapons of the Weak* (1985), Scott conducted 14 months of ethnographic fieldwork in a Malaysian village in which a new agrarian capitalist class was emerging as a result of a green revolution irrigation project. He explored the ways in which peasants were increasingly marginalized, but also their everyday forms of resistance, including calls on the moral obligations of the "winners." The central role of discursive strategies in resistance is examined further by Scott in *Domination and the Arts of Resistance* (1990), in which, using wide-ranging examples from literature and history, he contrasts the "public transcripts" of encounters between the powerful and the powerless with the "hidden transcripts" of what both say away from each other.

Challenging Gramscian understandings of hegemony and false consciousness, Scott argues that the hidden transcripts of the powerless present forms of resistance that undermine the powerful in many ways. In *Seeing Like a State* (1998), his most recent monograph, Scott takes a rather different approach by focusing on the state itself. He examines both the ways in which the state simplifies complex local realities in order to make them legible and therefore administrable, and how "high modernist" projects resulting from this tunnel vision have failed. This is explored through a series of case studies, ranging from scientific forestry in 18th century Germany, over Soviet collectivization, to Tanzanian *ujamaa* villages. One reason for the failure of such projects, Scott argues, is that they invariably ignore local communities' knowledge and practices (*metis*).

Scott has at times been accused of generalization and simplification, but the great sweep of material he engages with, the clarity of his statements, and the analytical vocabulary he provides mean that his books have made significant contributions to debates on power and resistance throughout the social sciences. They have also become cornerstone texts in those fields concerned with the environment, such as political ecology and environmental history. An influential contribution to subaltern studies, Scott's earlier work on resistance has informed many environmental historians and anthropologists working on South Asia, such as Guha, Bryant, Sivaramakrishnan and Peluso. At the same time, *Seeing Like a State* has become a seminal text in political ecology throughout the world, as one of the most powerful descriptions and condemnations of the effects of state planning on the environment.

SEE ALSO: Land Use Policy and Planning; Peasants; Political Ecology.

BIBLIOGRAPHY. James Scott, *The Moral Economy of the Peasant: Rebellion and Subsistence in Southeast Asia* (Yale University Press, 1976); James Scott, *Weapons of the Weak: Everyday Forms of Peasant Resistance* (Yale University Press, 1985); James Scott, *Domination and the Arts of Resistance: Hidden Transcripts* (Yale University Press, 1990); James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed* (Yale University Press, 1998); Sivaramakrishnan et al., "In Focus: Moral Economies, State Spaces, and Categorical Violence: Anthropological Engagements with the Work of James Scott," *American Anthropologist* (v.107, 2005).

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Sea Level Rise

SEA LEVEL RISE refers to the increased volume of water in the seas and oceans of the world and to the relative increase in height, therefore, compared to the land level. As the sea level rises, seawater covers increasing tracts of land with mostly negative impacts. First, the amount of habitable land decreases for mankind and for animal and plant species. Second, seawater may infiltrate existing fresh water sources and render them less useful or unusable for normal consumption. Third, and often most dramatically, sea level rise of one to three millimeters per year increases the threat from flooding in many coastal areas. Countries such as Bangladesh demonstrate the vulnerability of millions to flooding, with the threats of waterborne disease, malnutrition, and endemic poverty. This rise is unprecedented in recorded human history and, although the figures do not appear to be spectacular, the effects of the steady rises are accentuated in areas with low elevation above current sea level or in low-lying areas.

The causes for the rise in sea levels are twofold. First, global warming has led to the melting of ice at both polar regions and that water is added to the existing bodies of water. Second, excessive extraction of groundwater in some areas, notably in east Asia, has caused the ground level to sink by up to one decimeter or more annually, and this has a similar effect to the rise in sea levels. Scientists are still trying to establish the exact rates at which rises in sea levels are occurring. New research suggests that past estimates of global climate change were too conservatively framed and that such change is intensifying. As ice sheet thawing in places such as Greenland and Siberia releases water from frozen masses, it is increasingly possible that the world will lose significant amounts of land mass.

A sea level rise of even 1–3 mm. per year threatens islands such as this one in the Maldives.

The financial costs of these changes are not quantifiable, since accurate data and models of future change have yet to be established. However, attempts to do so have been undertaken by government organizations and by industry bodies, including the insurance industry. It has been estimated that, at current rates of rise, the cost of a one-meter increase in the sea level in the United States would range between $270–$475 billion.

SEE ALSO: Bangladesh; Coastal Zone; Floods and Flooding; Global Warming; Water.

BIBLIOGRAPHY. Bruce C. Douglas, Michael S. Kearney, and Stephen P. Leatherman, *Sea Level Rise: History and Consequences* (Academic Press, 2000); Julian A. Dowdeswell, "The Greenland Ice Sheet and Global Sea-Level Rise," *Science* (v.11, 2006); Kelvin S. Rodolfo and Fernando P. Siringan, "Global Sea Level Rise is Recognized, but Flooding from Anthropogenic Land Subsidence is Ignored around Northern Manila Bay, Philippines," *Disasters* (v.30/1, 2006); J.G. Titus et al., "Greenhouse Effect and Sea Level Rise: Loss of Land and the Cost of Holding Back the Sea," *Coastal Management* (v.19/2, 1991).

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Seasons

THE SEASONS OF the year are characterized by the ever-changing patterns of stars and weather that come and go year after year. There are astronomic seasons and climatic (also called meteorological) seasons. Seasons vary in different parts of the earth both astronomically and meteorologically. Each of the four seasons of spring, summer, autumn, and winter are three months in duration, but they vary in the amount of daylight and darkness, temperatures, and weather conditions.

The astronomical seasons of the year are measured by the rotation of the earth around the sun. The axis of the earth is an imaginary line running through the earth from the North Pole to the South Pole. The earth is not perpendicular to the plane of its orbit around the sun, but permanently tilted on its axis at 23 degrees and 26 minutes away from the sun. If the earth were not tilted on its axis, there would be no seasons and the weather would be about the same every day of the year.

The astronomical seasons are caused by changes in the earth's relationship to the sun in its annual orbit. The earth's orbit around the sun is elliptical, but it is not the varying distance from the sun that causes seasonal changes. Seasonal changes are rather due to the way the earth's tilt on its axis causes sunlight to strike the earth at different angles throughout all the days of the year. The equator receives the most sunshine in an almost uniform manner, but the amount of sunshine on the North and South poles varies enormously over the days of each year.

For half of each year, the sun's light falls almost directly overhead in the Northern Hemisphere. For the other half of the year, it falls almost directly overhead in the Southern Hemisphere. For this reason, the temperate zones of the Southern and Northern Hemispheres occur in reverse; when it is winter in the Southern Hemisphere, it is summer in the Northern Hemispheres. The two hemispheres are seasonal opposites of each other.

When viewed from earth, the daily track of the sun across the sky reaches different positions above the horizon. The angle of the sun relative to the earth's surface reaches its peak about noon on June 20 or June 21 each year in the Northern Hemisphere when the angle is at 23 degrees and 26 minutes north latitude. In contrast, in the Southern Hemisphere this is the time when the sun's angle is diminished to its lowest position.

Some annually varying hour occurring between June 20 and June 21 is the hour that marks the longest day of the year, or the shortest night, in the Northern Hemisphere. From June 20 or June 21 the angle of the sun declines day by day in the Northern Hemisphere. Meanwhile, it increases day by day in the Southern Hemisphere until September 21 arrives, when the length of the day and the night are exactly the same.

As the earth continues its journey around the sun, the days shorten in the Northern Hemisphere and lengthen in the Southern Hemisphere until December 21. This is the shortest day and the longest night in the Northern Hemisphere and the opposite in the Southern Hemisphere, making it winter in the Northern Hemisphere and summer in the Southern Hemisphere. On about March 20 and September 22 each year, the length of the days and night are exactly the same. March 20 or March 21 marks the vernal equinox and September 22 or September 23 marks the autumnal equinox. June 20 or June 21 marks the summer solstice and December 21 or December 22 marks the winter solstice. The exact day for the beginning of each season varies from year to year because the amount of time it takes the earth to travel around the sun each year varies. Besides the influence of gravity—which can speed or slow the journey of the earth—its orbit is not exactly 365 days in length. There is a fraction of a day that can cause the day that begins each season to shift forward or backward each year.

The lengths of the seasons are in part due to the elliptical path of the earth. As the earth gets closer to the sun, its movement speeds up, while the further it gets, it slows down. The earth's closest point to the sun is called perihelion, and its most distant point is called aphelion. The exact lengths of the seasons in the Northern Hemisphere are 92.76 days in the spring, 93.65 days in the summer, 89.84 days in the autumn, and 88.99 days in the winter. These seasonal lengths total an annual year of 356.24 days. Climatic seasons are measured by temperature, while astronomical seasons are measured by the relationship of the earth to the sun.

As the earth makes its annual journey, the amount of sunshine builds and recedes as the days lengthen and shorten. The amount of heat on the surface of the earth increases as the phenomenon of heat lag occurs, which is the warming and cooling of the earth. The time of maximum insolation in the Northern Hemisphere peaks on June 21 and is thereafter decreasing because the days are shortening again. However, the heating of the earth increases as the land masses and air masses continue to increase in temperature. As a result, the astronomical and meteorological seasons do not exactly match each other. The temperature of the summer season is the hottest time of the year. But its temperature usually rises with the heating of the earth during the summer even though sunshine is actually diminishing.

The North and South Poles have two seasons: a light season (summer) and a dark season (winter). In the dark season, there is no light available from the sun, while in the light season, it is light for 24 hours a day at the peak of the summer. In tropical zones where the heating of the earth by the sun is fairly constant, there are usually two seasons. In the wet season, rains come regularly, while a dry season elicits no rain. During the wet seasons, tropical storms such as hurricanes or typhoons occur.

SEE ALSO: Hurricanes; Climate; Climate, Arctic and Subarctic; Climate, Arid and Semiarid; Climate, Tropical.

BIBLIOGRAPHY. Charles Laird Calia, *The Stargazing Year: A Backyard Astronomer's Journey Through the Seasons of the Night Sky* (Penguin Group, 2006); Jerry Dennis, *It's Raining Frogs and Fishes: Four Seasons of Natural Phenomena and Oddities in the Sky* (HarperCollins, 1992); Robert Gendler, *A Year in the Life of the Universe: A Seasonal Guide to Viewing the Cosmos* (MBI Publishing Company, 2006); Jeff Kanipe, *A Skywatcher's Year* (Cambridge, 1999); Stanley J. Lilijaszek and S.S. Strickland, eds., *Seasonality and Human Ecology* (Cambridge University Press, 1993).

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Sea Turtles

THERE ARE SEVEN species of sea turtles: olive ridley (*Lepidochelys olivacea*); Kemp's ridley (*Lepidochelys kempii*); green (*Chelonia mydas*); loggerhead (*Caretta caretta*); leatherback (*Dermochelys coriacea*); hawksbill (*Eretmochelys imbricata*); and flatback (*Natator depressus*). Sea turtles are protected under several international agreements, including the Convention on International Trade in Species of Wild Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species of Wild Animals, and the Inter-American Convention for the Protection and Conservation of Sea Turtles.

Sea turtles are listed in the Red List of the World Conservation Union (IUCN), with Kemp's ridleys, hawksbills, Mediterranean greens, and leatherbacks classified as "critically endangered," greens, olive ridleys, and loggerheads as "endangered," and flatbacks as "data deficient." Because of the difficulties associated with assessing population status for long-lived, globally distributed species, where large portions of the population are difficult to monitor (that is, at sea), these listings have been controversial and the value of the Red List for sea turtles has been questioned.

Sea turtles are vulnerable to predators at all life stages. Eggs and hatchlings are taken for food by small mammals, crabs, and fish, and juvenile and adult turtles are preyed on by large fish, including sharks, and mammals (for example, jaguars on nesting beaches). At all sizes, turtles are taken by humans. Both subsistence and commercial uses of sea turtles, as well as international trade in turtle products, has historically been widespread. International trade has been greatly reduced in the post–World War II era.

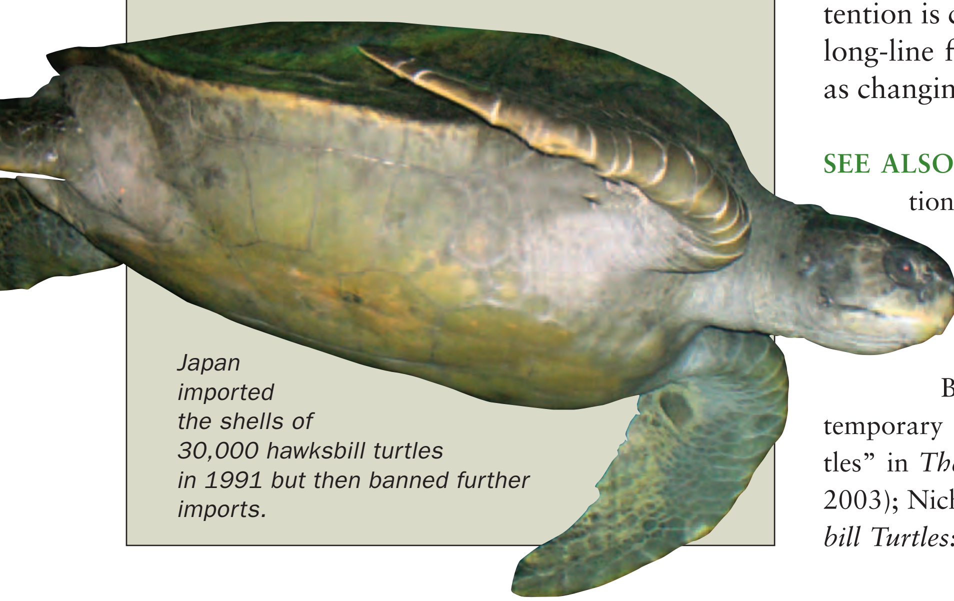
For example, a Caribbean-based green turtle fishery that supplied European and U.S. markets with turtle meat and soup had significant impacts on turtle populations before trade fell off in the 1960s and was eventually eliminated in the 1970s. Traditional Japanese jewelry is made from hawksbill shell and was supported by international trade until 1994. Olive ridley leather is used in manufacturing boots and handbags, and in Mexico, an extensive olive ridley fishery existed until 1990. Local subsistence and commercial use has also declined, but to a lesser extent.

The role that sea turtles have played, and continue to play, in traditional coastal and sea-faring communities has been documented by archaeologists, historians, anthropologists, and geographers.

Terengganu

With most of the population of Malaysia located along the west coast, some of the beaches along the east coast have long been popular with sea turtles. Four turtles can be regularly seen in Malaysian waters: the leatherback turtle, the hawksbill, the green turtle, and the olive ridley. At the beach of Rantau Abang in the Malaysian state of Terengganu giant leatherback turtles come every summer to lay eggs. Traditionally, the local people have captured a few for meat, and also used the eggs, but with the turtles so endangered, the locals now treasure their "guests." A Turtle Information Centre manned throughout the year raises public awareness of their plight.

During the 1970s and 80s tourists came to Rantau Abang and other beaches and shined torches at the turtles or otherwise harassed them when they climbed up the beach at night to lay their eggs. This caused a massive decline in turtle numbers and laws were introduced making it illegal to touch them, shine torches at them, or use flash photography. Access to part of the beach is now prohibited. Rangers also dig up the eggs of the turtles after they have been laid in order to look after them in incubators until the young hatch. They are then released into the water with rangers ensuring that they do not fall prey to predatory birds or crabs as they scurry down the beach.



Japan imported the shells of 30,000 hawksbill turtles in 1991 but then banned further imports.

In some places, they remain a central part of cultural identity (for example, for the Miskito Indians in Nicaragua). While most of the conventions cited above make allowances for the continued use of sea turtles for economic subsistence purposes of traditional communities, these terms are undefined and the use of sea turtles continues to be a controversial issue in the conservation community. This issue is likely to become more contentious as some sea turtle populations increase as a result of protection activities.

Indirect impacts of human activities on sea turtles are also of concern. Nesting sea turtles have become popular as tourist attractions, and the impacts of turtle viewing on nesting behavior and success are mostly unknown. Changes in habitat pose threats to sea turtles; as coastal development progresses, hatchling mortality can be increased by artificial beach lighting, and adult females face nesting obstacles such as beach renourishment and coastal armoring. Pollution is also of growing concern, as sea turtles ingest plastic and oil. Further habitat degradation is anticipated via global climate change and associated sea level rise.

The mortality caused when sea turtles are captured as by-catch in fisheries is currently a major concern in the conservation community. Trawling, drift netting, and long-lining have all been implicated. While mortality through shrimp trawling has been reduced by turtle excluder devices in trawls, and a gradual curtailment of drift net fishing (supported by a number of United Nations resolutions) has reduced concern about this method, much attention is currently focused on reducing by-catch in long-line fisheries through gear modifications such as changing hook shape, size, bait, and set depth.

SEE ALSO: Animals; Animal Rights; Beaches; Convention on International Trade in Species of Wild Fauna and Flora (CITES); Endangered Species; Habitat Protection; Marine Pollution; Subsistence.

BIBLIOGRAPHY. Lisa M. Campbell, "Contemporary Culture, Use, and Conservation of Sea Turtles" in *The Biology of Sea Turtles,* vol. 2 (CRC Press, 2003); Nicholas Mrosovsky, *Sustainable Use of Hawksbill Turtles: Contemporary Issues in Conservation* (Key

Centre for Tropical Wildlife Management, 2000); Bernard Nietschmann, *Between Land and Water: The Subsistence Ecology of the Miskito Indians, Eastern Nicaragua* (Seminar Press, 1973); James Parsons, *The Green Turtle and Man* (University of Florida Press, 1962); World Conservation Union (IUCN) Red List, www.redlist.org (cited July 2006).

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Second Contradiction of Capitalism

THE SECOND CONTRADICTION of capitalism is an ecological Marxist theory predicting an environmental crisis that develops from the capitalist economy. This theory, developed out of Marx's writing by later theorists, points to reasons that capitalist societies, no matter how well-meaning and conservation-oriented, face environmental limits to their system of production.

Though Marx himself believed that capitalist farming produced negative ecological consequences, he never articulated a broader ecological theory of capitalist contradiction. Rather, the exploitation of labor played the central role while nature and natural resources occupied a peripheral concern. For Marx, capitalism is understood to contain within it the seeds of its own downfall in the form of an internal contradiction.

Specifically, Marx posited that the relationship between the "forces of production" (a combination of labor and infrastructure) and "relations of production" (the social system supporting capitalism) tends to produce an overproduction crisis that threatens continued capital accumulation, potentially leading to its unraveling.

Marx suggests this contradiction threatens continued accumulation. As unpaid labor diminishes, he explained, "a reaction sets in: a smaller part of revenue is capitalized, accumulation slows down, and the rising movement of wages comes up against an obstacle." In such a situation, consumption ultimately cannot keep up with production. This overproduction crisis, referred to as the first contradiction of capitalism, provokes a crisis point in capitalist relations of production, leading to social change and a new, more sustainable economy.

This predicted crisis does not include or consider environmental factors. Marx was not alone in overlooking the role of resource exhaustion in capitalist production. Neo-Malthusian explanations of environmental degradation, though positing limits to growth, also ignored the endemic feature of resource exhaustion in capitalism

More recent ecological Marxist critiques of capitalism, however, suggest an additional contradiction, that between the relations of production and the conditions of production (including such things as soil, water, and worker health). In the first issue of the journal *Capitalism Nature Socialism*, James O'Connor (1988) sought to explain the emerging and increasing environmental crises that he argued originated from treating nature as a marketable, and undervalued, commodity. He elaborated this ecological Marxist critique by suggesting that capital's uses and abuses of nature constitute a distinct form of contradiction in capitalism and a threat to environmental systems. This is rooted in the fact that capitalist production necessarily relies on certain conditions such as the free and unfettered access to the raw materials of production. This capitalization of nature externalizes the true costs of production thus raising production costs elsewhere in the system.

O'Connor was influenced by Karl Polanyi's work on the development of free market capitalism. Polanyi suggested that the 19th-century liberal state's reliance on a self-regulating market treated land, labor, and money as mere commodities. The liberal creed that emerged in the early 20th century sought a highly regulated form of a "free" market as the only means to maintain access to the inputs of capitalist production. O'Connor suggested that the commodification of nature inevitably leads to an undervaluation of natural resources. For example, as the raw material for forestry timber becomes lumber only through a production process that demands cheap, unfettered access to forest resources. This pattern provokes resource exhaustion as the true costs of resource access are not borne by those exploiting the resources. Polanyi suggested that such a scheme "could not exist for any length of time without annihilating the human and natural substance of society." Much as with the contradiction between forces and relations of production, the second contradiction leads inexorably to the destruction of the very conditions on which it relies, in this case the biophysical foundation of life.

Sympathetic critics have argued about O'Connor's notion of a second contradiction in the pages of *Capitalism Nature Socialism* and the *New Left Review*. The debates have included V. Toledo's concern that O'Connor's theory "impute(s) every ecological problem to capitalism," or, more directly, that the distinction is merely a different form—natural conditions versus social conditions—of the contradiction Marx defined between forces and relations of production.

SEE ALSO: Capitalism; Commodification; Communism; Markets; Malthusianism; Marx, Karl; Trade, Free.

BIBLIOGRAPHY. Karl Marx, ed., *Capital: A Critique of Political Economy,* vol. 1 (Penguin Books, 1990 [1867]); D.H. Meadows, D. Meadows, and J. Randers, *The Limits to Growth* (Universe Books, 1972); J. O'Connor, "Capitalism, Nature, Socialism: A Theoretical Introduction," *Capitalism, Nature, Socialism* (v.1/1, 1988); Karl Polanyi, *The Great Transformation* (Beacon Press, 1957 [1944]); V. Toledo, "The Ecological Crisis: A Second Contradiction of Capitalism," in T. Benton, ed., *The Greening of Marxism* (Guilford Press, 1996).

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Seed Bank

SEED BANKS CAN be either natural or anthropogenic in origin, and both are related to maintaining diversity of plant species in the face of human activity on the landscape. Natural seed banks, or soil seed banks, refer to the dormant seeds of various plant species that are present in the soil of a particular location. Anthropogenic seed banks, also called genebanks, are collections of dormant seeds, either of crops or natural plant species, that are being conserved *ex situ* as a means of preventing these species from becoming extinct.

Soil seed banks are greatly impacted by agricultural activity. Prior to disturbance, the dormant seeds present in the soil of a given location will reflect the species composition of the surrounding vegetation. Initial disturbance of this vegetation will release the seeds of the seed bank for growth, and the recovering vegetation will have a similar species composition of the original vegetation. Repeated disturbance to a plot will gradually exhaust the seed bank, however, and alter the species composition of recovering vegetation. It has been observed in the tropics that frequent burning of plots for agriculture exhausts the seed bank in this manner and species composition shifts toward a greater frequency of highly dispersible r-species, including non-native species, over slower growing, less dispersive native k-species.

Anthropogenic seed banks are *ex situ* conservation efforts designed to prevent the extinction of plant species or crop varieties. The dominance of agribusiness in global agriculture has caused fewer varieties of patented high-yielding varieties and genetically modified crops to dominate production (supported by increased irrigation and reliance on chemical fertilizers) at the expense of a wide variety of locally developed strains of that crop that are adapted to local soil and moisture conditions (sometimes referred to as heritage varieties). The genetic diversity of any given crop is thus at risk of being lost as a few varieties become dominant in the market. Seed banks have been implemented as a means of preserving the diversity of these crops.

Preservation of local varieties is also viewed as a defense against poverty, whereby households maintain access to seed stock that has been maintained culturally in the face of having to buy the dominant varieties from agribusiness. The Global Crop Diversity Trust is an organization that maintains seed banks throughout the world for the sake of preserving these local crop varieties, and has recently announced plans to build an immense facility on Spitsbergen Island in Norway to act as a back up facility for the world's crops.

Seed banks have also been utilized to preserve endangered plant species. Although *in situ* conservation of habitat is regarded as the best means of preventing plant extinctions, conserving plant germplasm is viewed as a viable alternative when *in situ* conservation is not possible or in the face of the uncertainty from global change. Seed banks are capable of preserving a greater degree of genetic variation within a species than by the *ex situ* conservation of living individuals of that species. The Royal Botanic Gardens of Kew, for example, have initiated the Millennium Seed Bank Project and hope to protect around 24,000 plant species from extinction.

SEE ALSO: Conservation; Genetic Diversity; Plants; Seeds, Agrodiversity and.

BIBLIOGRAPHY: Canadian Botanical Conservation Network, "Seed Banks: A Resource for the Future," www.rbg.ca/cbcn (cited January 2007); Global Crop Diversity Trust, "Start with a Seed," www.croptrust.org (cited January 2007); Martin Kellman and Rosanne Tackaberry, *Tropical Environments: The Functioning and Management of Tropical Ecosystems* (Routledge, 1997); Royal Botanic Garden, Kew, "Millenium Seed Bank Project," www.rbgkew.org.uk/msbp (cited January 2007); Lakshman Yapa, "What are Improved Seeds? An Epistemology of the Green Revolution," *Economic Geography* (v. 69, July 1993).

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Seeds, Agrodiversity and

IF A CROP that is desired for food, fodder, or fiber, is to be available for the next planting season, some of its seeds must be preserved. For biologists, agricultural scientists, gardeners, and farmers, there is growing concern about the dependence upon seed companies. Seed companies produce billions of dollars worth of seeds every year; however, their products are often hybrid varieties of seeds that produce a high yield one year, but not in subsequent years. For example, some varieties of hybrid tomatoes give large abundant tomatoes the year that they are planted; however, if seeds are saved for the next year, the resulting tomatoes are small, full of liquid and seeds, and covered by a tough skin. There are several reasons critics give for lessening dependence upon seed companies and upon hybrids. One reason is the danger of the loss of disease resistance in seeds because a plant pathogen such as a mold, fungi, rust, virus, or bacteria has mutated or has developed resistance to pesticides. Another reason is the cost of seeds purchased each year is greater than those simply saved each year. A third danger is that many genetic characteristics have been bred out in successive generations of hybrids. The danger for society if this situation were to prevail is that the original gene pool that included a gene resistant to a viral strain or to some forms of bacteria may be lost.

There is a growing movement among gardeners, scientists, and agriculturalists to promote heirloom varieties of seeds. Many of these heirloom varieties have genetic features that enable them to be preserved by "seed savers" and to be replanted from year to year. Agrodiversity is a fundamental feature of farming systems around the world. Using heirloom seeds preserves agrodiversity and increases seed security from the dangers of plant diseases that could conceivably wipe out a major food plant. Organizations and universities, as well as informal groups of gardeners, are developing databases of heirloom seeds. Others are making it a point of pride to plant them, even though a hybrid might give somewhat better results.

The cost of seeds is an important factor in the growing interest in agrodiversity through the preservation of old seed stocks. The Southern Region Sustainable Agriculture Research and Education (SARE) program at the University of Georgia is promoting a Southern Seed Legacy (SSL) Project in order to identify and to preserve the diversity of seeds in the American South. The program is also creating a database of memories in which people describe how older crops were grown, how they tasted, and other culturally significant information.

The United Nations (UN) is developing a program to preserve seed stocks. Food security is a major motivation. Unless the "gene pool" for domesticated plants is maintained, the world's supply of many staples could be destroyed by the emergence of a new form of pathogen, or by the global spread of a disease that could kill plants that were not previously infected. The UN program is called

"People, Land Management, and Environmental Change" (PLEC). It recruits farmers in the tropics who work small plots of land. Projects to locate and study farms that could be sources of biodiversity in places like Tanzania are already in place. Because these farmers have been choosing crops that match their local ecology, they have also preserved more of the genes of the species they plant, which means that their crops have more inherent agrodiversity.

SEE ALSO: Crossbreeding; Genetic Diversity; Seed Bank.

BIBLIOGRAPHY. Peter Loewer, *Seeds: The Definitive Guide to Growing, History, and Lore* (Timber Press, 2005); Virginia D. Nazarea, *Heirloom Seeds and Their Keepers: Marginality and Memory in the Conservation of Biological Diversity* (University of Arizona Press, 2005); Vandana Shiva, *Stolen Harvest: The Hijacking of the Global Food Supply* (South End Press, 1999); U.S. Department of Agriculture, *Seeds: The Yearbook of Agriculture* (University Press of the Pacific, 2002).

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Semple, Ellen Churchill (1863–1932)

ELLEN CHURCHILL SEMPLE received her B.A. and M.A. degrees in history from Vassar College during the first decade of the 20th century. At that time, American geography was strongly influenced by geology and the sub-discipline of physical geography commanded its orientation. Semple received her introduction to geography through attending lectures by the noted German geographer Freidrich Ratzel, whose two-volume work, *Anthropogeographie*, reflected the current thinking in the field. Semple worked with Ratzel at the University of Leipzig for several years, but received no degree because women were not allowed to matriculate.

Carl Ortwin Sauer, the American geographer who would become the unofficial dean of cultural geography, heard several of Semple's lectures when she visited the University of Chicago. Sauer remarked about her penchant for documenting the influences of the physical environment on human occupants. The theme of "influences" would become the hallmark of her subsequent writings.

Semple was 38 years old before she received her first permanent faculty appointment. In 1921, she joined the geography faculty at Clark University, becoming the first female faculty member at that institution. She taught courses in the geography graduate program until her death. The year 1921 was important in another way: In that year she became the first female president of the Association of American Geographers. Some years earlier, Semple was a founding member of that prestigious organization.

During her career, Semple received a number of awards, including an honorary doctorate from the University of Kentucky, largely in recognition of her seminal research on the Anglo-Saxon communities living in the mountains of that state. This study was unique in its approach in that it combined principles and concepts from geography, history, and anthropology. The work was precedent-setting as well because it involved her in extensive field research in the region, a practice described as relatively uncommon in the discipline in those years. Other awards included the Cullum Medal from the American Geographical Society (1914), and the Helen Culver Gold Medal from the Geographical Society of Chicago (1931).

Semple's two most prominent books, *American History and Its Geographic Conditions* (1903) and *Influences of the Geographic Environment* (1911), were attempts to unite geography and history in process investigations of place and time. Her explanations of historical development during the westward movement included discussion of the impact of the physical environment, and of its significance given the transportation technology of the time. In the view of many scholars in history and geography, her conclusions about the influence of the physical barriers encountered during the westward movement were too pointed and paid little attention to the culture groups involved.

Unfortunately, once the grip of environmental determinism was loosened following the publication in 1925 of Carl Sauer's article "The Morphology of

Landscape," her influence on the discipline waned. Semple had long been cast as an environmental determinist, especially after working with Ratzel and following his arguments in the first volume of *Anthropogeographie*. In later years Semple's work was seen in a different light. She was recognized for her research approach in human-environment interaction, a geographic theme that is central within the modern discipline.

SEE ALSO: Geography; History, Environmental; Sauer, Carl.

BIBLIOGRAPHY. Wilford E. Bladen and Pradyumna P. Karan, eds., *The Evolution of Geographic Thought in America: A Kentucky Root* (Kendall/Hunt Publishing Company, 1983); Ellen Churchill Semple, *Influences of Geographical Environment* (Henry Holt and Company, 1911); Ellen Churchill Semple, *American History and Its Geographical Conditions* (Houghton Mifflin Company, 1933); John K. Wright, "Miss Semple's Influences of the Geographical Environment: Notes Toward a Bibliography," *Geographical Review* (v.52, 1962).

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Sen, Amartya (1933–)

AMARTYA KUMAR SEN was born in 1933, and grew up in Dhaka (then India, now Bangladesh). He has worked as a professor of economics since the age of 22, at Jadavpur University, the University of Delhi, the LSE, Oxford, Cambridge and (currently) Harvard. His many awards include the 1998 Nobel Prize in Economics.

Sen is a leading spokesperson for ethical and rigorous economic inquiry, although he abstains from activism and policy advice. He is critical of neoclassical economists' attachment to utilitarianism and markets, but has not adopted the structuralist reasoning and Marxist approaches of their critics.

His "cautious boldness" has been applied to social choice theory, welfare economics, the understanding and measurement of poverty, explanations of famine and hunger, agrarian change, gender and rural development in South Asia, identity politics, and the ethics, moral philosophy and meanings of "development." Understanding and tackling inequality is the core of his work: Environmental issues are less central. Two areas of scholarship, chosen from many, stand out.

HUMAN CAPABILITY

Capability is the freedom of a person to lead one kind of life rather than another, and for Sen it is the goal of development. In *Development as Freedom* (1999) he argues that "Development consists of the removal of various types of unfreedoms that leave people with little choices and little opportunity of exercising their reasoned agency." Achieving development requires the expansion and improvement of capabilities and entitlements for the poor and underprivileged. He believes democracy is best suited to the expansion of freedoms, and—against Gandhi—he favors cosmopolitan, secular democracies over communitarianism, localism, and potentially damaging forms of identity politics.

Sen has also revised the measurement of poverty rates and human development, contributing to the Human Development Index (HDI) in the *Human Development Report*. The argument is that development policy should enhance capability, rather than blindly pursue economic growth. Critics have applauded Sen's reasoning, but lament the lesser focus in his work on exactly how freedoms are diminished by violence, oppression, and state actions.

POVERTY AND FAMINE

Secondly, understanding poverty and famine. Sen witnessed the effects of the 1943–45 famine in India. His most famous work, *Poverty and Famines* (1981), suggests famine is caused by the inability of individuals to access food in times of great need, even when food supplies are adequate. Famine is a food demand problem, not a supply problem, as Malthus had argued. Those who starve are people who lack entitlements to food.

There are various types of entitlements, including those based on production, labor, trade, and inheritance. The entitlement model has been widely accepted. It is used in famine relief, and famine early warning systems now look carefully at price signals and purchasing behavior. Sen argues that famines don't occur in political democracies. Yet as Ben Fine, a former Sen student, says, there is always a political economy to famine that best explains why people starve.

Michael Watts concurs that entitlements are constituted and reproduced through conflict, negotiation and struggle. Entitlement failure, therefore, is embedded within a social and political process. Alex de Waal and David Keen have pointed out the shortcomings of the entitlement model where war and conflict are used as political weapons by states and rebels—greed and grievance, rather than entitlement failures, may also explain the presence of famine in such situations.

These criticisms do not detract for the enormous influence Sen has had, as a public intellectual and scholar, in a variety of scholarly and applied debates and practical actions. He is widely praised as the "conscience" of neoclassical economics, although his contributions are much broader than this.

SEE ALSO: Development; Famine; Malthusianism; Political Economy; Poverty.

BIBLIOGRAPHY. S. Alkire, *Valuing Freedoms. Sen's Capability Approach and Poverty Reduction* (Oxford University Press, 2002); S.E. Corbridge, "Development as Freedom: The Spaces of Amaryta Sen," *Progress in Development Studies* (2, 2002); S. Devereux, "Sen's Entitlement Approach: Critiques and Counter-critiques," *Oxford Development Studies* (v.29/3, 2001); J. Drèze and A. Sen, *The Political Economy of Hunger*, 3 vols. (Clarendon Press, 1990–91); B. Fine, "Amartya Sen: A Partial and Personal Appreciation," CDPR Discussion Paper 1601, Centre for Development and Policy Research (SOAS, 2001); D. Gasper, "Development as Freedom: Taking Economics beyond Commodities—The Cautious Boldness of Amartya Sen," *Journal of International Development* (12, 2000); A. Sen, *Poverty and Famines: An Essay on Entitlements and Deprivation* (Clarendon Press, 1981); A. Sen, *Development as Freedom* (Oxford University Press, 1999); A. Sen, *Identity and Violence: The Illusion of Destiny* (W.W. Norton, 2006).

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Senegal

AFTER WINNING INDEPENDENCE from France in 1960, Senegal entered four decades of socialist rule. In 1982 Senegal and The Gambia, which is virtually an enclave of its larger neighbor, joined forces as Senegambia but broke apart seven years later. Despite some dissatisfaction from separatists, the Republic of Senegal is a stable democracy, which takes an active role in international peacekeeping. Since 1994, when the government made a strong commitment to economic reform, Senegal has experienced steady growth. The economy has become more diversified through industries that include agricultural and fish processing, phosphate mining, fertilizer production, petroleum refining, construction materials, and ship construction and repair.

More resources are now being directed toward government programs as a result of Senegal's participation in the Highly Indebted Poor Countries debt relief program that relieved the country of two-thirds of its debt burden. Senegal's only natural resources are fish, phosphates, and iron ore. Almost 13 percent of the land area is arable, and 77 percent of Senegalese are engaged in the agricultural sector, much of it at the subsistence level.

With a per capita income of $1,700, Senegal is ranked 192 of 232 countries in world incomes. Unemployment is high at 48 percent, and at least 40 percent of the unemployed are urban youth. Some 54 percent of the population lives in poverty, and almost a fourth of Senegalese are undernourished. Income is unevenly distributed, with the most affluent 10 percent of the population holding over a third of the country's wealth. The poorest 10 percent of Senegalese share 2.6 percent of all resources. The United Nations Development Programme's Human Development Reports rank Senegal 157th in quality-of-life issues.

The westernmost country in Africa, Senegal borders on the North Atlantic Ocean. In addition to the Atlantic coastline of 531 kilometers, Senegal has 4,190 square kilometers of inland water resources. Senegal shares land borders with The Gambia, Guinea, Guinea-Bissau, Mali, and Mauritania. The terrain of Senegal is mostly low rolling plains that rise to foothills in the southeast section of the country. Elevations range from sea level to 581 meters at an unnamed point near Nepen Diakha. The tropical climate is generally hot and humid, with a distinct rainy season accompanied by strong southeast winds from May to November. The five-month dry season that follows is marked by the harmattan, a hot, dry, dust-laden wind that is capable of causing great ecological damage. Further ecological damage occurs during the rainy season when the lowlands are prone to flooding. Senegal is subject to periodic, environmentally damaging droughts.

Senegal's population of 11,987,121 is susceptible to environmental health hazards. Some 28 percent of the people lack sustained access to safe drinking water, and 48 percent lack access to improved sanitation. Senegalese face a very high risk of contracting food and waterborne diseases that include bacterial and protozoal diarrhea, hepatitis A, typhoid fever, the water contact disease schistosomiasis, and the respiratory disease meningococcal meningitis. In some areas, the people are also at very high risk for contracting vectorborne diseases such as dengue fever, malaria, yellow fever, Crimean-Congo hemorrhagic fever, and Rift Valley fever.

Although Senegal has escaped the high rates of HIV/AIDS that plague many poor African nations, 44,000 Senegalese are currently living with this disease, which has killed 3,500 since 2003. High vulnerability to preventable diseases has left Senegal with a lower-than-expected life span (59.25 years) and growth rate (2.34 percent), and a higher-than-expected infant mortality (52.94 deaths per 1,000 live births) and death rate (9.42 deaths per 1,000 population). Senegal's high fertility rate (4.38 children per female) is partially a response to the high infant mortality rate and partially a response to the difficulty in disseminating health and environmental information among a population with a literacy rate of 30.7 percent for adult females and 50 percent for adult males.

Almost half of Senegal's population is urbanized, and Dakar, the capital city, experiences problems similar to many large cities, including decreasing air quality and difficulties in handling solid waste products. Agricultural mismanagement has led to overgrazing and soil erosion. The strong winds are a major contributing factor in increasing levels of desertification. Overfishing produces challenges to the food supply and threatens marine life. Deforestation is occurring at a rate of 0.7 percent annually in response to indiscriminately cutting trees for fuel use. The resulting loss of habitat, combined with widespread poaching, is threatening Senegalese wild life. The government has protected 11.6 percent of the land area, which includes six national parks. Of 192 mammal species that have been identified, 12 are endangered, as are four of the 175 bird species found in Senegal. In 2006, scientists at Yale University ranked Senegal 107 of 132 countries on environmental performance, in line with the relevant income and geographic groups. Low scores were given in the categories of environmental health, air quality, and water resources.

The Senegalese Constitution guarantees the rights of citizens to live in a safe environment. Since 1981, when an environmental ministry was created, environmental protection and sustainable development have been major government priorities. In 1983 the legislature adopted the Code de l'Environnment, updating it in 2000. The Ministry of Environment and Nature Protection is responsible for the implementation and monitoring of national environmental policy in conjunction with other ministries that have environmental responsibilities such as Health, Agriculture, Commerce, Industry, and Scientific and Technical Research. Specific codes have been enacted dealing with overall environment, hygiene, water management and pollution, air pollution, and the phasing out of lead. In 2003 the Senegalese government shut down all mines that were operating in protected forests and announced that efforts would be made to reclaim the areas and prevent further damage to habitats and ecosystems.

Senegal is one of four riparian countries involved in the World Bank's Senegal River Basin Authority program that is designed to protect the rights of the four countries and the 12,000,000 people who depend on the river. Senegal has also signed the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Wetlands, and Whaling.

SEE ALSO: Colonialism; Disease; Gambia; Riparian Areas.

BIBLIOGRAPHY. Central Intelligence Agency, "Senegal," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Senegal," hdr.undp.org (cited April 2006); World Bank, "Senegal," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Sentience

SENTIENCE IS THE capacity of living beings to sense objects or other beings in their environment. Usually the term is applied to animals and not to plants. However, some plants do seem to react to prey or to potential enemies as if they were sentient. Sentience refers to feeling or to perceiving. This requires that sensory organs or nerve agents be engaged in the animal that is sensing. Sentience may, but does not necessarily include self-awareness. Many mammals have a sentience that includes a limited degree of self-awareness.

It is widely believed, however, that only humans are conscious of self in connection with time, so that memory and imagination can project mental images back into the history of that being, or into some imagined future state. This includes the ability to imagine being in a different place than in the present. Sentience is awareness. It is not knowledge that is acquired from self-reflection such as the awareness that an itch is being caused by a mosquito biting. Nor is sentience wisdom that requires insight, whether practical or moral.

Aristotle referred to animals as possessing an anima or soul. This means that they have some "rationality." He spent some years observing shellfish, birds, and other animals. He noted that with only a few exceptions, like barnacles that attach themselves to a surface for life, sentient beings move.

Movement requires a sensory response to locate food, shelter, reproductive opportunities, and responses to dangers. Even in those that do not move, like oysters, there is still a sensory capacity for responding to environmental conditions of heat and cold, the availability of food, sexual stimuli, and defensive moves if danger is detected. The sensory responses are part of the sentience of all animals.

A broader view of sentience is that found in ideas of panpsychism, which claims in a similar fashion to hylozoism that physical nature is composed totally of living individuals. Panpsychism sees the whole world system as alive in such a way that it is a sensing mind. What is at stake is the problem of how nonliving matter can produce not only living matter, but also apparently noncorporeal mind. Two major environmental concerns arising from sentience lie in the ethical treatment of animals and the good stewardship of biosystems.

Some modern philosophers have sought to link sentience with animal rights. The Utilitarian philosopher Jeremy Bentham argued that the sadistic torture of animals linked nonhuman suffering with sentience. Humans have always killed animals for food and for sport. However, the philosophical position of numerous organizations dedicated to prevent animal suffering or to promote animal rights is that killing animals for the pleasure of seeing their suffering is unethical for humans and ought to be illegal with laws that draw heavy punishments. The philosopher Colin McGinn argues that sentience cannot be understood. He believes that neuroscience can never understand sentience, regardless of how well it understands the brain.

The idea of sentience possessed by beings other than humans is found in Hinduism, Buddhism, and Jainism. For Jains, killing any animal (including insects) inflicts suffering and adds to the karma of the killer. Jain monks often wear face masks, sweep the pathway they are walking, and strain the water they drink in order to keep from accidentally killing even the tiniest of life forms. In Mahayana Buddhism a Bodhisattva (an enlightened being) devotes himself to the liberation of sentient beings from karma. The first vow that a Bodhisattva takes is "Sentient beings are numberless; I vow to free them."

Science fiction writers have posed the question of sentience being a quality possessed by robots; that is, if artificial intelligence gives them the attribute of sentience. First, intelligence is not sentience, but a kind of mental rationality (sapient). On the other hand, a machine built with sensors can be called sentient, but it is simply a sensory device.

SEE ALSO: Animal Rights; Animals; Anthropomorphism; Religion.

BIBLIOGRAPHY. Austen Clark, *A Theory of Sentience* (Oxford University Press, 2000); Wallace I. Matson, *Sentience* (University of California Press, 1976); Colin McGinn, *Mysterious Flame: Conscious Minds in a Material World* (Basic Books, 2000); Ming Singer, *Sentience: Companion to Reason* (Free Association Books, 2003); Jacky Turner and Joyce D'Silva, *Animals, Ethics and Trade: The Challenge of Animal Sentience* (Earthscan/James & James, 2006).

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Septic Systems

SEPTIC SYSTEMS ARE locally buried waste treatment systems. Historians believe that the first use of septic systems was in France during the 1850s. By the mid-1880s, two-chambered septic systems were introduced in the United States. Today, from a quarter to one-third of all American households use a septic system.

Septic systems are usually composed of a watertight tank that has been built to receive and to hold toilet and kitchen sink material. Septic tanks are usually made of concrete, plastic, or fiberglass; tanks made from these materials can have a 50-year life span. Steel is not recommended because it rusts quickly and gives an operational life of 10 or perhaps 20 years. When a toilet is flushed into a septic tank, it receives the raw wastewater from a pipe that flows into the two-chambered watertight tank. The size of septic tanks varies depending upon local code requirements. However, a tank with a capacity of 1,500 liquid gallons is common for a family of four in a single dwelling.

Most septic system tanks have two semi-compartments or chambers. The two open chambers improve the tank's solid removal efficiency. When the raw wastewater arrives in the first chamber of the septic tank, it separates the settleable materials and retains them. Any floatable solids suspend in the raw wastewater. The settleable solids settle to the bottom of the tank where they become part of a layer of sludge. A scum layer is formed from grease and other light materials. Eventually, both the scum and the organic solids in the sludge are liquefied by bacteria, which break them down into water-soluble fatty acids. In between the scum layer and the sludge layer is a soup of water-soluble materials. It contains urea (from urine) and household chemicals (soaps, detergents, creams, toothpaste). Baffles in the design of the tank help to prevent its solid materials flowing into the second chamber.

The operational component of the septic system is bacteria. The flushed wastewater in the first chamber contains microbes excreted from human digestive tracts. Human digestive tracts contain bacteria that participate in the digestive process. These bacteria do not require oxygen (anaerobic). Some of them are health hazards like *Escherichia coli* (*E. coli*) bacteria. Anaerobic and some aerobic bacteria in the buried tank convert the solid wastes into liquids that can then be allowed to filter through the ground. Gasses are formed in the liquefaction process, but these are vented through the building's plumbing vent stack. These gases are usually methane and hydrogen sulfide, although other gases may be present. The second chamber receives its load next; it is usually semi-clarified wastewater. The finer materials in the wastewater in the second chamber then settle to the bottom. The liquefied waste leaches into a drain field where it is absorbed by the ground. Regular scheduled pumping of the tank prevents build up of sludge and extends the life of a system. When toilets do not flush or there is a backup in the system, there is a problem.

A low level of bacteria often causes septic system problems. Soaps, high organic material, bleach, or other household chemicals may kill bacteria. Simply flushing too much water into the system interferes with its smooth operation. The solution to most septic system problems is to restore the bacteria level so that the bacterial "eating" process can continue to break down proteins, starches, carbohydrates, animal and vegetable fat, oils, cellulose, and other materials. There are a wide variety of commercially prepared septic bacterial powers or liquids available that can be flushed or drained into a septic system. Most of the time this will restore the flow in the system, however, it may also degrade the leach field and shorten the life of the system.

The drain field must be far enough above the water table that septic system effluent does not leach into it. Also, layers of impermeable clay or other soils can interfere with the efficient work of the system if they are too close to the level of the tank. However, if the soil has a high percolation rate and no impermeable layer of soil exists, then the system may permit septic effluent to contaminate the water table. This is extremely important if water is drawn from a well that is in the general area of the septic system. Floods or severe drought can interfere with the normal and successful operation of the drain field. Other factors affecting leaching in the drain field are the pH of the soil, soil moisture, and its natural ecology of microbes that are competitors for effluent bacteria. Metals from pipes or from the ground may affect the operation and life of a septic system.

In recent years there has been a growing awareness that the rate of failure in septic systems (or "on site wastewater treatment facilities") is far higher than had previously been estimated. The leakage of sewage into groundwater allows a range of inorganic and organic chemicals to migrate through aquifers to streams and riparian areas, causing extensive environmental damage and health risks for human populations. More management and more direct regulation throughout communities across the United States may be needed. The widespread distribution of these facilities, however, along with the difficulty of assessing their condition and the potential expenses for homeowners, make this a problem with little immediate prospect for resolution.

SEE ALSO: Sewage and Sewer Systems; Waste, Human; Wastewater.

BIBLIOGRAPHY. C.H. Swartz et al., "Steroid Estrogens, Nonylphenol Ethoxylate Metabolites, and Other Wastewater Contaminants in Groundwater Affected by a Residential Septic System on Cape Cod, MA," *Environmental Science & Technology* (v.40/16, 2006); U.S. Environmental Protection Agency, *Wastewater Treatment Systems Manual* (EPA, 2002); J.D. Wickham et al., "Statewide Empirical Modeling of Bacterial Contamination of Surface Waters," *Journal of The American Water Resources Association* (v.42/3, 2006); R. Dodge Woodson, *Builder's Guide to Wells and Septic Systems* (McGraw-Hill Professional, 1997).

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Serbia and Montenegro

THE COUNTRY OF Serbia and Montenegro has two member states: The state of Montenegro and the state of Serbia. Serbia includes the Autonomous Province of Vojvodina and the Autonomous Province of Kosovo and Metohija, which is currently under an international administration. Serbia and Montenegro is situated in southeast Europe on the Balkan Peninsula with access to the Adriatic Sea. It covers a territory of 39,654 square miles (102,173 square kilometers). The country borders on Bulgaria, Romania, Hungary, Croatia, Bosnia-Herzegovina, Albania, and Macedonia.

Serbia and Montenegro has a population of 8,118,146 inhabitants (excluding Kosovo and Metohija). The capital of the country is Belgrade. Serbia and Montenegro is a multinational state with 37 different nationalities. Most of the population (67 percent) are of south Slavic origin. Geographically, Serbia and Montenegro are very different. In the north of Serbia is the rich fertile land of the Pannonian plains, which rise up to 328 feet (100 meters) above sea level; the central part of Serbia is characterized by hills and mountains. Montenegro is largely mountainous. In the southwest, the country is bounded by the Adriatic Sea. The climate is continental in the north and Mediterranean in the south.

Most of Serbia and Montenegro's rivers drain into the Danubian system, while others flow into the Black Sea. The most important rivers are the Danube, Drina, Tisa, Great Morava, and Tara. The Tisa and the Danube are connected by the Grande Canal, which is 76 miles (123 kilometers) long.

Serbia and Montenegro is one of the most important European centers of biodiversity: 74 percent of all European birds can be found there, as well as some 67 percent of all European mammals. Also, more than 50 percent of European fish and about 39 percent of European vascular plants are found in this country and its coastal waters.

During the NATO bombings of the country in spring 1999, the environment was seriously affected. According to the Regional Environmental Center for Central and Eastern Europe, NATO bombings caused a high level of pollution around the main military targets, particularly the chemical industry plants. More than 1,000 tons of ethylene dichloride and nearly 1,000 tons of hydrogen chloride spilled from the Pancevo petrochemical complex into the Danube. Vinyl chloride monomers reached a concentration of 10,000 times above the acceptable level. Air pollution, and soil and drinking-water pollution, are currently very high in Serbia and Montenegro. Scientists anticipate serious effects on human health, including long-term effects from toxic carcinogenic substances and radiation.

Economic and social development in Serbia and Montenegro officially accords with the principles of environmental protection. Serbian law has placed 6.5 percent of the territory under an environmental protection regime, and this is expected to increase to 10 percent by 2010.

In 1991, the Parliament of Montenegro adopted a declaration proclaiming Montenegro the first ecological state in the world. The Constitution defined Montenegro as a “democratic, social and ecological state.” The Montenegrin Environmental Law states that the Republic is committed to preserving environmental resources and improving environmental quality, reducing threats to human life and health from pollution, and remedying and preventing the harmful environmental impacts of pollution; the overall aim is to safeguard and improve the quality of life for all.

SEE ALSO: Biodiversity; Danube River; Pollution, Air; Pollution, Water; Wars.

BIBLIOGRAPHY. *Encyclopedia of the World's Nation* (Facts on File, 2002); “National Parks Target of Development Crime,” www.danas.co.yu (cited April 2006); Serbian Government, www.gov.yu (cited April 2006); *Statistical Yearbook of Serbia* (Belgrade, 2004); *Statistical Yearbook of Yugoslavia* (Belgrade, 1998).

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Sewage and Sewer Systems

SEWAGE (ALSO CALLED wastewater) refers to the liquid and solid waste, usually containing human excrement, that is refused from a home, business or industry. Sewer systems are designed to dispose of human, household, and industrial waste in a manner that reduces human contact with harmful pathogens and toxins, decreases exposure to unpleasant sights and odors, and reduces the environmental impacts of dumping sewage directly into the physical environment. Modern sewer systems consist of various sizes of underground pipes that lead to a sewage treatment plant so treated sewage effluent can be safely returned to rivers and other waterways. Sewer systems may also require the use of lift or pump stations to move sewage from lower to higher elevations, while manholes provide access to sewer systems for maintenance and construction purposes.

Sewage contains a variety of dissolved and suspended materials, including organic compounds and nutrients, viruses, bacteria, other pathogens, paper, feminine hygiene products, food, and grease. The term sanitary sewage is used to refer to wastewater leaving a home or business that contains human waste and general refuse water from toilets, sinks, and drains. Sanitary sewage may be combined with wastewater from storm sewers, which may contain other components such as leaves, cigarettes, small animals, and toxins from streets and parking lots.

Residences or businesses that are not located near a sewer system or sewage treatment plant may use septic systems that store and treat sewage (usually through biological processes) or alternative sewage treatment methods (such as the application of sewage that has received primary or secondary treatment on agricultural fields or golf courses). Most urbanized areas and industrialized countries have specific regulations and policies regarding the disposal and treatment of sewage and other wastewaters, though proper disposal of sewage and wastewater remains one of the most costly and challenging environmental and health concerns worldwide. Water previously containing sewage is often discharged back into surface waters after sewage treatment, making sewage treatment particularly important for general water quality and drinking water supplies as well.

EARLY AND MODERN SEWER SYSTEMS

Early forms of sewer systems date as far back as 4000 to 3000 B.C.E. in the Indus Valley, Mesopotamia, Scotland, and Crete. The earliest sewer systems usually consisted of holes or latrines that held human waste, which were sometimes connected to a system of sewer lines to remove the waste from homes and other buildings. Rome developed an extensive sewage system of latrines and sewer lines from approximately 800 B.C.E. to 300 C.E. Despite some of these extensive developments in sewer systems in early civilizations, discharging untreated sewage directly into surface waters was the primary method of wastewater disposal for many communities through the 19th century, where the contaminants and odors present in sewage could be diluted in large waterways. Other cities allowed sewage to be discharged in or near public spaces and streets through the 17th century.

Sewage sanitation and treatment methods were not widely employed until after the Middle Ages, when diseases and epidemics were traced to poor hygiene and exposure to human wastes. During the 16th and 17th centuries, cities such as Paris, London, and Hamburg began to develop sewage disposal systems to reduce public contact with human waste. In the United States, sewer systems began to be built by private individuals and public services in the mid 1700s in cities such as Boston.

Today, three primary types of municipal sewer systems are used in the United States, including combined sewers, separate sanitary sewers, and separate storm sewers. Combined sewer systems (CSS) are designed to carry sanitary sewage (domestic, industrial, and commercial wastewater) *and* storm water runoff through a single sewer pipe to a wastewater treatment plant. Municipal separate sanitary sewer systems (SSS) convey *only* domestic, industrial, and commercial wastewater (sanitary sewage) to a wastewater treatment plant, and are not designed to carry large amounts of storm water runoff. Instead, separate storm sewer systems are used to carry storm water runoff directly into nearby waterways.

Every year, U.S. CSOs release more than 1.2 trillion gallons of raw sewage and wastewater prior to treatment.

Cities in the United States may have both combined sewer systems and separate sewer systems, or they may have only separate sanitary and storm water sewer systems. Cities with separate storm and sanitary sewers may offer little or no treatment of storm water before discharging it into local waterways, meaning that high levels of toxic pollutants from streets and parking lots can be released into surface waters. Separate sanitary sewer systems are the most predominant type of wastewater collection system in the United States today, although combined sewer systems are often found in older communities in the United States. Estimates from the U.S. Environmental Protection Agency (EPA) value all of the county's sewer systems at more than $1 trillion.

SEWERS AND SEWAGE TREATMENT

Sewage treatment may contain several steps, ranging from preliminary treatment to remove large objects such as sticks, rocks, food, and paper debris, to tertiary treatment involving the use of chemical processes. Primary sewage treatment refers to the removal of suspended solids through the use of screens and settling tanks. The solid materials that settle out of raw wastewater are referred to as sludge (or biosolids), which can be treated using biological processes and disposed of in landfills, incinerated, or in some cases applied to land as fertilizer. Once thought of as an acceptable disposal method, the application of treated biosolids containing human waste has fallen out of favor in the United States during the past decade amid concerns about pathogens and other toxins.

After wastewater has received treatment through screening and settling, it may also receive secondary sewage treatment where microorganisms are added to the wastewater to consume dissolved organic compounds. Pathogens and other harmful materials can be removed through tertiary treatment and disinfection methods, such as the addition of chlorine to wastewater or exposing the effluent to ultraviolet light. Wastewater containing high nutrient loads may require the removal of nitrogen and phosphorus to avoid excessive biological growth in receiving waters.

SEWER OVERFLOWS

One of the biggest environmental concerns regarding sewer systems in the United States is the occurrence of sewer overflows, which can pollute local waterways and expose communities to potentially harmful viruses, bacteria, and other pollutants. The EPA recognizes two main types of sewer overflows: Combined sewer overflows (CSOs) and separate sanitary overflows (SSOs). A combined sewer overflow is the release of sanitary sewage and storm water from a combined sewer system prior to treatment at a wastewater treatment facility. Generally, a combined sewer system functions properly by transporting all sanitary wastewater and storm water through a single pipe to a treatment facility, where it is cleaned and released into nearby waterways. However, during episodes of heavy rainfall or snow melt, a combined sewer system may exceed its designed capacity, requiring the discharge of excess untreated sewage, wastewater, and storm water directly into local streams and rivers through designated release points. Combined sewer systems and CSOs are typically associated with older communities and wastewater infrastructure that was built prior to major federal water quality regulation, which did not appear in the United States until the late 1950s. Because CSOs are a point source of water pollution, they are legal discharges regulated by the Clean Water Act through National Pollution Discharge Elimination System (NPDES) permits. It has been estimated that individual CSOs release approximately 1.2 trillion gallons of raw sewage and wastewater in the United States every year.

A sanitary sewer overflow (SSO) is the unintentional and unauthorized discharge of untreated raw sewage from a separate sanitary sewage system due to sewer system malfunctions. SSOs generally occur at manholes, releasing untreated wastewater into roadways, waterways, and onto public and private property, but SSOs can also occur at sewer hookups located in the basements of private homes, directly exposing residents to untreated raw sewage. The EPA estimates that at least 40,000 SSOs and 400,000 basement SSOs occur in the United States every year, which can contaminate surface waters, cause private property damage, and pose significant public health risks. Importantly, sanitary sewer overflows are illegal under Section 301 of the Clean Water Act, which prohibits the discharge of pollutants into U.S. waterways without a permit. As such, the true number and volume of SSOs may not be known because many U.S. municipalities underreport, or do not report, their SSOs to the EPA.

Human health risks of CSOs and SSOs result primarily from exposure to overflow discharges, including contact with untreated sewage in streets, lawns, and parks, or through recreational activities such as swimming in water bodies that receive SSO discharges. Human exposure can also occur from contaminated drinking water sources or the consumption of shellfish that have been harvested from contaminated waters. Diseases that have been identified in SSOs include the stomach flu, cholera, dysentery, and hepatitis B. Water quality and ecosystem health are also affected by sanitary sewer overflows, including habitat degradation, harmful algae blooms, lowered dissolved oxygen levels, and fish kills. Sewer overflows have also been identified as one of the primary cause of swimming advisories and beach closures in the United States. Addressing sewer overflows through the replacement and upgrading of increasingly antiquated sewer systems remains one of the most persistent and challenging environmental and social problems in the United States.

POLITICAL ECONOMY OF SEWER SYSTEMS

Sewage treatment is primarily the responsibility of local and regional governments in the United States. The expenses associate with constructing and maintaining sewer systems require public consensus regarding the level and quality of sewage treatment a community wishes to provide for its wastewater. At the same time, sewage has become a significant economic activity with various companies and manufactures offering numerous treatment and management options. Sewage, despite its unpleasant nature, is both big business and major public policy.

In many ways, sewage and sewer systems sit at the very intersection of the physical environment and human society. For centuries, communities have had to negotiate the processes of urbanization and development—which concentrate and increase the amount of sewage in an area—with the impact of sewage on natural processes and living organisms, economic requirements for the construction and maintenance of sewer systems, policies to protect human health and ecosystem viability, as well as public perceptions regarding sewage. For something that rarely comes up in the conversations of everyday residents, sewage and sewer systems are particularly important and ubiquitous aspects of both the environment and society.

SEE ALSO: Pollution, Water; Recycling; Septic Systems; Urbanization.

BIBLIOGRAPHY. R. Field, D. Sullivan, and A. Tafuri, *Management of Combined Sewer Overflows* (Lewis Publishers, 2004); Jon C. Schladwelder, "Tracking Down the Roots of Our Sanitary Sewers," www.sewerhistory.org (cited January 2007); Frank R. Spellman, *Handbook of Water and Wastewater Treatment Plant Operations* (CRC Press, 2003); U.S. Environmental Protection Agency (EPA), *Sanitary Sewer Overflows: What are They and How Can We Reduce Them?* (Office of Wastewater Management, 1996); U.S. EPA, *Report to Congress: Implementation and Enforcement of the Combined Sewer Overflow Control Policy* (Office of Water, 2001); U.S. EPA, *Wastewater Management: Controlling and Abating Combined Sewer Overflows* (Office of Inspector General, 2002).

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Sewer Socialism

ALSO KNOWN AS Milwaukee Socialism, the term *sewer socialism* derives from the policies and practices of Socialists who ran the City of Milwaukee, Wisconsin, in the late 1800s and early 1900s. The term is now broadly used for political leadership that focuses on programs of reform and development that accomplish positive changes in infrastructure, educational systems, or other aspects of urban life.

The Socialists who won election to Milwaukee's city government rejected the ideas of Progressivism as appropriate for reforming the activities of industry and its socio-economic consequences. The Social Democrats, led by Victor Berger, an Austrian immigrant, sought to reform the political culture and the environment of Milwaukee that had developed in the era of laissez-faire capitalism. Berger was editor and publisher of Wisconsin newspapers such as the *Social Democrat* and the *Milwaukee Leader*. He used these German language newspapers to spread his ideas of socialist reform, distributing free copies of papers to all Milwaukee homes before elections.

The ideas that Berger advocated appealed to the large German immigrant population in Milwaukee and catapulted him into leadership of the Socialists, although the group was more focused on honest government and reform than on ideology.

In 1910, Berger was elected to the Milwaukee city council and then later that year to the U.S. Congress as its first Socialist. That same year Socialists were elected to most of the seats on the Milwaukee city council and to its country board. Emil Seidel was elected mayor of Milwaukee, making him the first Socialist mayor of an American city. He and other Socialists sought to stop the corrupt political machines, led by urban bosses, that were in control. The boss-led machines viewed the public purse as a way to enrich themselves and their supporters at public expense.

In the election of 1912, both Berger and Seidel were defeated by Progressives; in the election of 1916 Daniel Hoan was elected mayor of Milwaukee as a Socialist. He continued to be re-elected until 1940. In 1918 Victor Berger was again elected to the House of Representatives, but he was denied permission to take his seat because his statements at a Socialist convention in St. Louis had expressed opposition to World War I. This was viewed by the majority of the representatives as a violation of the Espionage Act.

While the Progressives and Socialists often sought the same things, their methods were different. The Progressives preferred regulation of capitalist business and industry; the Socialists sought a planned economy of state-owned industries. With state ownership Socialists believed that abuses of workers that occurred in private industry would be eliminated.

While engaging in political campaigns that viewed class warfare as a reality, the Socialists were opposed to revolutionary violence. They instead sought an incremental set of political victories at the ballot box that would inevitably lead to gaining complete control of the means of production. Then they would change society according to their political vision. By patient application of political action, they foresaw gaining the ultimate victory of control of society. However, in the meantime, they would improve the living conditions of the working class with more efficient administration of government.

During Hoan's administrations close attention was paid to the infrastructure of Milwaukee. The goal was to repair the damage done to the environment by uncontrolled aspects of the Industrial Revolution. Sewer Socialists engaged in a back-to-basics strategy that was focused on the local level. Cleaning up neighborhoods, industrial areas, and business districts were prime goals. They also sought to install new sanitation systems, water systems, and power systems that were owned by the municipality these utilities served.

SEE ALSO: Cities; Progressive Party; Socialism.

BIBLIOGRAPHY. Elmer Beck, *Sewer Socialists: A History of the Socialist Party of Wisconsin, 1897–1940* (Westburg Associates, 1982); Daniel Webster Hoan, *City Governments: The Record of the Milwaukee Experiment* (Greenwood Publishing, 1973); Sally M. Miller, *Victor Berger and the Promise of Constructive Socialism, 1910–1920* (Greenwood Publishing, 1973); Bruce M. Stave, *Socialism and the Cities* (Kennikat Press, 1975).

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Sex

SEX REFERS TO the division between many biological species into male and female forms. These forms differ in their chromosomal composition and in those physical aspects that relate to reproduction. Sexual division is common among higher creatures, but is by no means the only arrangement. Many asexual species exist and do not show any disadvantage in evolutionary terms. However, the division, which is billions of years old, seems most likely to have been caused by evolution to increase genetic variation and, hence, survivability of the young. Asexual creatures reproduce through division into daughter creatures that are genetically identical to their mother; on the other hand, male and female partners mating provide a much wider possibility for variation.

Subsequently, evolution has led to changes in the bodies of the species concerned to facilitate the bearing of children by (most commonly, but not exclusively) the female, while males contribute toward reproduction but lack the organs necessary for this task. As males and females have different roles in producing children in humans and most mammals, these differences have been extended to roles in child-rearing, domestic responsibilities, and outdoor work. In some human societies, these differences have become ossified over centuries and have, in the great majority of cases, led to the subjugation and suppression of women and the denial of their equality with men. However, some societies have in modern years or even traditionally adopted more tolerant attitudes toward variations in the distribution of household responsibilities and of gender-based duties.

Just as for humans, many animals do not share the predilection for heterosexual attraction and form homosexual unions on either a temporary or permanent basis. Other creatures appear to have up to as many as five different sexes, all of which contribute in various ways to reproduction and bearing of young. Additionally, some individuals contain both or neither male and female sexual characteristics. Finally, there are creatures whose sexual orientation and physical sexuality change during the course of their lives. The Western philosophical tradition of establishing dichotomous opposites (for example, good-bad, heaven-hell, or black-white) is an inappropriate means of regarding sexuality.

The attempt to restore certain endangered wild animals through mating programs in secure locations is rendered more difficult in some cases by the apparent indifference toward sex of some species, notably giant pandas, which is a behavior without apparent evolutionary advantage other than reducing potential numbers of competitors. However, for most animal species, sexual behavior can include a wide range of exotic and sophisticated courtship ritual. Other species see females consume males after copulation or an apparent lack of connection between the involved parties apart from the physical act. Some animals have been known to conduct systematic rapes of female species and other forms of behavior considered aberrant.

SEE ALSO: Animals; Biodiversity; Birth Control; Birth Rate; Extinction of Species; Fertility Behavior; Fertility Rate; Gender; Plants; Population; Seeds; Sexually Transmitted Diseases.

BIBLIOGRAPHY. Richard Dawkins, *The Ancestor's Tale: A Pilgrimage to the Dawn of Evolution* (Mariner Books, 2005); Richard Dawkins, *The Selfish Gene* (Oxford University Press, 1976); Simone De Beauvoir, *The Second Sex* (Vintage, 1989 [1949]); Carol Pateman, *The Sexual Contract* (Stanford University Press, 1988).

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Sexually Transmitted Diseases

SEXUALLY TRANSMITTED DISEASES (STDs) may present themselves after someone contracts either a bacterial or viral sexually transmitted infection (STI). STIs are spread predominantly through sexual contact: Oral, anal, or vaginal. Common STDs include gonorrhea, chlamydia, syphilis, herpes, genital warts, hepatitis B and C, as well as human immuno-deficiency virus (HIV) and human papillomavirus (HPV).

STDs can be found throughout the world, although there are spatial differences in the overall distribution of these diseases. While some of these diseases can be treated with antibiotics if they are diagnosed early (such as gonorrhea, syphilis, and chlamydia), others are chronic illnesses that may only be managed through an ongoing regimen of medications, diet, and exercise (such as hepatitis B, HIV, and HPV). There are now vaccines that may stop the spread of some of these infections (hepatitis B and HPV), but many others must be prevented through minimizing the risks associated with their spread, including unprotected anal, oral, or vaginal sex. Prevention varies depending on the type of infection: Some, such as gonorrhea, are easily spread through oral sex, while others, such as HIV, are much less likely to be spread orally. In some cases, these illnesses have been spread through blood transfusions, or through injection drug users sharing unclean needles. Many blood supplies in wealthier countries are now tested for these infections before they are used.

While the connection to environmental conditions may not seem directly obvious, there are not only biophysical issues (the transfer of STIs through the exchange of bodily fluids) involved in the spread of these diseases. The immune system's ability to ward off infections is compromised in conditions of high endemic malnutrition, poverty, and pollution. A compromised immune system might lead to a much quicker death for someone who is exposed to other infections that are not sexually transmitted, such as malaria, tuberculosis, or cholera. In many parts of the world, those infected with STDs may die not from the STD itself but from another illness, the result of an attack on the compromised immune system.

Moreover, the use of nonbiomedical, or nonallopathic approaches, such as homeopathic remedies, including herbal medicines, are more common to ward off the symptoms of some of these diseases in areas where regular biomedical care is unavailable or too expensive (for example, in HIV, hepatitis B or C treatment). This means that access to community property or forest resources might be an essential component of the regular treatment regimen of many people living with the symptoms associated with HIV disease, HPV, or hepatitis. If managed, many people can live healthy lives despite the presence of some STDs.

There are also political and social conditions that place people at risk for contracting STIs, particularly in areas of war and violence where rape is common or in places of intense poverty, which forces individuals into certain high risk industries, such as commercial sex work. Some of these diseases, therefore, are more prevalent in regions such as sub-Saharan Africa, various parts of Asia (such as India, China, and Southeast Asia), as well as in parts of Russia and eastern Europe.

Contracting an STI and developing an STD is also gendered. In many cases, the receptive partner is much more likely than the penetrative partner to contract a STI. While this is not always the case (receiving oral sex is a common means of contracting gonorrhea), it means that women and men who are receptive partners of anal, oral, or vaginal sex are susceptible to STDs. This can change, of course, as certain STDs are co-factors for the spread of other STDs: Someone who has an active case of syphilis, which produces a sore on the penis, is then more susceptible for contracting HIV.

STDs such as syphilis, chlamydia, and gonorrhea are also more likely to manifest outwardly on male genitalia. This means that women can contract these diseases and not know they are infected until the STD begins to cause serious, and in some cases, permanent damage to their reproductive (or other) organs. Despite the global optimism of the reduction of STDs in the 1970s, there are numerous signs that this class of diseases continues to spread in different ways across a wide array of international contexts.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Center for Disease Control; Disease; Poverty; Sex; Syphilis; World Health Organization.

BIBLIOGRAPHY. Adaora Adimora and Victor Schoenbach, "Social Contexts, Sexual Networks, and Racial Disparities in Rates of Sexually Transmitted Diseases," *The Journal of Infectious Diseases* (v.191, 2005); Chris Beyrer, "Shan Women and Girls in the Sex Industry in Southeast Asia: Political Causes and Human Rights Implications," *Social Science and Medicine* (v.53, 2001); Michael Brown, "Sexual Citizenship, Political Obligation and Disease Ecology in Gay Seattle," *Political Geography* (2006); Paul Farmer, Margaret Connors, and Janie Simmons, eds., *Women, Poverty, and AIDS: Sex, Drugs, and Structural Violence* (Common Courage Press, 1996); M.C. Smith Fawzi et al., "Factors Associated with Forced Sex among Women Accessing Health Services in Rural Haiti: Implication for the Prevention of HIV Infection and Other Sexually Transmitted Diseases," *Social Science and Medicine* (v.60, 2005); Eileen Stillwagon, *AIDS and the Ecology of Poverty* (Oxford University Press, 2005).

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Sheep

SHEEP ARE RUMINANT animals of the genus *Ovis*. They have been domesticated for around 5,000 years and are an important source of food and textiles, as their fleece is customarily shorn annually to produce wool. Sheep meat is eaten in many countries, and some societies also use sheep's milk and cheese, although this is less common. Different species of sheep have been crossbred with the aim of improving their adaptability to local environmental conditions, and to improve the quality and usefulness of their products. Sheep farming is an important agricultural activity in a number of countries and it is estimated that more than 1,000 million animals are kept globally. A sheep known as Dolly has a particular place in history owing to its being an early example of cloning.

Sheep are herbivores and eat grasses and legumes. They are known for their willingness to flock together for fear of danger and for following any of their fellows who takes a lead. These characteristics have provided the basic structure to sheep farming. This includes the role of the shepherd, who keeps the sheep in outdoor locations overnight so that the sheep can graze on local plants. The shepherd frequently keeps a dog that has been trained to respond to the shepherd's direction and to cause the sheep flock to move in directions as desired by the shepherd. The dog also assists in protecting the sheep from predators such as wolves, which have been eliminated from the wilds of most developed countries. Since the sheep remain together, the labor requirement is comparatively low for most of the year, with additional input necessary during the lambing and shearing seasons.

Since sheep graze on grass growing in open spaces, sheep farmers are antithetical to small-scale agricultural holdings or homesteads. This was perhaps most clearly seen in 18th and 19th century Scotland during the Highland Clearances. England had attempted to dominate and control Scotland for several centuries. Smallholders, or crofters, populated the Highland area of Scotland. The English aristocracy forcibly dispossessed them to use the land for large-scale sheep farms, resulting in the rapid depopulation of the region. Sheep are recorded in religious and historical documents from the Middle East thousands of years ago and there are still large numbers in Iran. Today some of the largest numbers are kept in China, India, and countries of the former Soviet Union. The industry is also significant in

Merino Sheep

Merino sheep were bred in Spain in the Royal Escurial flocks and were noted for their substantial fleeces. The export of any of these sheep from the country was punishable by death. Eventually these harsh penalties were relaxed, and in 1723, some were exported to Sweden. In 1765, King Ferdinand VI of Spain sent some to his cousin Prince Xavier, Elector of Saxony, and sales to Hungary and Prussia followed. Late in 1786, King Louis XVI of France took possession of 366 sheep for the royal farm at Rambouillet, southwest of Versailles. There the Rambouillet breed was developed, descendants of which were taken to the United States in 1840. Merino sheep now make up two-thirds of all the sheep in the United States. In 1787, the British naturalist Sir Joseph Banks began buying merino sheep from Portugal. They were bred at Kew Gardens, but the flock was subsequently sold off. One of the buyers at the 1804 sale was John Macarthur, who had just returned to England from Australia. He bought seven rams and one ewe, taking them with him to Australia where the sheep were successfully bred.

During the Napoleonic Wars, the Spanish merino industry was all but destroyed. Some German breeders continued with the wool trade but it was not long before the Australian wool industry began to dominate world supply. In 1801, there were, according to a survey, 33,818 sheep in the country. With the arrival of the merino sheep five years later, the wool boom began. In 1813, the land beyond the Great Dividing Range was settled and by 1830 there were nearly two million sheep in the country. Sheep and the sale of wool still dominate the Australian agricultural sector.

Australia, New Zealand, Canada, and similar countries with wide-open grasslands, though these areas are more important to the agricultural industry.

Modern sheep farming approaches the intensive forms of agriculture practiced in other forms of farming, but the characteristics of sheep prevent the industrialization of their keeping. Sheep are subject to various pests, including scrapie and foot and mouth disease, which occasionally lead to the widespread culling of flocks. Incidents in which the feed of the sheep has been altered for commercial or technological reasons are often associated with the outbreak of pestilence.

The products of the sheep, as agricultural commodities, are also subject to demand and market fluctuations. This means that farmers have to contend with the impact of international trade negotiations over which they have little control. During the 1990s, French farmers seized and burnt some shipments of British lamb that they believed was receiving unfair trade promotion. In these circumstances, the comfort and convenience of the animals is rarely awarded top priority.

SEE ALSO: Cloning; Domestication; Farming Systems; Herders; Meat; Transmissible Spongiform Encephalopathies; Wolves.

BIBLIOGRAPHY. Food and Agricultural Organization, www.fao.org (cited July 2006); Iain S. Macdonald, *Glencoe and Beyond: The Sheep-Farming Years, 1780–1830* (John Donald Publishers Ltd., 2005); U.S. Department of Agriculture Foreign Agricultural Service, www.fas.usda.gov (cited January 2007).

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Shifting Cultivation

SHIFTING CULTIVATION IS a term referring to a wide range of traditional farming systems. Sometimes disparaged and sometimes romantically defended, shifting cultivation has been a lightning rod for arguments concerning the environmental sustainability of agriculture. A wide variety of diagnostic criteria are used to define the shifting cultivation system of agriculture, but a primary characteristic of this system is land rotation. Plots of land or fields (distinctive areas of agricultural land use such as cropping, pasture, and fallow) are rotated between different uses—rather than left to a single/permanent use—in order to achieve agronomic goals within this system. For instance, the rotation of land between cultivation and fallow is employed to regenerate soils through vegetation-soil nutrient cycling. The simple technology, limited modern agricultural input use, and a typical location within a tropical developing country are among the numerous criteria identified with shifting cultivation.

CHARACTERISTICS AND IMPLICATIONS

However, with the exception of the land rotation diagnostic criterion, the categorization of a large number of agricultural systems with widely varying characteristics under the term *shifting cultivation* is highly problematic. Shifting cultivation systems include systems of agriculture involving the movement of farmers' homesteads to new fertile lands when soils deteriorate under farming and those that do not involve shifting settlements. Shifting cultivation is also associated with areas of land abundance and those with less abundant land, with areas of low to medium population densities to those with high population densities, and with areas of varying cropping-fallow regimes—ranging from a few months of fallow to beyond the lifetime of a farmer, and with fallow periods being shorter, the same length, or longer than the period of cultivation. Greater reliance is placed on natural successional fallow growth for restoring soil fertility in some land rotational systems than in others. Some shifting cultivation systems involve heavy tillage of soils, while others have minimum tillage.

Furthermore, titles to land, land tenure, sizes of fields and farms, and labor arrangements in shifting cultivation systems vary widely. Yet another complication occurs when the term *swidden cultivation/slash-and-burn cultivation* is used as a synonym for shifting cultivation. Swidden/slash-and-burn systems describe temporary agricultural fields that are cleared/prepared for cultivation by burning the vegetation. However, not all temporary fields are cleared by fire. Further confusing matters is the general use of the term *bush fallow system* as yet another synonym for shifting cultivation. As noted, not all land rotation in the developing world is heavily reliant on natural successional fallow growth for soil regeneration. Some farms use rotational planted fallows (green manures) and crop rotation to regenerate soils more quickly.

Shifting cultivation, and its several synonyms, is more than a benign concept that is simply used to name a category of agricultural practices. Surrounding this concept are discourses whose knowledge about the environmental implications of shifting cultivation has served as the basis for interventions, or has served as the foundation of critiques of such interventions, into the agricultural practices of millions of farmers in the developing world. It is the power of such environment-society discourses in justifying interventions, or otherwise, into the lives of people that makes it critical to reflect upon whether a concept that encompasses such a wide variety of practices and characteristics is empirically useful, and whether interventions that are based on an over-generalized concept of shifting cultivation are misinformed.

A RANGE OF PERSPECTIVES

There are three perspectives about shifting cultivation. The most dominant discourse is one that views shifting cultivation with derision. Shifting cultivation is described pejoratively as slash-and-burn cultivation. It is viewed as wasteful of land, backward, destructive, and unsustainable. For instance, the use of fire in shifting cultivation systems, some insist, is the greatest threat to forests and biodiversity. The pattern of destruction associated with shifting cultivation is described as follows: Farmers cut and burn forests. This burning also destroys tree seeds, seedlings, saplings, and leads to the loss of many soil nutrients, such as carbon and nitrogen. Nutrient loss is accelerated by erosion and leaching. Following the clearing of the land, crops are planted. But soil fertility declines rapidly, and farmers abandon plots and clear other forests for more fertile plots. This process escalates with the high rates of population growth and rising population densities in the developing world. And to this escalation of problems is added the contemporary concern over the loss of forest carbon sinks, increasing carbon dioxide, and global warming. The ecological impacts of shifting cultivation are thus viewed negatively in this perspective, and this view of degradation has justified the action of some states to seize control of land from local farmers. The bush-burning aspect of shifting cultivation was actually criminalized and carried the death penalty in 1970s Guinea.

Yet another negative perception of shifting cultivation relates to its agronomic shortcomings. Shifting agriculturalists, with their traditional practices of land rotation and low applications of productivity-enhancing inputs, are viewed consistently by governments in the developing world as hardly the progressive farmers who can meet the food demands of the growing, increasingly urbanized, populations of the developing world. Addressing the low productivity and production levels of shifting cultivation systems is a constant item on the wish list of governments. Governments have focused their attention on diffusing Green Revolution technologies, and lately the gene revolution technologies. An example from Ghana illustrates this observed productivity shortcoming of traditional agriculture. This country's agricultural development program indicates that traditional yields of maize, sorghum, groundnut, and yam were between 40 to 60 percent of the yields of farms that used modern inputs.

An opposing discourse has insisted that shifting cultivation systems maintain equilibrium between the environment and agricultural societies, and that shifting cultivators have not produced any long-term environmental damage as alleged. In some of these perspectives, shifting cultivation is viewed as an embedded system comprising ecological, economic, social, and religious components, all of which act together to ensure that ecological and social systems remained in a functional equilibrium. This view has also insisted that modern agricultural practices have failed to prove their superiority in staple food production over the natural fallowing shifting cultivation system.

Lying midway between the two opposing discourses is a third view, which is more sensitive to the variations within this land rotation farming system and acknowledges both advantages and problems of shifting cultivation. For small-scale farmers in the tropical developing world who can hardly afford modern agricultural inputs, varieties of shifting cultivation provide an affordable farming system that is based on sound ecological principles. The clearing and burning of bushes produce ash that releases large stores of nutrient ions, such as potassium and phosphorous, from the biomass into the soils. After crops are cultivated for a varying number of years, the land is left to fallow for a number of reasons. First, soil nutrients decline. But often the land is abandoned long before soils are exhausted due to the increased competition of weeds, the labor involved in controlling proliferating weeds, and problems of pests. The successional fallow vegetation rapidly accumulates nutrients in its biomass, particularly in the leaves and twigs, during the first five years of fallow. The mineralization of litter fall, and nutrients from rain wash and root excretions from the fallow vegetation, replenish soil nutrients. Once fertility is regenerated the land is cultivated again. This nutrient cycling processes of regenerating soils during fallow is viewed as demonstrating the rich ecological knowledge of local farmers.

Population density pressure and problems of access to land, plus pressures to meet rising costs of living by intensifying production, have led to a trend of decline in the period of fallow, and land degradation has occurred in some shifting cultivation systems. Yet others have adapted to sustain soil fertility, for instance by improving natural fallows for more rapid soil regeneration through nurturing vigorous growth of trees and shrubs, and by planting more fallow vegetation. It would appear then that the jury is still out with a verdict on the environmental implications of shifting cultivation.

SEE ALSO: Carbon Cycle; Farming Systems; Fire; Genetically Modified Organisms; Green Revolution; Indigenous Peoples; Land Degradation; Soil Erosion; Soil Science; Underdeveloped ("Third") World.

BIBLIOGRAPHY. J. Brand and J.L. Pfund, "Site- and Watershed-Level Assessment of Nutrient Dynamics under Shifting Cultivation in Eastern Madagascar," *Agriculture, Ecosystems and Environment* (v.71, 1998); Harold Brookfield, *Exploring Agrodiversity* (Columbia University Press, 2001); P.H. Nye and D.J. Greenland, *The Soil under Shifting Cultivation* (Commonwealth Agricultural Bureau, 1965); Republic of Ghana, Ministry of Agriculture, *Ghana Medium Term Agricultural Development Program* (Ministry of Agriculture, 1990); P. Richards, *Indigenous Agricultural Revolution: Ecology and Food Production in West Africa* (Westview Press, 1985); H. Ruthenberg, *Farming Systems in the Tropics* (Clarendon, 1980).

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Shiva, Vandana (1952–)

VANDANA SHIVA WAS born in 1952 in the Himalayan foothills of northern India. Trained as a nuclear physicist, she has emerged as a philosopher of science and a persistent voice against neoliberal globalization and environmental destruction. Since the early 1980s, she has been engaged in the ecological, social, and economic struggles of subsistence farmers in India, drawing on the ethics of ecology and feminist thought in an effort to promote biodiversity and pluralism in knowledge, action, and culture. Shiva works actively with communities as they struggle against destructive forestry practices, large-scale dams, and multinational-dominated agribusiness. She has shared her knowledge in over 20 books and countless articles, starting with *Staying Alive: Women, Ecology and Development* (1989) and continuing through her most recent book, *Earth Democracy: Justice, Sustainability, and Peace* (2005).

In 1982, Shiva established the Research Foundation for Science, Technology and Ecology in her hometown of Dehradun. Since then Shiva and the foundation have worked on topics such as the protection of smallholder agriculture and local genetic resources, patenting of indigenous knowledge, the role of the World Bank and World Trade Organization in promoting unfair trade rules, and the role of women in maintaining ecological and cultural diversity. In 1991, she founded Navdanya, an Indian movement to protect biodiversity by setting up seed banks, supporting organic agriculture, and establishing direct producer-to-consumer links for food security. Her achievements were recognized in 1993, when she received the Right Livelihood

Award, widely known as the "alternative" Nobel Peace Prize. Following this honor she launched an international movement called Diverse Women for Diversity, was a founding member of the International Forum on Globalization, and has established Bija Vidyapeeth, a green college in Dehradun based on Gandhian principles.

Internationally recognized as an outspoken critic of the ways in which local knowledge is marginalized and displaced by the dominance of Western knowledge, Shiva has fought against the use of biotechnology in farming. In her book *Ecology and the Politics of Survival* (1991), she examines the politics of Western scientific knowledge, arguing that it is gradually fragmenting local knowledge of ecological relations, knowledge that includes understanding of the reproduction of natural resources, the erosion of soil, the production of humus, and the regeneration of water.

Her critique of monocultures not only challenges the dominant paradigm of agribusinesses, but also highlights her concern that women bear the brunt of destruction caused by globalization and economic development. In her book *Ecofeminism* (1993), she and Maria Mies challenge the ecofeminist movement to reject capitalist ideals of "the good life" based on high technology and consumerism. Instead, women's experiences, which have largely been trammeled in the development process, can provide the knowledge to support locally based, life-affirming, culturally diverse, and self-reliant agriculture production systems.

SEE ALSO: Biopiracy; Chipko Andolan Movement; Ecofeminism; Feminist Political Ecology; Globalization; India; Justice; Livelihood; Monocultures; Seed Banks; Subsistence; Sustainability; Trade, Fair; Trade, Free; World Trade Organization.

BIBLIOGRAPHY. Nanyna Jhaveri, "Globalization and Graduate Students: An Interdisciplinary Graduate Forum with Vandana Shiva," *Positions* (v.12/1, 2004); Maria Mies and Vandana Shiva, *Ecofeminism* (Zed Books, 1993); Vandana Shiva, *Staying Alive: Women, Ecology and Development* (Zed Books, 1989); Vandana Shiva, *Ecology and the Politics of Survival: Conflicts over Natural Resources in India* (SAGE Publications, 1991); Vandana Shiva, *Earth Democracy: Justice, Sustainability, and Peace* (South End Press, 2005); "The Right Livelihood Role of Honor, Vandana Shiva" (1993), www.rightlivelihood.org (cited April 2006).

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Shrimp

SHRIMPS ARE DECAPOD crustaceans from the infraorder *Caridea* found around the world in fresh and salt water and in both shallow and deep waters. There are about 2,000 species of shrimps; they range in length from a fraction of an inch to up to eight inches. Most are about 1.5–3 inches long, with the larger species commonly known as prawns. They are closely related to crabs, crayfish, and lobsters—the main difference is that they have a semitransparent body, a flexible abdomen, and a fan-like tail allowing them to swim easily. They often eat small plants, animals, or even carrion. Female shrimps may lay anywhere between 1,500 and 14,000 eggs depending on species and conditions.

The various types of shrimps include the common European or sand shrimp (*Crangon vulgaris* and *Crago septemspinosus*) found in the North Atlantic; the *Peneus setiferus* found off the east coast of North America from Mexico as far north as North Carolina; the brown-grooved shrimp (*Peneus aztecus*); and the pink-grooved shrimp (*Peneus duorarum*). The edible shrimps in the West Indies are *Xiphocaris,* which live in fresh water, with those from the genus *Macrobrachium* often being found in rivers in tropical countries.

Shrimps form the food source for numerous creatures, with the smallest type of shrimp, often known as krill—of which there are 82 species—providing the major part of the diet for baleen whales (such as blue whales, southern right whales, or humpback whales), and also for seals, penguins, squid, and fish. Blue whales consume many tons of krill each week. Krill, which are between one and two centimeters long as adults, live in vast swarms of up to 35 pounds per cubic yard in some parts of the Antarctic Ocean. It is not unknown for there to be tens of millions of krill in a single swarm, and this is what often attracts whales and other animals. Krill, which can often swim a few centimeters per second, can molt, leaving behind some of their skin, or exuvia, as a decoy for predators.

There is commercial fishing of krill in the Southern Ocean and the waters around Japan—krill is consumed by people in both Japan and Russia. However, its major use is as aquaculture feed, fish bait, and food for livestock and pets. To satisfy demand for these uses, there has been a recent increase in fishing fleets specifically designed to fish and process krill. This started in the Soviet Union during the 1960s, followed by Japan in 1972, and later by Poland, Chile, and South Korea. Ukraine also established its own krill fleet in 1991, and Japan, Poland, and the Ukraine are now the largest krill-fishing nations in the world.

The increase in whaling in the 19th century and for much of the 20th century allowed the krill population to increase. However, even with a much reduced whale population today, scientists have noticed a decline in krill numbers that they suspect is connected to the warming of the oceans from the greenhouse effect. If the cause of this is correct, this would affect the ecoenvironment of the oceans, as krill are an important part of the marine food chain. Krill may also have been affected by events such as the coccolithophore bloom in the Bering Sea in 1998, which resulted in a decline of diatoms, on which coccolithophores and krill both feed. Without the ability to feed on small coccolithophores, the population of krill off the coasts of western Alaska fell drastically with the result that there was a fall in other forms of fauna, particularly salmon.

Since the 1960s, shrimp farms have been built in Japan, Taiwan, Thailand, and elsewhere to meet world demand.

Prawns have long been a part of human diets around the world, with shrimps being high in calcium and protein but low in food energy. Many seafood dishes incorporate prawns, with fried shrimp being a popular part of Asian and North American cuisine. Shrimps are also used in paella in Spain, and in many other Mediterranean and Portuguese dishes.

Originally all prawns were caught at sea. Shrimp fishing was particularly hazardous because of the weight of the nets, and the fact that some prawns tend to swim in rainstorms, making the hauling of nets dangerous. Gradually, as demand grew, shrimp fisheries were established. The first of these were small-scale concerns in Japan and southeast Asia; the kuruma shrimp was cultivated in shrimp farms starting in the 1930s. In the 1960s, large shrimp farms were established throughout Japan, and in the 1980s, in Taiwan, although the industry there had problems with diseases and management. In 1985, shrimp farms were built in Thailand to meet increased worldwide demand for shrimp-flavored sauces. A small shrimp farm was built in Brazil in 1974, and in Ecuador in 1978, but major production in Latin American only started in the 1990s; Brazil now has one of the major shrimp farming industries in the world. Many commercial hatcheries are still known as Galveston hatcheries because they were first developed in Galveston, Texas.

SEE ALSO: Aquaculture; Fisheries; Food Webs (or Food Chain); Greenhouse Effect; Whales and Whaling.

BIBLIOGRAPHY. Dorothy E. Bliss, *Shrimps, Lobsters, and Crabs* (Columbia University Press, 1982); I. Everson, ed., *Krill: Biology, Ecology and Fisheries* (Blackwell Science, 2000); D.L. Grey, *A Guide to the American Penaeid Prawns* (Department of the Northern Territory, 1983); G. Smaldon, *British Coastal Shrimps and Prawns* (Linnean Society, 1979).

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Sierra Club

FOUNDED IN 1892 by conservationist, explorer, and naturalist John Muir, the Sierra Club has become one of the most prominent environmental organizations in the United States with more than 700,000 members. It also has affiliations in Canada (Sierra Club of Canada, founded in 1963) and a Sierra Club Student Coalition (founded in 1991). The U.S. Sierra Club organization consists of a nationally run chapter, chapters in all 50 states, the District of Columbia, and Puerto Rico, as well as hundreds of local and regional groups.

The Sierra Club organizes two main programs: The first promotes the use of political action to protect wilderness areas and the natural environment; the second encourages and facilitates outdoor activities, such as hiking and camping. Since its creation in the late 19th century, the national Sierra Club organization has engaged in a growing number of political campaigns related to the environment, including its current initiatives of increasing the nation's alternative energy sources to address the concerns of global warming and air pollution, promoting safe and healthy communities through the attainment of cleaner air and water, and protecting the nation's wildlife and natural landscapes.

Local Sierra Club groups also take on other specific environmental and social campaigns that are more closely related to local political, economic, and development concerns. In 2002, for example, the Central Ohio Group launched an aggressive campaign to stop sewer overflows that release untreated sewage into local rivers in Columbus, Ohio.

Strategies employed by the Sierra Club include litigation to enforce environmental regulations (such as the Clean Water Act), lobbying Congress, letter writing, public protests, political rallies, and community outreach and education. The Sierra Club and its tactics are generally considered to be more mainstream approaches to environmental activism, as opposed to extreme or violent methods of political action utilized by other environmental groups.

"THE TROUBLE WITH WILDERNESS"

The Sierra Club is widely known for its political activism with respect to environmental concerns, however, the organization (like many environmental organizations) is also important in shaping public perceptions and understanding of nature and society. For example, rhetoric used by the Sierra Club in its environmental campaigns and initiatives frequently refers to "wilderness" areas, protection of "wild places," and society's "connection to nature." Drawing upon its founder's conservationist vision, the Sierra Club advocates the creation and protection of public lands, wildlife refuges, and protected areas, where human impact on the physical environment is minimized or even eliminated.

Environmental efforts such as these have come under criticism from some scholars for their illusions of preserving an untouched, pristine nature. In his essay "The Trouble with Wilderness; or, Getting Back to the Wrong Nature," for example, William Cronon claims that this appeal to save an external, good, and untouched nature (that of "wilderness") creates and reinforces views of nature as an idea or object that is external to humans and society. This has reinforced a romantic nature/culture dichotomy that actually inhibits the environmental movement through its portrayal of humans as the very enemy from which nature must be protected. At the same time, that which is not wilderness (such as the urban landscape) becomes less important in the environmental protection movement.

Cronon's claims have been refuted by the Sierra Club and other scholars, including Bill Willers. In his essay, "The Trouble with Cronon," Willers argues that Cronon fails to recognize the "biological significance of wilderness" and the "philosophical truth" of nature's inherent right to exist. As such, the group disagrees with the critique of the Sierra Club's treatment of the environment and society posed by Cronon and others. The Sierra Club has continued to wage successful battles against environmental degradation and pollution in various political arenas, from national to local levels, in both "wild" and urban places, and is an important force in environmental policy making.

GLOBAL POPULATION DEBATES

The Sierra Club has also received attention and criticism regarding its global population and environment program. Currently, the Sierra Club's population program includes the promotion of family planning initiatives around the world and public education about reducing individual consumption levels to decrease pressures on natural resources that occur with increasing population.

These programs became especially contentious with respect to immigration and migration in the mid-1990s when the Sierra Club voted not to take an official position on U.S. immigration policy. This decision came under heavy criticism from individuals and organizations that believe U.S. population growth, which is driven largely by immigration, should be controlled. Critics argued that if the Sierra Club did not take a position on U.S. immigration, the result was a *de facto* pro-growth policy in the United States. Because individual consumption levels are among the highest in the world in the United States, critics contend that population growth there has a particularly high impact on resource use and consumption worldwide. However, the club's immigration policy remains neutral on immigration as of 2006.

The Sierra Club's initiatives, campaigns, and programs vary widely from remote wildlife protection to stopping urban water pollution. From wilderness protection to immigration policy, an environmental group such as the Sierra Club concerns society in nearly every position. It has significantly shaped both public perceptions and public policy in the United States and beyond.

SEE ALSO: Environmental Organizations; Litigation, Environmental; Muir, John; Nature, Social Construction of; Overpopulation; Population; Preservation; Pristine Myth.

BIBLIOGRAPHY. William Cronon, "The Trouble with Wilderness: Or Getting Back to the Wrong Nature," in William Cronon, ed., *Uncommon Ground: Rethinking the Human Place in Nature* (W.W. Norton, 1995); Frederick A.B. Meyerson, "Immigration, Population Policy and the Sierra Club," *Population and Environment* (v.26/1, 2004); James D. Proctor, "The Social Construction of Nature: Relativist Accusations, Pragmatist and Critical Responses," *Annals of the Association of American Geographers* (v.88/3, 1998); Sierra Club, www.sierraclub.org (cited January 2007); B. Willers, "The Trouble With Cronon," *Wild Earth* (6, 1996); Ben Zuckerman, "The Sierra Club Immigration Debate: National Implications," *Population and Environment* (v.20/5, 1999).

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Sierra Leone

A CIVIL WAR (1991–2002) in Sierra Leone led to the deaths of tens of thousands of people and the displacement of around a third of the population. Since United Nations (UN) peacekeeping forces left Sierra Leone in 2005, the government has begun the recovery process. Internal political tensions, the tenuous political and economic situation in Guinea, and security issues with Liberia, however, threaten the stability of Sierra Leone. Even though the country has a wealth of natural resources that include diamonds, titanium ore, bauxite, iron ore, gold, and chromite, weak infrastructures make adequate exploitation of resources difficult.

Nearly seven percent of land area in Sierra Leone is arable; two-thirds of the work force is engaged in subsistence agriculture, which provides 49 percent of the Gross Domestic Product. Alluvial diamond mining accounts for almost half of export earnings, and bauxite mining has resumed operation. Participation in the International Monetary Fund's Poverty Reduction and Growth Facility program has helped to promote economic stability. With a per capita income of only $900, however, Sierra Leone is the 16th poorest county in the world. Some 68 percent of the population lives below the poverty line, and half the population is seriously undernourished. Great income disparity exists in Sierra Leone, which ranks 62.9 on the Gini index of inequality. The richest 10 percent of society holds 43.6 percent of all wealth, with the poorest 10 percent sharing only 0.5 percent. The UN Development Programme's Human Development Reports rank Sierra Leone 176 of 232 countries on overall quality-of-life issues.

Bordering on the North Atlantic Ocean, Sierra Leone has a coastline of 402 kilometers and 120 square kilometers of inland water resources. The land is comprised of a coastal belt of mangrove swamps that give way to wooded hills and an upland plateau with mountains in the east. Elevations range from sea level to 1,948 meters at Loma Mansa. The tropical climate is hot and humid with distinct seasons. Sierra Leone is one of the wettest places in coastal west Africa, experiencing as much as 195 inches of rainfall per year. The summer rainy season from May to December is followed by a five-month dry season. Sierra Leone is subject to sand and dust storms; from December to February, the harmattan—a hot, dry, sand-laden wind—blows in from the Sahara Desert, creating massive environmental damage.

Like most poor countries in Africa, Sierra Leoneans face major environmental health hazards. Some 43 percent of the population lack sustained access to safe drinking water, and 61 percent lack access to improved sanitation. Consequently, the population of 6,005,250 has a very high risk of contracting food and waterborne diseases including bacterial and protozoal diarrhea, hepatitis A, and typhoid fever, the water contact disease schistosomiasis, and Lassa fever, which is contracted from contact with contaminated aerosolized dust and soil. In some areas, the risk is high for contracting vectorborne diseases such as malaria and yellow fever. An HIV/AIDS adult prevalence rate of seven percent is also causing major concern. Some 170,000 Sierra Leoneans have this disease, which has killed 11,000 people since 2001.

High disease incidences have produced a lower-than-normal life expectancy (40.22 years) and growth rate (2.3 percent), and higher-than-normal infant mortality (160.39 deaths per 1,000 live births) and death rates (23.03 per 1,000 population). The fact that only 20.5 percent of adult females and 39.8 percent of adult males can read and write English, Mende, Temne, or Arabic makes it difficult to disseminate health information, contributing to the high fertility rate of 6.5 children per female.

As the population has increased, intense pressure has been placed on Sierra Leone's environment. Overharvesting of timber, expanding grazing areas, and slash-and-burn agriculture has produced deforestation at a rate of 2.9 percent per year, threatening the ecological balance of the environment and posing great risks to wildlife. Agricultural mismanagement has led to soil exhaustion, and overfishing has damaged the marine systems and threatened food supplies. The years of war have taken an enormous toll on Sierra Leone's natural resources. Likewise, the mining industry has done considerable damage to the environment, accelerating levels of land degradation, soil erosion, and water pollution.

In 2006, a study by scientists at Yale University ranked Sierra Leone 111 of 132 countries on environmental performance, in line with the relevant geographic group and slightly above the relevant income group. The overall ranking was reduced by the low score on environmental health. The government has protected only 2.1 percent of land area in Sierra Leone, and hunting has continued to reduce wildlife populations, even in national parks. Of 147 identified mammal species, 12 are endangered, as are 10 of 172 bird species.

In 2000, Sierra Leone passed the Environment Protection Act and charged the Minister of Lands, Housing, Country Planning, and the Environment with planning, implementing and enforcing environmental laws and regulations that are aimed at sustainable development and conservation of resources. The ministry faces the daunting task of protecting Sierra Leone's environment from further damage in the midst of renewed economic activity in the post-war years. Sierra Leone is a participating party in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, and Wetlands. The agreement on Environmental Modification has been signed but was not ratified.

SEE ALSO: Deforestation; Disease; Mining; Wars.

BIBLIOGRAPHY. Central Intelligence Agency, "Sierra Leone," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Sierra Leone," hdr.undp.org (cited April 2006); World Bank, "Sierra Leone," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Silicosis

SILICOSIS BELONGS TO the family of occupational diseases called the pneumoconioses, in which dust in the industrial environment enters the lungs and, over the course of years or decades, deprives the tissues of their functional capacity, saps immune protection, and in many cases kills the victim. In the case of silicosis, the disease agent is silica dust. Deprived of lung function, many victims are too debilitated to continue their jobs or perform daily tasks.

A variety of occupations have been associated with silicosis; any job that exposes workers to fine, powdered quartz crystals places them at risk. The World Health Organization reports that 24,000 Chinese workers died of silicosis each year between 1991 and 1995. Affected workers in one industry in India had an average age at death of 35. One-quarter of people involved in hand-digging wells in one Brazilian state developed silicosis. The U.S. Department of Labor estimates that one million American workers are exposed to silica dust; one-tenth of those experience acute exposure through sandblasting, rock drilling, and mining. Fifty-nine thousand Americans actually develop silicosis and 300 die each year. Silicosis is incurable and irreversible, and lung condition typically continues to degenerate after exposure ceases.

This disease of the industrial environment has reflected and helped shape relationships among individual workers, technology, industry, medicine, and government in the United States for over 100 years. The growing mechanization of industrial processes in the late 19th century increased production but also the amount of dangerous dust generated in many occupations. One of the most scandalous incidents in the history of occupational disease was the cover-up by Union Carbide of the deaths of hundreds of African-American workers from acute silicosis while digging a tunnel at Gauley Bridge, West Virginia, in 1935. (The acute form of silicosis can develop in a matter of weeks.)

In the 1930s, thousands of families went to court to seek compensation for silicosis victims—just when the Depression left them vulnerable to job loss and dependent on compensation as a means of income. By 1936, however, new laws shifted responsibility for determining compensation to disability review boards, which tended to deny many workers an award. Meanwhile, labor laws required the use of respirators in dusty occupations and limited the concentrations of dust permitted in the work environment.

Despite seemingly appropriate regulations silicosis remains a serious hazard in many of the older occupations and in some new and growing ones worldwide. In recent decades in the United States, regulators and industry have struggled over standards on environmental dust. In the 1970s the U.S. National Institute of Occupational Safety and Health (NIOSH) determined that neither respirators nor existing environmental standards were sufficient to protect workers from silicosis; growing numbers of sandblasters employed by industries in the Sunbelt, including many young Latinos, were developing the disease.

Industry groups blocked proposed new standards in the early 1980s, when the pro-businesses Ronald Reagan presidential administration weakened federal labor agencies. NIOSH was finally able to tighten standards in the late 1990s just as new cases among miners, and a possible link to cancer, were coming to light. In addition, the threat of employee tort actions and calls to ban some kinds of sandblasting are likely to affect industry and workers for the foreseeable future.

SEE ALSO: Cancer; Center for Disease Control; Disease; Green Production and Industry; Litigation, Environmental; Mining; World Health Organization.

BIBLIOGRAPHY. Steven Kroll-Smith, Phil Brown, and Valerie Gunter, *Illness and the Environment: A Reader in Contested Medicine* (New York University Press, 2000); National Institute for Occupational Safety and Health, "Preventing Silicosis" (October 1996), www.cdc.gov/niosh (cited April 2006); David Rosner and Gerald Markowitz, *Deadly Dust: Silicosis and the Politics of Occupational Disease in Twentieth-Century America* (Princeton University Press, 1991); World Health Organization, "Silicosis" (May 2000), www.who.int (cited April 2006).

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Simon, Julian (1932–98)

JULIAN LINCOLN SIMON was an economist and professor of business administration at the University of Maryland who is best known for challenging some widely held public beliefs with respect to population growth and environmental change. His beliefs were that humanity had the ability to provide resources and means of survival for a continually growing global population indefinitely. Arguing from an economics-based framework, Simon held that increasing efficiencies of production would answer most needs for increased future demands and activists who held a particular political agenda had deliberately misled the public understanding of putative environmental disaster. As a result of this perspective, Simon found his work praised by libertarians and others who maintain that environmental pollution and climate change are not really happening.

Simon's reputation was established as a result of making his case directly to the public, bypassing his fellow economists, who were almost uniformly unimpressed with the level of his arguments. He initially supported the idea that population growth should be limited internationally, particularly in less-developed countries, because future demand for resources would not be sustainable. This followed orthodox thinking derived from the original conception of Thomas Malthus (1766–1834). However, he subsequently changed his mind and became known as an optimist and a contrarian who challenged what he considered wrongly accepted public knowledge.

He won a public wager with Paul Ehrlich, who was a leading light of the pessimist school of thought. The wager, in 1981, concerned the change in price of a combination of five different minerals over the subsequent decade. Ehrlich maintained that increased demand and resource depletion would cause the prices to rise. However, increased production capacity and efficiency meant the composite price decreased to less than half the original by 1990.

Despite winning the wager, Simon and those who agreed with him largely lost the public debate. Although he was able to demonstrate that the quality of human life had increased greatly over the previous two centuries, the prevailing mood of public opinion was that this was not sustainable in the future and that evidence of pollution, environmental degradation, and climate change demonstrated that current expenditure of scarce resources would lead to future scarcity. His reputation is likely to rest on the quality of his empirical investigation and his investigative methods, rather than any genuine contribution to scientific knowledge.

SEE ALSO: Ehrlich, Paul and Anne; Malthus, Thomas; Overpopulation; Population.

BIBLIOGRAPHY. Dennis A. Ahlburg, "Julian Simon and the Population Growth Debate," *Population and Development Review* (v.24/2, 1998); Bjorn Lomborg, *The Skeptical Environmentalist* (Cambridge University Press, 2001); Julian Simon, *The Ultimate Resource 2* (Princeton University Press, 1998); Julian Simon, *Hoodwinking the Nation* (Transaction Publishers, 1999).

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Sinclair, Upton (1878–1968)

UPTON SINCLAIR (1878–1968) was a prolific American author and social activist who made many unsuccessful bids for election to public office. He is best known for his early work *The Jungle* (1906), which exposed many abuses and scandals in the meat-packing industry and was instrumental in bringing about the Pure Food and Drug Act of the same year and greatly raised public interest in the industry.

Sinclair was motivated through his life by socialist ideals, which he wished to bring to fruition in American politics. However, his success in this regard was very limited as vested establishment interests mobilized strong media campaigns to label him a communist and his policies fanciful or dangerous. The closest he came to winning office was after moving from New York to California following his abandonment by his first wife and his campaign for election to the governorship of that state in 1934 in a race notable for its early use of media technology. Sinclair gained support from the Democrat Party for his campaign to end poverty in the state, which was then an issue of considerable importance. His other campaigns were run under the aegis of the Socialist Party. Having been defeated in 1934, he retired from the political arena and devoted himself to writing and promoting the various ideas he supported.

Not having an elected position, he was able to explore certain eccentric or nonstandard opinions in areas such as the use of psychic abilities and the benefits of prohibition. However, the majority of the approximately 90 books he wrote concern the need to promote the social welfare of the working people of America. These needs were explored through a variety of perspectives, notably in the case of the extensive Lanny Budd series of 11 novels, the third of which (*Dragon's Teeth*) won the 1943 Pulitzer Prize.

However, his work is largely disregarded in modern times, with the exception of *The Jungle*. This novel featured the tragic lot of the working people of the industry but the humanitarian element was lost in the public hubbub over food preparation conditions. Sinclair looked upon this book, therefore, as something of a failure. It is comparable to Robert Tressell's *The Ragged Trousered Philanthropists* in its depiction of the lowering of human dignity and the debasing of the work ethic among skilled and motivated workers caused by uncaring and unethical management.

Sinclair is generally portrayed as something of a holy fool, with passionate feelings and a desire to do good, but lacking awareness of human frailty that would have informed more successful political attempts. While this is somewhat unfair, his enthusiasms and his energy in describing them in print have led to his taking an iconic and not entirely flattering role in 20th century American history.

SEE ALSO: Food and Drug Administration (U.S.); Meat; Poverty; Socialism; United States, California.

BIBLIOGRAPHY. Anthony Arthu, *Radical Innocent: Upton Sinclair* (Random House, 2006); Upton Sinclair, *Dragon's Teeth* (Simon Publications, 2001); Upton Sinclair, *The Jungle: The Uncensored Original Edition* (See Sharp Press, 2003); Robert Tressell, *The Ragged Trousered Philanthropists* (Hard Press, 2006).

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Singapore

FOUNDED AS A British colony in 1819, Singapore became part of the Malaysian Federation in 1963. Two years later, Singaporeans opted to become independent. In the 21st century, Singapore is a thriving economy with a real growth rate of 5.7 percent and a per capita income of $29,900, making this southeastern Asian nation the 25th-richest country in the world. Governed under a "dominant-party" system that many have argued is somewhat repressive and undemocratic, public environmental movements in Singapore have only recently begun to emerge. Made up of the main island of Singapore and 60 islets, the country is surrounded by 120 miles (193 kilometers) of coastline that borders the Singapore, Main, and Jahore Straits.

Singapore has two distinct monsoon seasons that last from December to March in the northeast and from June to September in the southwest. With frequent thunderstorms occurring in the afternoon and early evening, Singapore's climate varies from tropical to hot, humid, and rainy. The terrain is made up of lowlands and central plains that provide a water catchment area and a nature preserve. Singaporeans enjoy a high standard of living. As a result, the United Nations Development Programme Human Development Reports rank Singapore 25th in the world in overall quality-of-life issues.

The country's only natural resources are fish and deepwater ports, and less than 2 percent of the land is arable. Consequently, the entire population of Singapore is urbanized. There are 122 passenger cars in Singapore for every 1,000 people. Between 1980 and 2002, the carbon dioxide emission rate per metric ton rose from 12.5 to 13.8. By the beginning of the 21st century, Singapore was generating 0.3 percent of the world's total of carbon dioxide emissions. The Singaporean economy is almost entirely dependent on electronics and manufacturing exports and the tourist industry to support the population of 4,492,150 people. However, an outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003 scared thousands of tourists away.

Because of the densely populated, heavily industrialized makeup of Singapore, environmental problems are similar to those in other highly industrialized nations. The environment is chiefly threatened by industrial pollution and improper waste disposal. Due to a lack of naturally occurring potable water, Singapore imports water from Malaysia. Forest fires in nearby Indonesia, which blanket Singapore with a seasonal smoke haze, are also of major environmental concern in Singapore. Singapore has no forests; the lack of land for development results in only 5 percent of the land being protected by the government. Of 85 endemic mammal species, three are endangered, as are seven of 142 endemic bird species.

The Singaporean government has established the Singapore Green Plan, a 10-year plan to promote sustainable development, under the leadership of the Ministry of the Environment. The ministry oversees the implementation and enforcement of environmental laws that range from regulating waste and hazardous materials disposal to pollution control and public health. Approximately 24 environmental laws have been passed in Singapore since the 1960s in the areas of environmental health, water pollution control, clean air, toxic and hazardous waste disposal, petroleum storage and transportation, air pollution, pesticide use, infectious disease control, radiation protection, land use, nature conservation, wildlife protection, and national parks. Amid growing environmental awareness in the mid-1990s following the Earth Day Summit of 1992, the privately funded Singapore National Council on the Environment evolved into the Environment Council and attained prominence with an articulated mission of promoting "Green Consciousness."

Singapore's commitment to the global environment has been demonstrated by participation in the following international agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Ship Pollution.

SEE ALSO: Carbon Dioxide; Tourism; Urbanization; Waste, Solid.

BIBLIOGRAPHY. Asia-Pacific Centre for Environmental Law, "Report: Singapore," sunsite.nus.edu.sg/apcel (cited April 2006); Central Intelligence Agency, "Singapore," *The World Factbook*, www.cia.gov (cited April

The Botanic Gardens

The Botanic Gardens in Singapore were initially established on Government Hill (now Fort Canning Hill) in 1822 by Stamford Raffles, the founder of the British colony there. At first, the aim was to develop a place that would help with the cultivation of nutmeg, clove, and cocoa. This first garden only lasted for seven years, and in 1859, a new botanic garden was established on Cluny Road, where it remains today.

Covering 129 acres (52 hectares), the Botanic Gardens have been open to visitors since their creation, and have been visited by botanists from around the world. Marianne North, the famous British botanical painter, spent January and February 1876 there. Henry Ridley was the director of the gardens from 1888 until 1911. It was there that he was involved in establishing rubber trees that later came to dominate the economy of Malaya (modern-day Malaysia). Ridley was succeeded by Isaac Henry Burkill, who wrote extensively about botany in the region. During the Japanese occupation of Singapore in World War II, the Japanese maintained the gardens. The gardens are now one of the major tourist sites in Singapore.

2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); United Nations Development Programme, "Singapore," hdr.undp.org (cited April 2006); World Bank, "Singapore," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006).

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Sinks (Biogeochemical)

BIOGEOCHEMICAL SINKS ARE geographical locations that hold in position certain chemicals, specifically gases, for extended periods of time. Sinks are particularly important in capturing greenhouses gases such as carbon dioxide and methane, and removing them from the atmosphere. Research is conducted to determine a sink's method of operation and, ultimately, how sinks may be manipulated or even created.

Gases within the earth's atmosphere are constantly in motion. The global atmosphere is in a state of dynamic equilibrium, in which constant change within the system is balanced by overall stability of the component parts. The sources and sinks of greenhouse gases remain in equilibrium in the atmosphere. Should one increase or decease, then the equilibrium changes until a new balance can be restored. The burning of fossil fuels and other industrial and commercial activities have caused greenhouse gases to increase in quantity and proportion in the atmosphere and have exceeded the ability of existing sinks to contain them. Consequently, the atmosphere is proceeding through a process of turbulence or disequilibria, which is quite different from any in recorded history.

The sinks for carbon dioxide (CO_2) include the surfaces of the oceans and natural vegetation. The oceans sequester approximately 92Gt (gigatons) of carbon from the atmosphere annually, and forests remove 61Gt of carbon annually through photosynthesis. The destruction of rain forests through over logging has significantly degraded the ability of remaining vegetation to accept carbon. Increased use of fertilizers has promoted vegetation growth in some parts of the world, but this has been insufficient to replace what has been cut down. The principal methane sink is provided by the chemical reaction with hydroxyl radicals (OH), which takes place in the troposphere. It is estimated that this process removes some 445MT (megatons) of methane from the atmosphere annually. However, this process is compromised by the concurrent reaction with carbon monoxide and from gases emitted by automobiles. The more that cars and other vehicles are used, the less methane is absorbed in the atmospheric sink.

Nitrous oxide (N_2O) also has an atmospheric chemical reaction as a principal form of sink. As in the case of other halocarbon gases released into the atmosphere, the exact nature and quantification of the effects of other forms of sinks has not yet been fully documented. The complexity of interactions within the atmosphere and with the earth mean there is a real need for baseline data to understand the role and significance of sinks. However, the rate of change of such conditions makes it very difficult to obtain that data.

SEE ALSO: Atmosphere; Carbon Dioxide; Methane; Nitrogen Oxides.

BIBLIOGRAPHY. Christopher B. Field and Inez Y. Fung, "The Not-So-Big US Carbon Sink," *Science* (v.285/5427, 1999); Andrew White, Melvin G.R. Cannell, and Andrew D. Friend, "CO2 Stabilization, Climate Change and the Terrestrial Carbon Sink," *Global Change Biology* (v.6/7, 2000).

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Slovakia

IN CONJUNCTION WITH the Czechs, the Slovaks were part of the nation of Czechoslovakia from 1918 until 1993, when the two countries once more established their separate identities. Since then, major progress has been made in Slovakia's recovery from the decades spent as part of the Soviet bloc. Unemployment remains high at 15 percent but the entire population has access to safe drinking water and improved sanitation. Ranked 64th in world income, Slovakia has a per capita income of $15,700. In 2004, Slovakia joined the European Union (EU). The United Nations Development Programme Human Development Reports rank Slovakia 43rd on overall quality-of-life issues.

The landlocked country has a temperate climate with cool summers and cold, humid winters. The central and northern parts of Slovakia are mountains, while the south is made up of lowlands. Significant geographic features include the Tatra Mountains in the north and numerous scenic lakes and valleys throughout the country. One of Slovakia's most valuable assets is arable land (30 percent). Other natural resources include brown coal, lignite, salt, antimony ore, mercury, lead, zinc, and small amounts of iron ore, copper, and manganese.

Slovakia's major environmental risks are air, water, and soil pollution that are by-products of industrial activity that includes brown coal mining, metal working, and chemical, fertilizer, and plastics plants. The pollution from these industries poses serious risks to Slovakia's population of 5,431,363 people. Roughly 58 percent of Slovaks live in urban areas, and Slovakia produces 0.2 percent of the world's carbon dioxide emissions. In 2006, a study by scientists at Yale University ranked Slovakia 25th out of 132 countries in environmental performance, below its geographic group but higher than the relevant income group. Slovakia's lowest ranking in the study was in the field of biodiversity and habitat. Acid rain is threatening Slovakian forests and threatening wildlife. Of 85 mammal species endemic to Slovakia, nine are threatened with extinction. Likewise, four of 199 endemic bird species are endangered.

A good deal of controversy has arisen in Slovakia over the Gabcikovo Dam project that diverts water away from the Danube River. Czechoslovakia and Hungary initiated the joint project in 1977 with the intention of damming the Danube from Bratislava to Budapest to generate hydroelectric power. In 1989, however, Hungary unilaterally withdrew from the project because of ecological concerns. When it proved impossible to come to terms, Slovakia turned to the International Court of Justice, which ruled against Hungary on September 25, 1997, contending that the original agreement was binding even though Czechoslovakia had been dissolved.

The Minister of Environment is responsible for implementing environmental policy in the Slovak Republic, and the Environmental Inspectorate oversees compliance with relevant laws and regulations. Controlling waste products is essential to controlling pollution in Slovakia, and current policy is designed to prevent further pollution, promote waste utilization and recycling, control the transportation of waste, and update existing waste disposal sites. The Slovak military has been responsible for a good deal of the pollution in Slovakia as a result of improperly disposing of dangerous and hazardous wastes. Therefore, new environmental laws apply equally to the military and civilian sectors. Other policies are aimed at reducing air, water, and soil pollution.

Slovakia's commitment to global health is demonstrated through participation in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution-Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands.

SEE ALSO: Acid Rain; Dams; Danube River; Industrialization; Pollution, Air; Pollution, Water; Privatization.

BIBLIOGRAPHY. Central Intelligence Agency, "Slovakia," *The World Factbook,* www.cia.gov (cited May 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Luboinir Kusnir, "Environmental Program in the Slovak Armed Forces and in the Slovak Republic," www.nato.int (cited May 2006); Slovakia.org, "Gabcikovo Dam Dispute," www.slovakia .org (cited May 2006); United Nations (UN) Development Programme, "Human Development Reports: Slovakia," hdr.undp.org (cited May 2006); UN Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Slovakia," *Little Green Data Book,* lnweb18.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited May 2006).

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Slovenia

HISTORICALLY PART OF the former Federation of Yugoslavia, the Republic of Slovenia won its independence in 1991 with a 10-day war. Political and economic ties to the West have been strengthened since that time through membership in the North Atlantic Treaty Organization (NATO) and the European Union (EU). Bordering on the Adriatic Sea, Slovenia has a coastline of 28.9 miles (46.6 kilometers). The climate is Mediterranean along the coast. Elsewhere, the continental climate produces mild to hot summers and cold winters in the plateaus and the valleys of the Alps. Slovenia is vulnerable to both flooding and earthquakes. Natural resources include lignite, coal, lead, zinc, mercury, uranium, silver, hydropower, and forests.

With a per capita income of $20,900, Slovenia's economic status is more in line with Western Europe than with other former communist countries. In March 2004, Slovenia made history by becoming the first transitional country to move from borrower status to donor partner in the World Bank. Despite an unemployment rate of around 10 percent, the Slovenian economy continues to grow as privatization efforts move forward. However, government corruption and unusually close ties between government and the business and banking sectors affect Slovenia's status in the EU. The United Nations Development Programme Human Development Reports rank Slovenia 26th in overall quality-of-life issues, the highest ranking for any transitional country.

Environmentally, Slovenia's most serious problems concern domestic and industrial waste in the Sava River and heavy metals and toxic chemicals in coastal waters. Because metallurgical and chemical plants have produced acid rain, there is also considerable damage to forests near Koper. Some 51 percent of Slovenia's 2,011,070 people reside in urban areas. With 438 cars per 1,000 people, Slovenia produces 0.1 percent of the world's emissions of carbon dioxides. In 2006 a study conducted at Yale University ranked Slovenia 31st of 132 countries on environmental performance, below both the relevant income and geographic group averages. The lowest score was in the area of biodiversity and habitat. The Slovenian government has protected 6 percent of the land. Of 201 bird species endemic to Slovenia, only one species is in danger of extinction. On the other hand, nine of 75 endemic mammal species are endangered.

Environment Indicator Net has ranked Slovenia on a number of environmental issues, determining that the country has made the most progress in controlling air pollution caused by nitrogen oxide and sulfur dioxide. Slovenia has not been so successful in controlling ozone depletion and pollution from particulate matter. More progress has been made in emissions control. Slovenia has cut down on emissions of nitrogen oxide, sulfur oxide, and ammonia but has failed to cut emissions of nonmethane volatile organic compounds significantly.

In the area of water pollution, Slovenia has reduced phosphates in lakes but still has work to do on improving the quality of drinking water and maintaining the proper ecological balance of rivers. Accidental oil spills continue to cause major ecological problems. Slovenia has not been successful at controlling the use of mineral fertilizers or in promoting the use of plant protection products. While Slovenia is still generating unacceptable amounts of hazardous waste, improvements have been made in disposal and trans-boundary transporting of such wastes.

The Slovenian National Assembly has passed a number of significant environment laws, including the Environment Protection Act, the Waters Act, the Nature Conservation Act, the Management of Genetically Modified Organisms Act, and the Act on Protection against Ionizing Radiation and Nuclear Safety. The Ministry of Environment is responsible for implementing all environmental laws and regulations in Slovenia.

Slovenia's commitment to the global environment is demonstrated through its participation in the following agreements: Air Pollution, Air Pollution–Sulfur 94, Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. The government has signed but not ratified the agreement on Air Pollution–Persistent Organic Pollutants.

SEE ALSO: Acid Rain; Carbon Dioxide; Oil Spills; Ozone and Ozone Depletion; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Central Intelligence Agency, "Slovenia," *The World Factbook,* www.cia.gov (cited May 2006); Environmental Indicators Net, "Kazalci okoljav Sloveniji," eionet-si.arso.gov.si (cited May 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Environment, "Environment," www.gov.si (cited May 2006); United Nations Development Programme, "Human Development Reports: Slovenia," hdr.undp.org (cited May 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Slovenia," *Little Green Data Book,* lnweb18.worldbank.org (cited May 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited May 2006).

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Slow Food Movement

SOCIAL CRITICS ARGUE that we live in a "runaway world" of "fast capitalism." Accelerating market forces homogenize cultures at the global scale, while prompting reactionary resistance from traditional communities at the local scale. The Slow Food Movement (SFM) resists the homogenizing effects of globalization. It does so by promoting local foods, flavors, and cultures in a way that promotes social equality and environmental sustainability.

Slow food can be explained by defining its opposite. Because companies need to preserve global brand identity, fast food has to be highly processed and laden with artificial ingredients to ensure it tastes the same regardless of where it was purchased. The need for product standardization also forces change on farms, manufacturing processes, and the scale of the agrifood system. Locally-produced foods are hard to find. The average carrot travels 1,800 miles from the farm to a Chicago consumer.

Proponents of industrial agriculture argue that it produces abundant, low-cost food. Fast food has geopolitical significance as well. It has been said that there has never been a war between two countries that both host McDonald's. A country embracing open markets will spur middle class expansion and fast food consumption. Open markets also reduce middle class support for wars because people fear financial loss. Hence, the economic system that produces food for McDonald's also secures peaceful coexistence between countries.

There are costs, though, to this industrialized agrifood system. It requires petrochemicals that pollute the environment. Fast food has high fat content and is consequently not healthy. It also contributes to the erosion of familial and community relationships because it replaces home-cooked, sit-down meals eaten with family. Also, the need for food product standardization necessarily marginalizes and even destroys local food traditions. Some argue that this homogenization is nothing short of cultural imperialism as Western foods and cultural practices are forced onto non-Western societies.

The SFM originated in the piedmont region of northern Italy in 1986 to counter globalization, especially as expressed through fast food. Its 83,000 members from 100 countries embrace the principle of slowing down and taking time to celebrate local food, wines, and culture. The SFM gradually adopted a political voice, however, as its leaders recognized that they could only preserve small-scale farming, artisanal food production, and local cultures through overt political action.

SFM philosophy borrows from the French idea of *terroir,* which describes how the unique geography of a place is reflected in the local wines. Similarly, SFM philosophy holds that traditional foods produced in a region reflect the sense of place of that

With today's industrial agriculture, the average carrot will travel 1,800 miles from the farm to a Chicago consumer.

region. Paradoxically, the SFM is a global effort to preserve local culture and agriculture.

It is important to note that values such as the desire to preserve small-scale farms, to promote biodiversity and environmentally sustainability, and to enjoy eating locally-grown foods are not unique to the SFM. Rather, the SFM should be seen as just one response to globalization.

The community-supported agriculture (CSA) movement developed contemporaneously with the SFM during the latter half of the 20th century. In its simplest form, a CSA is a small farm that grows vegetables, fruits, herbs, and other commodities. Each spring the farmer sells subscriptions or shares to families who essentially form a consumer cooperative. The farmer takes the subscription money and purchases seeds and other materials needed for planting. Each week during the growing season, subscribers receive a basket of seasonally-appropriate produce. This model enables the farmer and the subscribers to share the risks of a bad growing seasons and the bounty of a good one.

CSAs and the SFM both promote small-scale farming, biodiversity, sustainable agriculture, fresh food, and a sense of community. Because they also represent local, peaceful, and progressive responses to globalization, CSAs and the SFM counter the idea that peaceful coexistence only occurs by embracing fast capitalism and the agrifood system that produces fast food.

SEE ALSO: Fast Food; Globalization; Green Consumerism; Green Production and Industry; Organic Agriculture; Sustainability.

BIBLIOGRAPHY. Ben Agger, *Fast Capitalism* (University of Illinois Press, 1989); Patricia Allen, *Together at the Table: Sustainability and Sustenance in the American Agrifood System* (Penn State University Press, 2004); Thomas Friedman, *The Lexus and the Olive Tree: Understanding Globalization* (Anchor Books, 1999); Anthony Giddens, *A Runaway World: How Globalization is Reshaping our Lives* (Routledge, 2000); Vandana Shiva, "Terra Madre v. Terra Nullius," *Slow, Herald of Taste and Culture* (v.51, 2005).

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Smallholders

SMALLHOLDERS ARE A large and diverse group of farmers found throughout the world who depend on small plots of land for their survival. The term is widely used but not easy to define because arbitrary size categories do not fit varying environments and cultures. Generally, smallholder agriculture is associated with farming in the developing world. Family or household units commonly carry it out on land that is owned or worked, and it is often characterized by a high proportion of subsistence production.

In the developing world, smallholders constitute the most common agricultural production unit. As such, they are critical for food production not only because of the way they support large rural populations, but also because their surplus production finds its way to markets both locally and globally. Smallholders can be found on land that they own themselves, on communally held land that is allocated to them, or on land rented from landlords. Smallholders may be a relic of past peasant and communal systems, now existing as tenants or right holders, or they may be the consequence of recent forms of rural transformation, such as government resettlement schemes or clearing of forest by new settlers. Smallholders can span an enormous range of livelihoods, from some of the most severe forms of rural poverty, to quite prosperous small farms. They are found throughout the developing world, from the paddy fields of southeast Asia, to maize plots in central Africa, or to the new settlers in the Amazon Basin. There are even some similarities with smallholders in the developed world, those living on family farms.

Smallholder agriculture is characterized by intensive systems of farming with high inputs of household labor, though rarely of capital, and concentrated use of land. Because of the concern for household food production, diversity of agriculture is common, with a range of crops, trees, and some livestock usually in evidence. These household food crops may provide a small surplus for sale, though some smallholders may engage in specialist cash cropping perhaps at the expense of their own food needs. Some smallholding systems are more directly involved in commercial crop production, sometimes (as with sugar cane in Fiji) when linked to larger company or cooperative operations that may contract them to specialize in certain products and sometimes (as with coffee in Kenya) when selling on open commodity markets. In these circumstances, smallholders are successful and play a useful role because they bear the risks of market price fluctuations and because of their low costs of labor.

Despite predictions that smallholder systems will eventually disappear to be replaced by larger commercial farms and rural wage labor, smallholder agriculture has proved to be remarkably flexible and durable. The use of unpaid family labor and the concern for subsistence production means that smallholders can often withstand market and other shocks at times when purely commercial operations fail. It is common for smallholder households to be engaged in part in nonfarm activities, such as wage labor or petty trading, and this provides both supplementary cash income and a buffer against fluctuating returns from agriculture. In addition, smallholder systems are useful in absorbing population growth. With the centrality of family and kin in their organization, smallholders can usually provide some form of livelihood for increasing numbers of people by intensifying labor inputs and land use beyond the limits of what would be considered profitable.

There is a controversial relationship between smallholders and environmental degradation. On one hand smallholders are blamed for much environmental damage. Driven by poverty and desperation, smallholders are seen to contribute to problems such as soil erosion and declining soil fertility by cropping or grazing land too heavily, or to deforestation by clearing bush for pasture and gardens or setting fire to forests. On the other hand, smallholders in some parts of the world have carried out remarkably sustainable forms of agriculture for centuries, modifying the environment in many cases to provide water or protect soil fertility, but not greatly damaging associated landscapes or ecosystems. Unfortunately it is easy for governments to blame relatively powerless smallholders for environmental degradation when deeper causes and other agencies are at work. Smallholders may not form the most effective foundation for strategies seeking rapid agricultural development and modernization, but they are a successful and necessary basis for providing a basic livelihood for many millions of rural inhabitants.

SEE ALSO: Farmers' Markets; Farming Systems; Farmland Conservation; Land Degradation; Livelihood.

BIBLIOGRAPHY. Frank Ellis, *Peasant Economics: Farm Households and Agrarian Development* (Cambridge University Press, 1988); R.M. Netting, *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture* (Stanford University Press, 1993); Ian Scoones, Stephen Devereux, and Lawrence Haddad, "Introduction: New Directions for African Agriculture" *IDS Bulletin of Development Studies* (v.36/2, 2005); Richard L. Tinsley, *Developing Smallholder Agriculture: A Global Approach* (AgBe Publishing 2004).

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Smallpox

SMALLPOX IS AN acute infectious disease caused by the variola virus that has been responsible for more human deaths than almost any other agent in history. The disease was declared eradicated by the World Health Organization (WHO) in 1980 after the annual number of deaths dropped from around 50 million people in the 1950s to two million annually in the late 1960s to zero between 1977 and 1980 thanks to a program of vaccinations. The virus is kept in four secure laboratories around the world in case there is a need to restart production of vaccines, although stocks of vaccine sufficient to treat some 200 million people are maintained. This fact has given rise to some concern over the possible use of the virus in a future terrorist attack. Two infections are recorded in 1978 based at one of the laboratories, but there have been no further outbreaks to date.

Smallpox is recorded in history more than 3,000 years ago and well known individuals believed to have been killed by the disease include the Pharaoh Ramses V (d.1156 B.C.E.), Queen Mary II of England (1662–1702), Tsar Peter II of Russia (1813–51) and King Louis XV of France (1710–74). It is likely to have originated in India or Egypt and spread across most of the rest of the world. Epidemics flashed across continents on a regular basis and killed untold millions.

The fatality rate approached 30 percent and many of the sick were afflicted with numerous small scars, primarily on the face. The initial symptoms are a fever and then skin eruptions that pass through the stages of papule, vesicle, and pustule. This causes the scars, although the exact number and severity of these varies on a case-by-case basis. It is during the early feverish phase of the disease that it can be passed to another person. Fortunately, it is not a highly infectious disease. However, some people suffered a variola minor infection that left them able to continue functioning and hence able to spread the disease more widely. Smallpox was endemic in some societies to the extent that it was considered bad luck to name a child before it had survived the disease.

Smallpox unquestionably played some significant role in the European colonization of the New World. While exact numbers or proportions are hard to come by, death rates among indigenous Aztec of Mexico succumbing to the disease likely were far greater than those in previous European outbreaks, owing to the lack of immunity among New World native populations. Along with other diseases, moreover, smallpox left a very small labor force for European plantation, and so increased the incentives for the violent trans-Atlantic slave trade of following centuries.

The WHO reports a survey in Vietnam from 1898 that demonstrates that 95 percent of adolescents were pockmarked by smallpox and 90 percent of all cases of blindness were attributed to the disease. No effective treatment of the disease has been discovered, but Edward Jenner helped to indicate possible courses of action by inoculating with cowpox in 1798 and showing this prevented infection.

The capacity to create and implement programs of vaccination was slow to develop. It was not until the creation of the WHO in 1948 that it became possible to mount a truly global attempt to eliminate a problem that endangered the lives of 60 percent of the world's population. The eradication of the disease is one of the great achievements of international human cooperation. It required the adoption of a single, universal method of approach and a standardization of scientific methods.

SEE ALSO: Disease; Vaccination; World Health Organization.

BIBLIOGRAPHY. Herve Bazin, *The Eradication of Smallpox: Edward Jenner and the First and Only Eradication of a Human Infectious Disease* (Academic Press, 2000); Donald R. Hopkins, *The Greatest Killer: Smallpox in History* (University of Chicago Press, 2002); R. McCaa, "Spanish and Nahuatl Views on Smallpox and Demographic Catastrophe in Mexico," *Journal of Interdisciplinary History* (v.25/3, 1995); Zack S. Moore, Jane F. Seward, and J. Michael Lane, "Smallpox," *Lancet* (v.367, 2006).

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Smokey Bear

SMOKEY BEAR IS a mascot of the Forest Service of the U.S. Department of Agriculture (USDA) primarily directed at educating the public on the dangers of forest fires and the importance of fire control. While the Forest Service claims that the original Smokey Bear was a cub rescued from a New Mexico fire in 1950, the character was originally drawn and conceptualized by illustrator Albert Staehle for the USDA in 1944, following a number of experimental campaigns using woodland creatures and fearful images of devastating flames. The character was then redesigned for posters and countless uses by Rudy Wendelin, an employee of the USDA. A happy figure resembling a big teddy bear, Smokey Bear is a friendly inhabitant of the forest who asks children to respect nature and be cautious with fire. Sporting a ranger hat, a brass belt, and dungarees and carrying a shovel in his paw, Smokey Bear imitates a forest firefighter.

Smokey Bear allows the U.S. Forest Service to target youth with specific messages, giving children a part to play in the protection of wildlife, public lands in national forests, and grasslands. Although unknown outside the United States, the Smokey Bear character is seen by many Americans as a part of their popular culture and heritage and a symbol of fire prevention. Smokey Bear became so famous that several books were written about him with such titles as *Smokey Bear Saves the Forest* and *Smokey Bear's Camping Book*. A popular song, *Smokey the Bear*, was written by Jack Rollins and Steve Nelson in 1952. In the late 1960s, Smokey Bear earned his own animated cartoon series.

The popularity of the Smokey Bear character even created some copyright issues. In 1952, Congress passed an act to take Smokey out of the public domain and place him under the USDA. The Advertising Council licensed Smokey's image to private firms for memorabilia. At some point, the mascot received so much mail from children that the U.S. Post Office decided to give Smokey Bear the personal ZIP code of 20252. A new companion to Smokey Bear, Woodsy Owl, appeared in the 1970s, with his own slogan: "Give a hoot. Don't pollute." Both mascots appear from time to time in big events organized by the U.S. Forest Service. A commemorative stamp was issued for Smokey Bear's 40th birthday in 1984. Not surprisingly, Smokey Bear has his own Web site today.

The strong and central message of Smoky Bear has been made problematic, however, by changes in ecological theory. For seven decades, Smokey Bear repeated the slogan, "Only you can prevent forest fires" (reminiscent of Uncle Sam's slogan, "I want YOU for the U.S. Army"). This is in keeping with the fact that a majority of forest fire ignitions remain human-caused, including abandoned campfires and cigarettes thrown from cars. The tone of the campaign, however, has arguably led to the notion that all forest fire is inherently unnatural, an idea far out of step with current ecological science, now grounded in paleoecology and disequilibrium theory, as well as in the practical experience of both the Forest Service and the Park Service.

After 2000, Smokey's famous slogan was slightly changed to, "Only you can prevent wildfires," perhaps in deference to that more complex understanding. Generally, however, the Smokey Bear campaign is rooted in an era and management history of total fire control, one with less ecological and economic relevance now than it had in the mid-20th century.

SEE ALSO: Animals; Department of Agriculture (U.S.); Disequilibrium; Environmentalism; Fire; Forest Service (U.S.); Mass Media.

BIBLIOGRAPHY. Bill Adler, ed., *Letters to Smokey Bear* (Wonder Books, 1966); Elliott S. Barker, *Smokey Bear and the Great Wilderness: The Story of the Famous Symbol of Fire Prevention* (Sunstone Press, 1997); Kennon Graham, *Smokey Bear Saves the Forest* (Whitman, 1971); William Clifford Lawter, *Smokey Bear 20252: A Biography* (Lindsay Smith Publishers, 1994); Smokey Bear Act, www.symbols.gov (cited December 2006); "Story of Smokey," www.smokeybear.com (cited December 2006); U.S. Forest Service, www.fs.fed.us (cited December 2006).

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Smoking

THE CAUSAL RELATIONSHIP between cigarette smoking and the reduced health of active, as well as passive, smokers is well established. Global tobacco use causes nearly five million deaths per year, or one death every 6.5 seconds. Of the 1.5 billion regular smokers alive today, half are expected to die prematurely from tobacco-related disease, and half of them will do so between the ages of 35 and 69 years. Although the toll is somewhat less for nonsmokers exposed to secondhand smoke at home or work, their risk of developing lung cancer or heart disease is approximately 25 percent higher than that experienced by people who are not routinely exposed to secondhand smoke. Tobacco is the only consumer product that causes death to the primary and secondhand consumer when used as intended by its manufacturers.

Globally, about 15 billion cigarettes are sold daily, or 10 million every minute. One in five teens, aged 13–15 years, smoke. Roughly 100,000 children start smoking every day, half of whom live in Asia. Evidence shows that about half of the people who start smoking in adolescence will go on to smoke for the next 15–20 years of their lives. East Asia and the Pacific have the highest smoking rate, where nearly two-thirds of the male population smokes.

A vast majority of the world's smokers—900 million people (84 percent of the world's total)—live in developing and transitional economy countries. A directly proportional relationship between the lung cancer incidence rate and the cigarette consumption rate has been reported in data for 61 nations.

China is the world's largest consumer and producer of unmanufactured tobacco, producing roughly 2.2 million tons (two million metric tons) of dry weight tobacco annually, and consuming slightly more at 2.4 million tons (2.2 metric tons). Brazil is the second largest producer at about 880,000 tons (800,000 metric tons) but is a lower than average consumer. Brazil is followed by India at about 660,000 tons (600,000 metric tons), and the United States at 440,000 tons (400,000 metric tons). Both India and the United States exhibit a 20 percent approximate differential between what they produce and what they consume, with India consuming slightly less than they produce, and the United States consuming slightly more.

China is also the world's largest cigarette producer, producing roughly 30 percent of the cigarettes manufactured annually, followed by the United States at 13 percent, Japan at 4.5 percent, and Indonesia at 3.8 percent.

Although cigarette smoking was definitively linked to increased lung cancer risk in the 1950s, it was not until 1964 that the U.S. Surgeon General released a report stating that smoking causes cancer and other diseases. At that time, public health professionals proposed the logical hypothesis that reducing the exposure of smokers to particulate matter in cigarette smoke would reduce the risk of developing lung cancer. The report concluded that those smokers who were unable to quit should make every effort to lower their dose of tobacco smoke. Cigarette manufacturers initially responded to this new public perception of health risk by adding filters to cigarettes, and then offering filtered cigarettes that delivered less tar. The term *tar* is an industry-coined term used to describe the total particulate matter in smoke, minus the water and nicotine.

In order to evaluate objectively the tobacco industry's unsubstantiated health benefit claims made in the 1960s for low-tar cigarettes, the Federal Trade Commission (FTC) developed a method of testing cigarettes for their tar and nicotine content that was based on methods developed and used by the tobacco industry in the 1930s to compare cigarettes for developmental and manufacturing purposes. In 1970, the FTC proposed rules that would have required disclosure of tar and nicotine yields in advertising, and cigarette manufacturers agreed to voluntarily include FTC tar and nicotine ratings in advertising and even on some of the cigarette packaging. Unwittingly, the FTC provided the tobacco industry with a very persuasive marketing tool to reassure concerned smokers and provide them with an easier alternative to quitting smoking.

It is now known that the FTC method does not differentiate between the disease risk caused by different brands or types of cigarettes in any meaningful way, a fact made more poignant by the immediate and sustained popularity of the low-tar cigarettes upon their introduction to the public in the 1960s, which were coined "light" and "ultra-light" by the tobacco industry. Epidemiologic data gathered before and after the introduction of light and ultra-light cigarettes show no accompanying reduction in smoking-related disease. In fact, overall rates of lung cancer have increased, specifically

Eighty-four percent of the world's smokers live in developing and transitional economy countries.

in the deep airway adenocarcinoma type of cancer, suggesting that smoking such cigarettes may have actually increased the risk of some cancers.

Many cigarette smokers become addicted to nicotine and thus require dosing at levels that are high enough to satisfy cravings, but not so high as to cause acute noxious effects. Unlike the smoking machines used to generate the cigarette yield data for the FTC method, addicted smokers will adjust their smoking behavior to sustain their preferred level of nicotine intake; this behavior is called "compensatory smoking." Tobacco industry documents that were disclosed to the public as part of the United States's 1998 multi-billion-dollar tobacco industry settlement indicate that tobacco industry scientists specifically engineered cigarettes to facilitate compensatory smoking and ensure consumers could get much higher levels of tar and nicotine than indicated in their advertising. Three of these cigarette design features include: the use of chemical additives to increase the bioavailability of nicotine, burn accelerants that produce less smoke when the cigarette is smoked on slow-puffing machines versus faster-puffing humans, and virtually invisible ventilation holes that are not blocked by smoking machines, but unconsciously blocked by smokers, thus providing the smoker a higher dose of tar and nicotine than what is measured using the FTC method.

The World Health Organization's (WHO) Framework Convention on Tobacco Control (FCTC), developed in 2003 in response to the global tobacco epidemic, is charged with developing and implementing worldwide tobacco demand reduction strategies. The WHO's FCTC is one of the most widely endorsed treaties in United Nations history, ratified by more than 130 countries.

SEE ALSO: Carcinogens; Tobacco; World Health Organization.

BIBLIOGRAPHY. D.K. Hatsukami, J.E. Henningfield, and M. Kotlyar, "Harm Reduction Approaches to Reducing Tobacco-Related Mortality," *Annual Review of Public Health* (v.25, 2004); J. Mackay and M.P. Eriksen, *The Tobacco Atlas* (World Health Organization, 2002); K. Stratton, P. Shetty, R. Wallace, and S. Bondurant, *Clearing the Smoke: Assessing the Science Base for Tobacco Harm Reduction* (National Academic Press, 2001); Tobacco Control Research, *Monograph 13: Risks Associated with Smoking Cigarettes with Low Machine-Measure Yields of Tar and Nicotine* (2001); U.S. Department of Agriculture, *Tobacco: World Market Trade* (Foreign Agricultural Service, 2005); U.S. Department of Health, Education, and Welfare, *Smoking and Health: Report of the Advisory Committee to the Surgeon General of the Public Health Service* (DHEW Publication No. 1103, 1964); U.S. Department of Health and Human Services, *The Health Consequences of Smoking: A Report of the Surgeon General* (Office on Smoking and Health, 2004); U.S. Department of Health and Human Services, *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General* (Office on Smoking and Health, 2006); J. Wilkenfeld et al., "It's Time for a Change: Cigarette Smokers Deserve Meaningful Information About Their Cigarettes," *Journal of the National Cancer Institute* (v.92/2, 2000); World Health Organization, *WHO Framework Convention on Tobacco Control* (WHO, 2005); World Health Organization Framework Convention on Tobacco Control, *Facts and Figures About Tobacco* (WHO, 2006).

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Snail Darter and Tellico Dam

IN THE 1970s the Tellico Dam and the snail darter became the center of a legal battle that drew national attention. The Tellico Dam is located in Loudon County, Tennessee. It is an impoundment dam holding water for downstream use and does not produce electricity. It impounds the Tellico Reservoir on the Little Tennessee River, a tributary of the Tennessee River. The Tellico Reservoir flooded the Cherokee town sites of Chota, Tenasi (whose name was anglicized into the word *Tennessee*), and Tuskegee.

Many of the thousands of dams in America were built by federal agencies such as the Army Corps of Engineers, the Bureau of Reclamation, or the Tennessee Valley Authority (TVA). The Tellico Dam was built by the TVA, but was blocked from final development for several years by litigation. Litigation to block the building of the lake was based on the Endangered Species Act of 1973. When the law was passed, Congress expected that the law would protect bears, buffalos, endangered birds, or large animals. Nothing in the legislative history of the act suggested that it would apply to a tiny, obscure fish.

The snail darter (*Percina tanasi*) is a small perch-like freshwater fish. There are approximately 130 known species of darter that are native to North American streams. Some kinds are widespread, and others limited to a single stream. Several types of snail darter are native to the rivers and streams of eastern Tennessee. They grow to around 3.5 inches long (about nine centimeters) and feed on aquatic snails in clean gravel beds. Snail darters were first discovered on August 12, 1973, in the Little Tennessee by David Etnier, then an ichthyologist at the University of Tennessee in nearby Knoxville. At the time of the discovery he was doing research in connection with a lawsuit under the National Environmental Policy Act (NEPA). The fish was previously unknown in the area. At that time it was thought the snail darter only occurred in the Little Tennessee, which was about to be dammed. It was feared that this would cause its extinction. The snail darter soon became one of the most famous fish in America, because in January 1975, the Secretary of the Interior listed the tiny snail darter as an endangered species.

A suit was filed against the TVA by Hiram G. Hill, Jr. The basis of the suit was the Endangered Species Act of 1973. The Federal District Court took the case and eventually ruled against the TVA that the dam threatened the existence of the snail darter. The U.S. Supreme Court in *Tennessee Valley Authority v. Hiram G. Hill*, 437 U.S. (1978) decided that the District Court's decision to bar the dam from closing its doors and flooding the Little Tennessee, even at the cost of millions of dollars, was the proper interpretation of the Endangered Species Act. Eventually, the TVA successfully introduced the snail darter into the nearby Hiwassee (Hiawassee) River. The snail darter was later found in several other Tennessee streams, and in 1979 Congress exempted the Little Tennessee and the snail darter from the Endangered Species Act.

SEE ALSO: Dams; Endangered Species; Endangered Species Act (ESA); Locks and Dams; Rivers; Tennessee Valley Authority (TVA).

BIBLIOGRAPHY. Robert K. Davis, *Tellico Dam and Reservoir: A Report* (The Office, 1979); Shannon C. Petersen, *Acting for Endangered Species: The Statutory Ark* (University of Kansas Press, 2002); Jim Thompson, *Tellico Dam and the Snail Darter* (Spectrum Communications, 1991); William B. Wheeler and Michael J. McDonald, *TVA and the Tellico Dam, 1936–1979: A Bureaucratic Crisis in Post-Industrial America* (University of Tennessee Press, 1984).

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Social Capital

THOUGH THE CONCEPT has myriad slightly divergent definitions, social capital generally refers to the various investments and advantages obtained for individuals and groups through collective organization, action, and networking. Social capital is produced by collective community interactions. These networks are created at different scales from community and civic activity to the interaction at the family and friends. Like other forms of capital, social capital also has value. When people act together with shared objectives for their common good, both individual and collective benefits are achieved.

As a concept, social capital draws attention to the significance of social and symbolic resources in the maintenance and prosperity of communities and organizations. Though the processes involved are often disputed among social scientists, the concept has been widely adopted by national governments, international organizations and nongovernmental organizations (NGOs). Similar to concepts like sustainability, or globalization, the term *social capital* has become an elastic concept that lends itself to many issues and interest groups. Prudence should therefore be exercised in finding its application in research or guiding the formulation of social and environmental policy.

Although it is a relatively new term in the lexicon of social scientists, the ideas underlying the concept of social capital have established roots in social theory. Reference to the significance of associational life and relationships has long been studied by philosophers, sociologists and economists. Dispersed through the writings of Alexis de Tocqueville, John Stuart Mill, Alfred Marshall and George Simmel are frequent discussions on anomie, social networks, trust, and civic society.

Recent interest in social capital, however, can be almost exclusively related to the success of Robert Putnam's texts *Making Democracy Work* (1993) and *Bowling Alone* (2000), which are among the most highly cited works in contemporary social science. By offering a coherent explanation of social transformation and an effective model of political intervention particularly in terms of social policy, Putnam's work has become paradigmatic in terms of shaping a framework around which many social problems are investigated. Putnam argues that a decline in voter turnout, church going, membership in trade unions and political parties, and lower participation in voluntary organizations lead inevitably to social problems like poor education achievement, higher unemployment, crime, and even poor health. Growing individualism—created by the decline of community living—and increases in commuting, the proliferation of gated communities, urban deprivation, television, and the increased participation of women in the paid labor force have all variously been blamed for this phenomenon. Putman's communitarian construction stresses societal rather than individual benefits through social networks, norms, trust, and obligation that facilitate cooperation for mutual benefit. On the basis of this assumption, he argues that societies with high levels of trust and interpersonal networks experience more positive economic, political, and social development.

A less commonly used "critical" construction is derived from the works of the social theorist Pierre Bourdieu. It links social resources to networks of acquaintance and recognition. For Bourdieu, social capital emerges from other types of capital: social, cultural, and particularly economic, and is legitimized, realized, and essentially transformed into a resource that individuals and groups can use to achieve goals. So, for Bourdieu, it reinforces the prestige and power of certain individuals and groups over others. Social capital can also be exclusive and isolating to "others" through barriers to entry, whether these be financial or cultural. The critical approach does not assume that wealth produces greater social capital. Indeed, for example, in the wealthy a lack of social cohesion may be evident, thereby reducing levels of social capital.

Commentators have also reflected on who is excluded from the benefits of social capital. For example, shared identity and social cohesion undoubtedly supports collective action and member well-being. They also may exclude those, however, without the shared norms and identities and even put pressure on group members to conform; and hence can threaten the more vulnerable segments of marginalized communities. On a related note, understandings of groups, from both without and within, can reinforce their social hierarchies and positions in society. Hence, dominant groups—and especially their gatekeepers—continue to get more resources, power, and influence. For Bourdieu, individuals with high levels of economic and cultural capital are the people who want to know and benefit from being known.

For environmental issues and problems, social capital has become a conceptual tool for understanding how collective action or cooperation occurs for managing resources, especially common pool resources vulnerable to over-exploitation through individual behaviors. As Common Property Theorists have observed, many community-based systems exist around the world for the coordination of individual behaviors in support of mutual benefit, despite the pessimistic predictions laid out in the "Tragedy of the Commons" scenario. For example, systems of traditional forest, fisheries, or pasture management help maintain the productivity of resources by restraining over-exploitative or chaotic uses by individuals. The investments required to coordinate these activities, however, can be significant; social capital is understood, therefore, as essential for sustainable resource use, and its disintegration under conditions of political or economic change has been used as an explanation for land and water degradation.

SEE ALSO: Common Property Theory; Land Degradation; Tragedy of the Commons.

BIBLIOGRAPHY. P. Bourdieu, *Distinction: a Social Critique of the Judgment of Taste* (Routledge, 1979); P. Bourdieu, "The Forms of Capital," in J.G. Richardson, ed., *Handbook of Theory and Research for the Sociology of Education* (Greenwood Press, 1986); R.D. Putman, *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton University Press, 1993); R.D. Putman, *Bowling Alone: The Collapse and Revival of American Community* (Simon and Schuster, 2000).

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Social Darwinism

SOCIAL DARWINISM ASSERTS that humans compete with one another and all of the plant and animal inhabitants of the biosphere for dominance, and that dominance is ceded to the species and the members of that species who are the fittest and most capable of competing.

Though based in part on British naturalist Charles Darwin's theory of natural selection forwarded 30 years earlier in his 1859 *Origin of Species*, it was British Victorian biologist and social philosopher Herbert Spencer who coined the phrase "survival of the fittest." Spencer and the other leading 19th century promoters of social Darwinism, Walter Bagehot in Britain, and William Graham Sumner in the United States where the philosophy was more accepted, asserted that societies are organisms the evolution of which is dominated and shaped by those people and species more fit to survive than others. Social Darwinism was used at times to rationalize the disregarding of environmental concerns and the denial of social responsibility for the care of poor and weak members of human society.

According to social Darwinism, the strong (i.e., the rich and powerful) are superior and possess the evolutionary advantage in any competition over the weaker members of society and the weaker species within the biosphere. The strong win in war, business, and life because they are better suited to dominate society and the biosphere than those who are less fit, less able to compete on the same level. Thus, social stratification, inequities in wealth, wars, and use of social, political, and economic power by superior beings to dominate, control, and abuse inferior people or species are all part of the natural process of life. The rich and powerful are rich and powerful because they adapt better to changing social, political, and economic conditions than the poor and weak members of society. The ascendancy of the rich and powerful is natural and proper because it is nothing more than the superior animal or plant surviving the natural selection process.

In a similar vein, the children of the rich and powerful have the natural advantage over the children of the poor and weak in future competitions just as the next generation of plants and animals descended from the dominating variation within their species and against other species have the hereditary advantage passed to them. Slowly and inexorably the rich and powerful get richer and more powerful and the poor and weak get weaker and less powerful. It is the survival and thriving of the fittest. Human society evolves just as animals and plants evolve with the superior or fitter within human society dominating the less fit or less competitive.

Just as inferior species die off naturally as the superior species dominates more and more and requires more and more of the available resources, so it should be with inferior races and individuals in human society. Social Darwinists asserted that the weaker members of society should be allowed to naturally lose their position in society. It is therefore counterintuitive, counterproductive, and wasteful to promote the survival, elevation, and reproduction of those who cannot compete in human society. The same is true for plant and animal species driven to extinction by the superior human species. The extinction of these species is natural and should not be avoided.

Anything that the superior human species and the superior humans within their species need or desire in their continued ascendancy should be theirs for the taking and anything that artificially aids the ascendancy or retention of inferior species and inferior humans within their species should be avoided. Thus, welfare, minimum wages, labor unions, universal education, universal healthcare, anti-poverty programs, and anything that interferes with the natural progress of societies and economic systems should be avoided. Social, political, and economic inequalities are natural, and the best course of action to facilitate the natural and proper development or evolution of society is the natural process of the "survival of the fittest" through competition based on self-interest.

The conclusion of many of America's most successful capitalists of the 19th century, men such as Andrew Carnegie and John D. Rockefeller, both known as "robber barons"—a derogatory name for American businessmen who allegedly were unprincipled in their business operations and stock manipulations to the detriment of the workers whose labors allowed these industrialists to amass great personal fortunes—was that their good fortune was theirs naturally by virtue of their innate superiority. That superiority gave them the right, even responsibility, to promote the prosperity of those in society who had the ability and desire to prosper rather than elevate those who were innately incapable or undesirous of competing. The idea that it was natural and proper for the rich and powerful to prosper at the expense of the weak and the poor led to the more exploitative aspects of capitalism such as the refusal to negotiate with labor unions and even use vastly superior power to attempt to negate or destroy them.

Even the philanthropy of the more prosperous members of America's Gilded Age (1865–1901) was guided by the idea that those who should be helped are those with ability and desire, not those seeking a handout or unearned elevation in social and economic status. It was for this reason that Carnegie directed his giving to the establishment of libraries, a university, and other public institutions that helped those with ability and desire to elevate themselves and not to social institutions offering handouts to the undeserving.

The idea that by virtue of being the fittest one could do what one wished without regard to any inferior species or inferior person also provided the rationale for both Carnegie and Rockefeller to disregard the environment in their use of natural resources on which their wealth was based and the pollution that their industries created. Superior humans did not need to regard inferior species or inferior humans in their use of the available resources because their dominance was natural and proper, it was the way species and societies evolved.

Extreme forms of social Darwinism promoted eugenics programs designed to cull inferior members from the species. The eugenics movement in the United States, led by such members of the prospering elite as Alexander Graham Bell, promoted this culling through sterilization laws and immigration limitations.

Though social Darwinism was a significant force in the United States until the early 1930s, it fell into disfavor as it became associated with the rise of German National Socialism—Nazism—and the Nazi emphasis on eugenics, racial purity, and racial superiority. It was during this period as well that anthropologists such as Franz Boas, Margaret Mead, and Ruth Benedict asserted that human cultures differentiate humans from animals and thereby severed the theoretical link between social Darwinism and biological evolution asserted by Spencer. More generally, Social Darwinism lacked any meaningful or compelling proof. While it was convenient and compelling to believe that the social position of individuals reflected genetic merit, hard data remained impossible to find.

Any hope for a resurrection of social Darwinism in the 20th century necessarily relied on advances in genetics and in population-scale statistics in educational performance and other areas. Watson and Crick's discovery of the genetic encoding in DNA led some to assert that the social behavior of humans is in part genetically encoded. The recent mapping of the human genome, however, has demonstrated that genetic variations within the human species are remarkably minimal, and that the complex interconnection of traits and environmental influences makes any hope of salvaging social Darwinism remote. In the mid-1970s, Edward O. Wilson and Richard Dawkins came to assert "sociobiology" and argued that human and societal behavior is rooted in both biology and culture, which complicates any efforts to defend a simple relationship between social success and natural advantage.

Other efforts to connect genetics, especially race, and performance have been asserted in recent years relying on population-scale statistics. Richard J. Herrnstein and Charles Murray's 1994 book *The Bell Curve* asserted a "cognitive elite," higher IQ scores amongst a small population, and a non-random relationship between race and intelligence. The findings were effectively criticized both on statistical grounds and improper inferences from findings. Specifically, the inheritability of IQ was drawn into serious question. Perhaps the most notable retort of the book and its place in the history of social Darwinism was *The Mismeasure of Man* by Stephen Jay Gould published a few years after. Social Darwinism, with or without support, however, persists into the early 21st century as a system of belief.

SEE ALSO: Biosphere; Darwin, Charles; Evolution; Human Genome Project; Socialism; Sociobiology.

BIBLIOGRAPHY. Peter Dickens, "Social Darwinism: Linking Evolutionary Thought to Social Theory," *Concepts in the Social Sciences* (Open University Press, 2000); Stephen J. Gould, *The Mismeasure of Man* (W.W. Norton, 1996); Mark Hawkins, *Social Darwinism in European and American Thought, 1860–1945: Nature as Model and Nature as Threat* (Cambridge University Press, 1997); R.J. Herrnstein and C. Murray, *The Bell Curve: Intelligence and Class Structure in American Life* (Free Press, 1994); Richard Hofstadter, *Social Darwinism in American Thought* (Beacon Press, 1992); Howard Kaye, *The Social Meaning of Modern Biology: From Social Darwinism to Sociobiology* (Transaction Publishers, 1997); Alexander Rosenberg, "Darwinism in Philosophy, Social Science and Policy," *Cambridge Studies in Philosophy and Biology* (Cambridge University Press, 2000); A. Thakur, *Legacy of Social Darwinism* (Global Vision Publishing House, 2006).

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Social Ecology

THE POLITICAL AND social philosopher, anarchist, and environmentalist Murray Bookchin (1921–2006) developed the concept of social ecology in the 1960s as an interdisciplinary field drawing on philosophy, political and social theory, anthropology, history, economics, the natural sciences, and feminism. Social ecology as it is understood in the interdisciplinary or Bookchin sense differs substantially from the theoretical applications of social ecology (more widely known as human ecology) as developed in the field of sociology.

Human ecology developed in the first quarter of the 20th century as the study of individuals, groups, and their social environments using theoretical concepts and ideas from natural ecology. For example, mid-century human ecologists such as Amos Hawley applied ecological theories of succession and adaptation to analyze changing community populations, spatial distributions of human groups, and systems of social organization. Contemporary human and social ecologists have broadened the scope of research from strictly social phenomena to also consider the relationship and interactions between human populations and their changing physical environments. For example, a human ecologist today might look at changes in a forest dwelling community in terms of social organization and livelihood strategy following extensive deforestation.

In this vein, Bookchin argued for the creation of a more holistic "science of social ecology [that] deals with social and natural relationships in communities or 'ecosystems.'" The key for Bookchin, as in contemporary human ecology, is the inclusion of environmental factors or variables in the formation of social phenomena. Bookchin saw that nature itself played an active role in the emergence of social structures and change. In his view, nature is "as much a precondition for the development of society—not merely its emergence—as technics, labor, language, and mind."

Bookchin also played an important role in developing a critical social theory that relates the domination or degradation of nature to what he saw as the larger problem of social domination or social hierarchy. While the concept of social ecology in this sense never gained widespread prominence in academic discourse, the ideas of Bookchin and others within social ecology were influential in the fields of environmental ethics, democratic theory, and to a certain extent, environmental sociology, and gained even wider prominence in the environmentalist and community development literature. Central to the development of theories of social ecology is the conception that social inequalities lie at the root of all environmental problems, and that the resolution of social hierarchy will result in a more sustainable society-nature relationship.

The emphasis within social ecology on the social origins of environmental problems led to an important and long-standing debate beginning in the mid-1980s between social ecologists and deep ecologists who accused one another of anthropocentrism and biocentrism, respectively, labels that neither would camp would necessarily reject. The deep ecologists (Arne Naess, Dave Foreman, Bill Devall) relate environmental degradation to the sets of human belief systems (religions, philosophies, or ideologies) that led to the alienation and complete separation of human individuals from a pristine or "wild" nature. Deep ecologists advocate the recovery of nature through the restoration of an individual ecological consciousness. Conversely, social ecology argues that the distinct ability of humans to reason can lead to the integration of a democratic human society with a complex and dynamic ecology.

This democratic society would take the form of "libertarian municipalism," another key contribution of Bookchin's social ecology. Following his belief that an ecologically sustainable society must be built upon the foundation of a participatory democracy, Bookchin proposed the development of a type of social organization based on "face to face democratic politics and decision making" that would replace the traditional nation-state. Echoing the concurrent development of the idea of bioregionalism, libertarian municipalism implies that a sustainable and participatory society is best developed by local people in distinct local places, joined together in a loose confederation rather than through a state governance system. Decentralization of the economy into worker-controlled entities and local trading systems is also seen as a way to reduce the domination of nature by capitalist or state-controlled enterprises.

SEE ALSO: Deep Ecology; Ecology; Kropotkin, Peter; Mutual Aid; Social Capital; Social Darwinism; Socialism; Sociology.

BIBLIOGRAPHY: Murray Bookchin, "The Concept of Social Ecology," *CoEvolution* (Winter 1981); Murray Bookchin, *The Ecology of Freedom: The Emergence and Dissolution of Hierarchy* (Cheshire Books, 1982); John Clark, ed., *Renewing the Earth: The Promise of Social Ecology* (Green Print, 1990); Andrew Light, ed., *Social Ecology After Bookchin* (Guilford Press, 1998); Damian Finbar White, "Hierarchy, Domination, Nature: Considering Bookchin's Critical Social Theory," *Organization & Environment* (v.16/1, 2003).

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Socialism

RAYMOND WILLIAMS COLLECTED notes on the usage of particular words that he felt were socially and politically significant and published a set of essays about them in his 1976 book *Keywords: A Vocabulary of Culture and Society*. Williams's reputation as one of Britain's foremost socialist intellectuals of the 20th century no doubt explains why the term *socialist* is one of the keywords he included. About the variations, usage and meanings of the term, Williams suggested that by the 1840s, *socialist* and *socialism* were associated with notions like *cooperative*, *mutualist*, *associationist*, *societarian*, *phalansterian*, *agrarianist*, and *radical*. He also pointed out that as late as 1848, *Webster's Dictionary* defined socialism as "a new term for agrarianism." As useful as *Webster's* is for seeing the link between socialism and the environment, the main elements of what we today call socialism have existed for many centuries ranging from Plato's *Republic* to Moore's *Utopia*.

The political history of socialism is most directly embedded in Marxist discussion about alternative models of political economic organization. It is rooted within our collective intellectual imagination as a result of Karl Marx and Frederich Engels's publication of the *Communist Manifesto* (1848) and Marx's *Critique of the Gotha Programme* (written in 1875; published in 1891). While they are seen as very different notions in the present day, socialism and communism were once synonymous. It was V.I. Lenin who pointed out in his *State and Revolution* (1917) that in *The Critique of the Gotha Programme* Marx suggested that socialism was a first, or lower, phase of communist society. As communism grew in character through its supporters, the differentiation between socialism and communism became more distinct.

Many socialists drawn to communism in its early history disagreed on how it could be implemented in society. Some of these early socialists included Charles Fourier, Ferdinand Lassalle, Pierre-Joseph Proudhon, and Claude-Henri de Saint-Simon. They and others disagreed about centralized versus decentralized control of resources, private property relations, the degree to which egalitarianism should be implemented, and family and community organization structures. While agrarian issues were at the core of early socialist tensions, ecological issues were not as central as they should have been.

Raymond Williams also included the term *ecology* in his *Keywords*. While the term is widely attributed to Ernest Haeckel's use during the 1870s—referring to notions of *habitat*—Williams also points out a curious utilization of the term by Henry David Thoreau in 1858. Thoreau's earlier use, which was a more socially-oriented use, better foreshadowed the connections between socialism and ecology that were seen in the 19th and 20th centuries. Also regarding the connections between socialism and ecology, Williams mentioned H.G. Wells's use of ecology to suggest economics was a branch of ecology, that is, the ecology of human society.

These linkages were central to Marx's theory about capitalism. Building on von Liebig's (1840) notion of metabolism, he articulated the physical and social processes through which individuals transform their local environments. In Marxist parlance, metabolization is at the heart of the relationship between human survival and the emergence of commodity production. As such, this relation is vital for understanding the production and commodification of nature, especially those resources that are explicitly shaped for consumption. Within Marx's theory, although unfortunately absent from most of the history of Marxist theory, nature is the definitive metabolic manifestation of preconceived forms of collective human labor.

While Marx was plainly aware of the ecological foundations that were both necessary to support society and at the same time fueled capitalism, many people associated with socialism have failed to make some of the important connections between socialism and ecology. One of the most important contemporary thinkers to flesh out some of these connections has been James O'Conner, who started the journal *Capitalism Nature Socialism* in 1988. O'Conner has spent many years working to explain notions of ecological socialism, or ecosocialism, as both an intellectual and political endeavor.

O'Conner's explanation for the need of a theory of ecosocialism relates to the contradictory way in which socialists have theorized ecological resources and relations. He starts his justifications by pointing out that socialists often focus on capitalism's subordination of use value to exchange value and concrete labor to abstract labor. In turn, O'Conner points out that socialist struggles have tended to focus on higher wages, shorter hours of work, full employment, rent control, and other social mechanisms that relate to distributive justice. Instead of distributive justice, O'Conner suggests socialist critiques of capitalism should lead to forms of productive justice. The end result of this contradiction has been that socialists have mounted a qualitative theoretical critique of capitalism, and at the same time responded with a quantitative political project.

O'Conner's notion of ecosocialism is geared toward theories and political movements that organize production for need, not profit. Central to his proposition is what he calls the "second contradiction of capitalism," which is fundamentally a crisis related to the destruction of nature as a contingent condition of production. What becomes clear through O'Conner's theorizing of ecosocialism is that consumption without production is really the antithesis of the production/consumption relation. Diminished expenditure on production conditions in various kinds of environments represents O'Conner's second contradiction of capital, whereby underproduction of production conditions result in fiscal and ecological crisis. This contradiction within capitalism diminishes the vitality of the capitalist system, ultimately leading to collapse via the contraction.

There are many different kinds of theoretical and political treatments of socialism within contemporary society. While social democratic countries are evidence of the possibility that some socialist notions can prevail, present day dominance of neoliberal capitalism and corporate plundering of nature and society both make the future of socialism less likely and at the same time more necessary. Just as O'Conner's theorizing of ecosocialism has helped the Left evolve, more work is needed to incorporate the broad diversity of social and ecological struggle that will foster continued forms of socialism in the future.

SEE ALSO: Capitalism; Communism; Marx, Karl; Second Contradiction of Capitalism; Thoreau, Henry David.

BIBLIOGRAPHY. Justus von Liebig, *Principles of Agricultural Chemistry, With Special Reference to the Late Researches Made in England* (Walton and Maberly, 1840); James O'Conner, *Natural Causes: Essays in Ecological Marxism* (Guilford, 1998); Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (Oxford University Press, 1983).

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Sociobiology

IN HIS WATERSHED 1975 work *Sociobiology*, Edward O. Wilson defined sociobiology as the systematic study of the biological basis for human social behavior. Wilson hoped to define more clearly the biological foundations of human social behavior. His later work on the biophilia hypothesis combines work on human sociobiology with the political philosophy of conservation biology to suggest that the innate, evolved human affinity for other life provides ample ammunition for an environmental ethic. Traditionally, parceling out the relative influence of genetic or biological and cultural determinants of behavior has been the primary task of the social sciences and much of the humanities. After the introduction of sociobiology, however, some of this weighty task could be shouldered by natural scientists.

The seeds of sociobiology were planted in the late 1960s. The theory of kin selection, which suggested that genetically-related individuals within a particular species operated as the unit of evolutionary selection, became an increasingly popular explanatory tool for animal behavior. Wilson's *The Insect Societies* detailed many of the ways that social insects communicate and associate, and was the first scholarly work to effectively fuse entomology and population biology. Wilson argued that sociality in animals could be explained through adaptation and differential reproductive success, which ultimately depended on the perpetuation of genes. It was Wilson's seminal work *Sociobiology: The New Synthesis*, however, that first attempted to extend the genetic basis of social behavior beyond invertebrates to vertebrates including *Homo sapiens*.

It is difficult to overstate the importance of Wilson's work, which is considered a milestone in zoology and biology. But Wilson was also harshly criticized for applying sociobiological theory to human behavior and was accused by biologists Stephen Jay Gould and Richard Lewontin of reducing human behavior to biology or genetics. Gould and Lewontin founded the Sociobiology Study Group (SSG) at Harvard University, dedicated to challenging the claims of sociobiology. Critics also argued that if sociobiological theory were true, then genetically-based differences in the capacities of humans could lead to racism, sexism, and other injustices.

The fear was that the plight of minorities or other oppressed peoples might be attributed to genetic deficiencies of some kind, creating the worst sort of social Darwinism.

Richard Dawkins's *The Selfish Gene* further challenged the SSG by providing a theory of genetic selection that depended, even more than Wilson's work, on the determinative power of genes. Genes, Dawkins argued, essentially act as the engines of natural selection. Genotypes provided the template for phenotypes that behave in a selfish and competitive manner, so that even altruism could be explained as a programmed maneuver to preserve genetic lineages.

The complexity of human behavior and new insights into animal behavior from noted ethologists like Marc Bekoff and Jane Goodall—such as uncertainties about cognitive processing, relationships between the mind and body, and the role of emotion in determining behavior—complicate simple applications of sociobiology. The complex cognitive lives of humans and other animals continue to challenge reductionistic descriptions of sociality.

Despite the criticisms, research supporting Wilson's original contention continues to accumulate. Sociobiology paints a more complex picture than the critics generally acknowledge. For Wilson and his intellectual offspring, human nature is not reducible to either genes or cultural influences. Instead, for them, genes and cultures co-evolve, and the possible range of responses to the environment is determined by a set of epigenetic rules inherited from a deep, biological past. These epigenetic rules of mental development likely include, according to Wilson, adaptive responses to the environment, a predisposition that Wilson termed *biophilia*.

The biophilia research program continues to expand in the work of Stephen Kellert, who has conducted cross-cultural research suggesting the ways that humans may value the natural world, all ultimately attributable to the adaptive advantage they provide for the individual. For both Wilson and Kellert, the protection of biological diversity is an ethical matter since deep, historical interaction with the natural world provided, and continues to provide, physical, emotional, intellectual, and spiritual sustenance for humans. In his more recent work, Kellert has attempted to demonstrate that a spiritual reverence for the natural world, derived from evolutionary adaptations in human beings, should manifest in ethical regard for nature. Ethics, for Kellert, may provide a bridge between science and spirituality by acknowledging the deep dependence of humans on the natural world for the perpetuation of our species. It seems that sociobiology—as Wilson, Kellert, and a growing chorus of scholars articulate it—may provide rich explanations for the impulse (even if nascent and fragile) toward both sociality and sustainability.

SEE ALSO: Biodiversity; Biophilia; Conservation Biology; Human Genome Project.

BIBLIOGRAPHY. Richard Dawkins, *The Selfish Gene* (Oxford University Press, 1976); Richard Dawkins, *The Extended Phenotype: The Long Reach of the Gene* (Oxford University Press, 1982); Stephen Kellert, "Biophilia Hypothesis," in Bron Taylor, ed., *Encyclopedia of Religion and Nature* (Continuum Press, 2005); Stephen Kellert and Timothy Farnham, eds., *The Good in Nature and Humanity: Connecting Science, Religion, and Spirituality with the Natural World* (Island Press, 2002); Stephen Kellert and Edward O. Wilson, eds., *The Biophilia Hypothesis* (Island Press, 1993); Edward O. Wilson, *The Insect Societies* (Harvard University Press, 1971); Edward O. Wilson, *Biophilia: The Human Bond with Other Species* (Harvard University Press, 1984); Edward O. Wilson, *Sociobiology: The New Synthesis* (Harvard University Press, 2000).

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Sociology

SOCIOLOGY IS A relatively new science born at the beginning of the 19th century. Together with philosophy, psychology, political science, and anthropology, sociology belongs to the humanities and explores "society" in its broad sense. It is the science of social phenomena, structures, relations, social problems, and their causes. The actions of individuals and groups; the social meaning that these actions obtain; the social interactions caused by coexistence in organized, rule-based societies; the ways with which social cohesion is achieved and social conflict is resolved; as well as the regulatory power mechanisms in societies are some of the main questions of modern sociology's research agenda. Processes of institutionalization, socialization, and social stratification are of paramount interest for the several subfields of sociology.

Sociology is neither a homogenous science, nor does it consist of a unified analytical framework; a series of various methods and methodologies has been developed since its birth. Sociological research is constructed both on empirical methods and on theoretical models, attempting to argumentatively interpret and causally explain social reality and social phenomena. Empirical research is based both on quantitative methods like statistics and on qualitative ones, like interviews, questionnaires and observation. Theoretical models use historical analysis and are in critical dialogue with opposing social theories.

Most sociological approaches combine theoretical and empirical methods and also attempt new methodologies, comparisons and critiques. Because the approaches to the social world differ from one social theory to another, the questions under research differ as well. Therefore, the social problems that are each time chosen for analysis among others, as well as the social aspects that are considered most appropriate to focus on, depend on a variety of differentiating factors between sociological schools. These include: The ways with which political needs, political orientations, and ideological starting points affect the structuring of the sociological approach; the observing position of sociologists and their social and economic status; and their educational and cultural background.

Most importantly, the research issues that are each time considered to necessitate further examination, elaboration or critique, depend on the historical socioeconomic and political circumstances in which they were born and established. Thereby, sociological theories are not isolated from society, its ruling power and the social needs that are prioritized in a given spatio-temporally defined social condition. On the contrary, they stand in a dialectical relation with these social conditions. Either by analyzing them in order to make them more efficient for some parts of society, or by criticizing and deconstructing them, sociological theories reflect the specific conditions and historical circumstances that allowed and signified their production.

Among the abundance of sociologists who provided sociology with important analytical instruments and enriched the field, a few pioneering figures were: The positivist philosopher August Comte (1798–1857) who has been named as the "father of sociology" and was seeking to create a social science resembling natural sciences; Karl Marx (1818–83) with his theory of capitalism, class struggle, and historical materialism; Max Weber (1864–1920) who introduced the concept of rationalization and studied the structuring of the modern state and its bureaucracy mechanisms; Emile Durkheim (1858–1917) who studied the division of labor and introduced the concept of anomie in order to examine the consequences of social change; and Georg Simmel (1858–1918) who discussed the development of modern cities and the effects of urbanization processes on the lives of individuals.

Sociology has been influenced by the enormous and rapid historical changes that defined the transition from agricultural feudal societies to modern industrial ones. The process of industrialization and the consequent urbanization, the construction of the modern state and of the implicit political institutions, and the polarization of mass society as well as the technological progress caused by the Industrial Revolution have been elements that formed sociology's research agenda. Furthermore, the two World Wars as well as the Cold War and their innumerable consequences regarding national states and international relations have also been integrated into the sociological agenda.

Given the complex development of modern social formations and the intensive historical and political changes defining "modernity," sociology became increasingly fragmented in its interests and purposes. Social theory and sociological schools of the present devote themselves to a series of different social phenomena. The study of the democratic state, the parliamentary parties system and the political elites—as well as the theories of different kinds of government and governance—have been from the beginning a fundamental part of political sociology. Influential sociologies are: economic and historical sociology, criminology, sociology of space, and the sociologies of mass media and information systems, of genders, of science, of violence and law, of social exclusion and social control, of the mode of production, of work, of social stratification, of globalization, of technology, of migration, of art, of culture, and of environment.

SOCIOLOGY OF ENVIRONMENT

Sociology of environment is a new and, since the 1970s, increasingly influential discipline. An important role in its construction has been played by the new environmental movements and ecological politics in Western Europe and North America. In a broad sense, it can be seen as part of both agricultural and urban sociology, although the field has also undergone fragmentation. Population growth, demography, environmental technology, changes in global climate, pollution, degradation of the environment, and the question of the limits of natural resources are seen as aspects neglected by traditional sociology. Generally, the research interests of sociology of environment concentrate on the relation between the natural environment and social formation. The ways with which the natural environment is socially perceived and used are subjected to a number of economic needs combined with political priorities that, in turn, have been the most important research problem of the sociology of environment.

ENVIRONMENTAL SOCIOLOGY

The development from sociology of environment to environmental sociology illustrates a shift in the focus of the discipline, although the examination of the relation between nature and society remains a crucial issue. Recent environmental sociology of the 1980s and onwards, however, has more intensively and pragmatically concentrated on concepts of "sustainable" environmental, urban, and agricultural development. Despite the differences in their perspective, the works initiated in the 1970s and 1980s by William R. Catton and Riley E. Dunlap, as well as by Allan Schnaiberg, are of paramount importance. Catton and Dunlap criticized the anthropocentric paradigms defining sociology, and through the emphasis on the increasing role of biological and environmental factors in the formation of societies, they vitalized the socio-ecological paradigm. Allan Schnaiberg analyzed environmental problems with regard to economic aspects of the global system of production and underlined the tight relation of the environment's use with the broader needs of global economy, as well as their consequences on social institutions like the family.

Sustainable environmental development relates to management and risk management in several areas including: Agriculture; farming; industrial exploitation of natural resources; biological control in food's mass production; epidemiology and toxicology; and the examination of the energy and fuel problem and its gradual exhaustion. The economic consequences that are now calling for global and collective solutions are also causing several forms of crisis as well, although there are possible alternatives to the problem. In addition, environmental sociology examines hazards and socioeconomic ruptures caused by natural disasters (earthquakes, hurricanes, floods). Although natural disasters are not a new phenomenon, the idea of politics that promote adjusting to natural disasters instead of spontaneous solutions of emergency is elaborated by environmental sociology.

SEE ALSO: Anthropology; Disasters; Marx, Karl; Research Methods; Sustainable Development.

BIBLIOGRAPHY. Riley E. Dunlap and William R. Catton, Jr., "Struggling with Human Exemptionalism: The Rise, Decline, and Revitalization of Environmental Sociology," *The American Sociologist* (v.25, 1994); Anthony Giddens, Dunier Mitchell and Richard P. Applebaum, *Introduction to Sociology* (W.W. Norton & Company, 2003); Allan Schnaiberg and Kenneth Alan Gould, *Environment and Society: The Enduring Conflict* (St. Martin's, 1994).

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Soil Erosion

SOIL IS ESSENTIAL for life. It is the top cover of the earth and home to numerous plants and animals. In addition, it is a very important food and mineral resource for humans. The soil covering the surface of the earth has taken millions of years to form. Soil appears to last forever, but every day soil particles are loosened by a process called *erosion*. Erosion is the displacement of solid particles from land, rocks, and minerals by the agents of water, ice, wind, and or gravity causing the soil to deteriorate. This process must be distinguished from weathering, which is the process of disintegration of soil and rock through direct or indirect contact with the atmosphere.

One of the most important types of soil erosion is water erosion—the removal of particles from the land by water. There are four steps in the water erosion process. The first step is splash erosion, which is the movement of small soil particles caused by the impact of raindrops on soil. The second step is sheet erosion, which is the result of heavy rain on bare soil where water flows as a sheet down any gradient, carrying soil particles; where precipitation rates exceed soil infiltration rates, runoff occurs and transports particles dislodged by the impact of raindrops. The third step is rill erosion, which results when surface runoff concentrates form small channels called rills. The fourth step in water erosion is gully erosion, which occurs when concentrated flows of water, formed by the coalescence of many rills, scour along a linear depression to create a trench or gully.

Another important type of soil erosion is wind erosion—the removal of soil particles from the surface by the force of wind. Fine material can be transported and deposited over long distances. This process of wind erosion, also known as eolian erosion, includes three stages that frequently occur at the same time. The first stage is suspension, which happens when fine soil particles are carried into the air and become atmospheric dust. The second stage is saltation, where dislodgement and movement of medium-sized particles is caused by their bouncing over the surface initiated by wind uplift and turbulence at the soil surface. The third and final stage is surface creep, where the largest or heaviest soil particles are rolled across the surface by wind force and by impacts from saltating processes.

Soil erosion is a natural process that is often healthy for the ecosystem, but it has been increased by human activities that make it occur much faster than under natural conditions, contributing to soil degradation. Soil erosion mostly due to over farming may cause two opposite events. On one hand, it can cause floods in intermediate zones of river valleys as well as reduction of downstream flow. However, in arid and semiarid areas, soil erosion due to over farming can result in drought and desertification—a process that implies great biodiversity loss and puts at risk the more than one billion people worldwide who are dependent on these lands for survival.

Activities such as construction, urbanization, grazing, forestry, agriculture, and surface mining modify the environment and contribute to soil erosion. One of the environmental impacts of these practices is the loss of vegetation cover. When vegetation and forests are removed, the soil is exposed to wind and water making it vulnerable to accelerated erosion and loss of fertility. The vegetation cover also acts as a sponge, retaining water from precipitation in order to gradually release it later, thus minimizing downstream floods as well as drought conditions. If the absorbent vegetation cover is removed, excess precipitation causes large runoff that can lead to floods.

The movement of equipment and the storage of materials on a construction site can compact the soils resulting in the loss of topsoil, minerals, and nutrients, and causes ugly cuts and gullies in the landscape. Plants also often have more difficulty growing in these sites because water from absorption by tree roots and soil aeration may be reduced.

The intensive use of soil for agriculture purposes often increases its erosion and, therefore, its sedimentation. In farming, soil erosion signifies a loss of the most fertile part of the soil, which contains most of the organic matter, and that means lost agricultural productivity. Moreover, agricultural irrigation techniques can contribute to soil salination because water contains salts that are left behind in the soil. In regions where overirrigation is practiced, these salts accumulate and concentrate, which causes soil degradation.

Another consequence derived from poor land use practice is contamination. Soil used for agricultural practices contains insecticides, herbicides, and pesticides that percolate and decrease the biodiversity within. These chemicals infiltrate in the soil and are taken up by the roots of the target plant, and the excess can be carried away by surface water or the wind.

Another source of soil contamination is derived from industry activities, which emit thousands of effluents that discharge directly into the soil without previous treatment. They infiltrate the soil and mix with groundwater. The most hazardous industrial emissions are: Mine emissions, which contain toxic sulphide and metallic elements; automobile industry emissions, which include petroleum hydrocarbons, oil and grease, compounds from gasoline, motor oil, antifreeze, and transmission fluids; and food industry emissions, which contain organic pollutants. Other industries create harmful soil-contaminating emissions that contain aluminum, cadmium, chromium, lead, and mercury.

Household waste can eventually contaminate the soil if it is not managed correctly. Some household wastes such as yard waste, newspapers, plastics, and food wastes are not necessarily considered hazardous, but should still be disposed of properly. However, other products such as batteries, pigments, paints, solvents, oils, cleaners, glues, and pesticides if they are not used, stored, or disposed of properly can contaminate soil.

The Food and Agriculture Organization (FAO) estimates that a significant quantity of high quality soil, mostly in Africa and Asia, will be degraded by 2010 unless better methods of land management based on sustainable, productive, and efficient use of soil are adopted. Preventing soil erosion requires political, economic, and technical changes. These have to be implemented taking into account the most effective and economical way of controlling such problems without disturbing the quality of the environment.

There are a lot of strategies that economic sectors can implement in order to reduce soil erosion and maintain life-giving nutrients that are found in the soil. On building construction sites, some practices are used to control erosion and sediment caused by soil compaction. Compaction, once it has occurred, is difficult and expensive to correct, but there are some prevention methods that are used to minimize its impact such as the reduction of traffic in the area, the use of barriers to filter coarse sediment, and locating the storage areas away from tress. Once compaction has occurred, mulching with wood chips or gravel can reduce its effect.

Agricultural and industrial sectors can also implement strategies to use clean technologies and reduce contamination by their operations. Industry can reduce soil erosion by controlling waste and toxic discharge, thus preventing soil infiltrations. In agricultural practices, soil erosion can be reduced by rotating crops, minimizing tillage, building terraces on hillsides, decreasing the use of chemicals, reducing synthetic nitrogen use, and keeping the soil rich in humus and nutrients by using compost and manure and encouraging water infiltration to reduce water runoff. The planting of trees and maintenance of a good vegetative cover is also imperative.

The removal of soil contaminants, combined with the preventative use of geotextiles and synthetic blankets, which provide a protective barrier impermeable to contaminants, are a few ways of reducing the levels of contamination in the soil. Another way of reducing contamination levels is the use of the soil vapor technique, which involves the installation of wells and pipes in the soil through which soil contaminants are extracted. Other biological techniques include microbial or phyto remediation, using microbes or plants in degrading contaminants, and using composting techniques.

Protecting soil from erosion is essential to prevent the loss of soil productivity through loss of nutrients, water storage capacity, and organic matter. It is necessary and possible to prevent, reduce, or halt erosion and degradation of the soil using sustainable and conservation practices. The implementation of these practices requires changes in the economic-political approach, society's attitudes, and cultural practices.

SEE ALSO: Desertification; Drought; Floods and Flood Control; Soils; Soil Science.

BIBLIOGRAPHY. Hanna Licht Al Kaisi, *Resources Conservation Practices: Soil Erosion and Water Quality* (Iowa State University, 2003); Australian Government, "Soil Condition: Soil Properties—Soil Erosion by Wind," www.nrm.gov.au (cited December 2006); Rose Eric, *Land Husbandry. Components and Strategies* (Food and Agriculture Organization, 1996); Food and

Agriculture Organization, *Assessing Soil Contamination. A Reference Manual* (Editorial Group, 2000); Heinegg et al., *Soil Contamination and Urban Agriculture. A Practical Guide to Soil Contamination Issues for Individuals and Groups* (McGill University, 2002); J.F. Leys, "Erosion by Wind, Effects on Soil Quality and Productivity," in *Encyclopedia of Soil Science* (Marcel Dekker, Inc., 2002); D. Scott, R. Mohtar, and G. Steinhard, *Sustaining the Global Farm* (2001); Preston Sullivan, *Sustainable Soil Management. Soil Systems Guide* (NCAT, 2004); G. Wall, C.S. Baldwin, and I.J. Shelton, *Soil Erosion: Causes and Effects* (Canadian Ministry of Agriculture, Food, and Rural Affairs, 2003).

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Soils

SOILS FUNCTION IN a myriad of ways, including supporting plant growth, serving as a major component of the hydrologic cycle, recycling nutrients, providing habitat for soil organisms, and acting as an engineering medium. The importance of these soil functions to the environment as well as society cannot be understated.

Soil's role as a medium for plant growth includes anchoring the plant's root system; providing air, water, and nutrients to the roots; and protecting the root system from the temperature fluctuations (and extremes) that occur at the surface. Soil's support of plant life and role in nutrient cycling provides food and fiber for subsistence as well as livelihoods. As a component of the hydrologic cycle, soils serve as a reservoir that fills up in times of abundant precipitation and, in time, releases the stored water to transpiring plants and recharges groundwater reservoirs.

Soils serve as a recycler by hosting microbial populations that assimilate organic waste, including plant and animal detritus, and converting it to humus, mineral forms that can be used by plants and animals, and carbon dioxide (used in photosynthesis). Soil's ability to incorporate organic wastes allows the treatment of animal, domestic, and industrial wastes, though application should be monitored with an eye to the texture and permeability properties of the soil to which these treatments are applied. Soils provide an engineering medium by either acting as the building material (e.g., gravel, sand, clay, fill, bricks) or providing the foundation on which structures are built. Soil properties including bearing strength, compressibility, shear strength, and stability are, therefore, very important. Knowledge of soils as an engineering medium prevents problems with roadway construction and maintenance, slope failures initiated by inappropriate roadcuts, or structural failures of buildings.

ENVIRONMENTAL FACTORS

V.V. Dokuchaev and his colleagues in Russia were the first to conceive ideas concerning the environmental factors associated with soil formation; these ideas were later formalized by H. Jenny. These "soil forming factors" include time, parent materials, climate, topography, and biota. The concept of time in soil formation is related to the process of weathering, as, over time, weathering processes produce the raw materials necessary for soil formation. Physical weathering breaks down rocks into individual mineral grains. Physical weathering is aided by the abrasive properties of water, wind, and ice, as well as the stress induced by changes in temperature.

Chemical weathering processes make use of water, oxygen, and acids in the breakdown of soil minerals to soluble nutrients useable by plants. Water molecules are integral to chemical weathering processes including hydration, hydrolysis, and dissolution, while oxygen and other electron donors are involved in oxidation-reduction reactions. Acids (e.g., carbonic acid formed by carbon dioxide dissolving in water) accelerate weathering by increasing the activity of hydrogen ions in water. These chemical weathering processes occur simultaneously and are interdependent. Some minerals, like quartz, are resistant to weathering, while other minerals are altered, decomposed, or recombined to produce new minerals. Those minerals resistant to weathering are called primary minerals, and the new minerals generated by weathering are called secondary minerals. Weathering also produces soluble materials.

Parent materials may have formed in place or been transported by wind, water, ice, or gravity. Cli-

Soils play a role in the global climate by sequestering carbon during photosynthesis and storing it as humus.

mate, in particular precipitation and temperature, greatly influences the nature of weathering as well as its intensity. Arid regions experience predominately physical weathering, while chemical weathering predominates in humid tropical climates. Warm temperatures combined with abundant precipitation produce the most highly weathered soils. Climate's role in soil formation, and climate changes as they are related to human influence, should, therefore, be noted. Soils experience the effects of climate change through alterations in temperature and water status that affect organic matter decomposition, nutrient cycling rates, and weathering.

Other soil forming factors include biota, topography, and time. Biota (e.g., vegetation, microorganisms, soil animals) influence processes including organic matter accumulation and profile mixing. More organic matter accumulates in grassland areas than under forest cover because the roots of the grasses introduce organic matter into the soil, while forests depend primarily upon leaf litter to add organic matter. Profile mixing, or pedoturbation, occurs when animals such as gophers, moles, and prairie dogs, as well as earthworms and termites, bring about soil mixing through burrowing activities.

Topographical impacts on soil formation are related to slope, aspect, and landscape position. For example, steeper slopes will experience less water infiltration, thus generating less vegetative cover and organic matter accumulation, while simultaneously being more likely to experience erosion, all of which contribute to soils that are, as a result, shallow and poorly developed. Other landscape positions, such as swales or the toeslopes of hills, tend to accumulate soil materials eroded from other parts of the landscape and thus result in a deeper profile. Time is required for any of these soil forming processes to produce results. Understanding the processes of soil formation and differences among the soils produced by various soil forming factors is relevant to society in terms of managing soils effectively as well as using soils as a record from which to reconstruct past environmental, social, and cultural history.

SOILS AND CROP PRODUCTION

Effective soil management is extremely important for crop production. Over the last 60 years, the world has seen a dramatic rise in agricultural production, primarily in cereal grains such as wheat, corn, and rice. These yield increases came about in response to the post–World War II population increase. Yield increases were made possible not only by intensifying agricultural land use, through irrigation and application of fertilizers and pesticides, but also by expanding agricultural lands. While agricultural intensification has benefits, such as maintaining necessary soil macronutrients (through fertilizer application) and soil organic matter levels (by increasing crop residue), it also has environmental drawbacks. One of the drawbacks associated with agricultural intensification is that the focus on crop monocultures has reduced biodiversity and made crops vulnerable to disease, thus encouraging pesticide use.

Salinization is another drawback that may be brought about by irrigation, particularly in arid or semiarid areas in which salts have accumulated in the soils previously exposed to long dry periods during which evapotranspiration processes have drawn water, along with soluble minerals, to the surface. If drainage to leach salts is not properly provided for when irrigating, salts are left behind when plants uptake water, eventually resulting in their accumulation in the soil. According to P. Rengasamy, salinization currently affects 2.05 billion acres (831 million hectares) globally. Excess nutrient application is another potential drawback to intensifying agricultural land use.

NUTRIENT AND CHEMICAL APPLICATION

Nutrient management in soils is important not only for agricultural production, but for protection of groundwater and surface water resources as well. Soil nutrients may be managed by recycling nutrients at a particular site (e.g., applying the manure generated by animals fed the products of a field back onto that field), recycling nutrients more generally (e.g., through land application of sewage effluent), or by tracking the balance between the nutrients inputs to the system and its outputs. Nutrient management is particularly important in light of water quality issues, as nutrients in runoff from agricultural landscapes, particularly nitrogen and phosphorus, have been known to increase nutrient levels in the waters draining these lands. One means by which nutrient runoff may be reduced is by limiting excess nutrient application and timing fertilizer application to coincide with periods of rapid nutrient uptake. Vegetation buffer strips along riparian corridors prevent most of the sediment and nutrients in runoff from reaching streams, and cover crops stabilize soil as well as augment soil quality. Crop rotation is also noted as a means by which yields may be maintained and even increased, while simultaneously decreasing fertilizer requirements.

In addition to nutrients and their impacts on our soil and water resources, we must also be aware of the risks associated with organic and inorganic chemicals applied to soils. Chemicals move through the soil environment taking a variety of routes—absorption, breakdown by microbes, uptake by plants or animals, or loss through volatilization, leaching, or runoff. The soil-water interface is of great importance because chemicals that enter water sources may do so at levels hazardous to human health. It should be noted that some soils (e.g., sandy soils in an area of abundant rainfall) pose a greater potential risk to surface or groundwater contamination because of their high permeability.

Methods for remediating soils with chemical contamination include modifying agricultural practices to limit or eliminate pesticide use, use of less toxic or mobile compounds, or use of chemicals that degrade more rapidly. Other methods for remediating soils apply physical and chemical treatments to the soil or enlist plants and microorganisms. Physical treatment of the soil uses temperature (i.e., incineration) to hasten chemical decomposition. Chemical treatments used in soil remediation include soil washing to leach pollutants or the use of surfactants to bind soluble organic contaminants until they are degraded.

Bioremediation is the method by which plants and animals are used to degrade contaminants. Microbes may be added to the soil to augment natural populations, or existing microbial populations may be stimulated by satisfying their nutrient needs, thus boosting their metabolism and ability to break down chemicals. Plants assist remediation efforts by metabolizing contaminants, accumulating them in their tissues (which can then be harvested), or exuding compounds that stimulate local bacterial growth and, thereby, degradation of the contaminant. Bioremediation has been used to deal with a variety of contamination scenarios, from leaking underground storage tanks (LUST) to mine tailings.

EROSION

Soil erosion, another pressing problem in soil management, occurs when soil is left exposed to rain or wind. Erosion not only impacts soil quality, in terms of organic matter, nutrient losses, and degraded soil structure, but also incurs social and economic costs associated with air and water pollution stemming from the sediment and dust produced. Conservation tillage is a means of stemming soil erosion and increasing soil quality. This process leaves vegetative cover on the soil surface; conservation tillage is, therefore, associated with a variety of terms from stubble mulching to no-till depending on the amount of vegetative cover left.

CONNECTION TO CLIMATE

Soils also play a role in global climate processes, as they serve as a carbon sink as well as a source of greenhouse gases (i.e., carbon dioxide, methane, and nitrous oxide). Soils act as a sink by sequestering carbon, removing it from the atmosphere during photosynthesis and storing it as humus. Carbon sequestration can be promoted by restoring degraded soils, as well as maintaining the quality of prime agricultural soils. Degraded soils may be improved by management practices that include erosion control, conservation tillage, and organic matter accumulation through increased crop production and use of cover crops. In addition, wetlands and marshlands also serve as carbon sinks, making restoration and reclamation of these lands another way to promote carbon storage.

Major avenues through which soils serve as sources of carbon include land conversions to agriculture, deforestation, and excess tillage. Land conversions to agriculture remove large portions of the plant material that prior to cultivation would have been returned to the soil, while tillage breaks up plant residues and makes them more available to microbial decomposers. Researchers have pointed out that, without regard to the real or perceived risk to global warming, soil carbon sequestration is important enough to be pursued for its own merits, particularly in light of its relation to soil aggregation, aeration, erosion, and nutrient cycling.

MAINTAINING SOIL QUALITY

These various issues affecting soils, from nutrient management to soil erosion, point to the importance of maintaining soil quality, defined by the Natural Resource Conservation Service (NRCS) as a soil's ability to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. General practices for maintaining soil quality include adding organic matter, avoiding excessive tillage, managing fertilizer and pesticide use, and increasing ground cover as well as plant diversity. Maintaining soil quality is important to the environment as well as society, in terms of food security as well as in support of the ecosystems services provided by soils.

SEE ALSO: Carbon Cycle; Farming Systems; Fertilizer; Hydrologic Cycle; Land Degradation; Monocultures; Pesticides; Salinization; Shifting Cultivation; Sinks; Soil Erosion; Soil Science.

BIBLIOGRAPHY. N.C. Brady and R.R. Weil, *The Nature and Properties of Soils* (Prentice Hall, 2002); N.K. Fageria, V.C. Baligar, and B.A. Bailey, "Role of Cover Crops in Improving Soil and Row Crop Productivity," *Communications in Soil Science and Plant Analysis* (v.36/19-20, 2005); M.S. Fennessy and J.K. Cronk, "The Effectiveness and Restoration Potential of Riparian Ecotones for the Management of Nonpoint Source Pollution, Particularly Nitrate," *Critical Reviews in Environmental Science and Technology* (v.27/4, 1997); H. Jenny, *Factors of Soil Formation: A System of Quantitative Pedology* (McGraw-Hill, 1941); K.A. Natarajan, S. Subramanian, and J.J. Braun, "Environmental Impact of Metal Mining: Biotechnological Aspects of Water Pollution and Remediation: An Indian Experience," *Journal of Geochemical Exploration* (v.88/1-3, 2006); R. Naylor, W. Falcon, and E. Zavaleta, "Variability and Growth in Grain Yields, 1950–94: Does the Record Point to Greater Instability?" *Population and Development Review* (v.23/1, 1997); P. Rengasamy, "World Salinization with Emphasis on Australia," *Journal of Experimental Botany* (v.57/5, 2006); C. Rosenzweig and D. Hillel, "Soils and Global Climate Change: Challenges and Opportunities," *Soil Science* (v.165/1, 2000).

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Soil Science

SOIL SCIENCE IS an interdisciplinary science with both pure and applied aspects. Soil science focuses on soil as a natural resource, in particular its use and management. V.V. Dokuchaev is considered the father of modern soil science. Previously, soils had been equated with bedrock. Dokuchaev suggested that soil was very different from bedrock because a range of soil forming factors (climate, topography, biota, parent material, time) influence its genesis.

Soil science is broad in scope, encompassing a range of subdisciplines working on topics including soil formation and classification and mapping, as well as soil fertility and soil's physical, chemical, and biological properties. Pedology is the branch of soil science that researches the nature, properties, formation, distribution (i.e., soil geography), and function of soils and is, therefore, involved in classification and mapping of soils. Soil physics studies the physical characteristics of soils, focusing in particular on water movement in soils, soil moisture and plant-available water, soil structure, aeration, drainage, irrigation, and methods of measuring soil's physical parameters.

Soil chemistry focuses on the organic and inorganic chemical reactions associated with soil, with major areas of study including soil acidity, nutrient cycling and availability, water and soil pollution, and methods for soil chemical analysis. Soil biology is the study of macro- and micro-flora and fauna in soils and how they affect soil systems. Soil biology research addresses topics including soil organic matter, nitrogen fixation, organism populations and habitat, pesticides, and waste disposal. Soil fertility research, focused on the interaction of plant and soil systems, examines topics including plant responses to various soil systems and amendments, ion uptake, plant and soil testing, soil moisture stress and nutrient availability, as well as the influence of organic matter on soil fertility.

Soil science has a long history of benefit to society, as much of its research has aimed to enhance agricultural and forest production. An important historic contribution of soil science is its role in the Green Revolution, wherein agricultural productivity increased rapidly due in part to insights from soil science. Advances in soil science over the past 40 years have come from both basic and applied research. Soil science advances, which have benefited both the environment and society, include: (1) the use of geospatial technologies such as geographic information systems (GIS) and remote sensing in soil resource assessment, (2) soil management efforts that include conservation tillage and precision agriculture, (3) bioremediation, and (4) promotion of carbon sequestration.

Remote sensing, primarily aerial photography, aids the process of soil survey by allowing soil scientists to delineate soil types based on factors including landform, topography, and vegetative cover; these delineations can later be field checked. GIS facilitates spatial analyses of soil survey data as well as improving the presentation and use of soil information. In addition, electronic access to soils data has increased its use by the public. Conservation tillage stems soil erosion and increases soil quality by leaving vegetative cover on the soil surface. Precision agriculture, a method of site-specific management, engages geographic information systems, the Global Positioning System (GPS), and remote sensing, and improves our ability to track the application of fertilizer, crop growth throughout the season, or productivity at harvest. Bioremediation uses plants and soil microbes to aid in degrading contaminants. Carbon sequestration by soils aids efforts to decrease greenhouse gases in the atmosphere.

Though soil science has clearly made advances, challenges remain. Future challenges to soil science include: (1) interdisciplinary research involving soil science subdisciplines, particularly soil chemistry, soil physics, soil biology, soil mineralogy, and pedology, brought about by the need to understand land transformations, their impact on the environment, and associated policy issues; (2) linking more effectively with other earth science disciplines in an effort to contribute additional data and knowledge to questions of environmental change; (3) communicating better with the public in an effort to increase understanding of soils, particularly among decision makers; and (4) increasing efforts to integrate indigenous soil knowledge with formal scientific investigations.

SEE ALSO: Carbon Cycle; Fertilizer; Global Positioning System; Greenhouse Gases; Green Revolution; Remote Sensing; Soils; Soil Erosion.

BIBLIOGRAPHY. T.A. Anderson, E.A. Guthrie, and B.T. Walton, "Bioremediation in the Rhizosphere," *Environmental Science and Technology* (v.27/13, 1993);

R.L. Blevins, M.S. Smith, G.W. Thomas, and W.W. Frye, "Influence of Conservation Tillage on Soil Properties," *Journal of Soil and Water Conservation* (v.38/3, 1983); D. Dent, A. Hartemink, and J. Kimble, *Soil—Earth's Living Skin* (Earth Sciences for Society Foundation, 2005); R.F. Follett, "Soil Management Concepts and Carbon Sequestration in Crop Soils," *Soil and Tillage Research* (v.61/1-2, 2001); A.B. McBratney, M.L.M. Santos, and B. Minasny, "On Digital Soil Mapping," *Geoderma* (v.117/1-2, 2003); National Academies of Science, "Frontiers in Soil Science Research Workshop," The National Academies, Washington, D.C., December 12–14, 2005, www7.nationalacademies.org/soilfrontiers (cited April 2006); N.Q. Zhang, M.H. Wang, and N. Wang, "Precision Agriculture—A Worldwide Overview," *Computers and Electronics in Agriculture* (v.36/2-3, 2002).

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Solar Energy

SOLAR ENERGY COMES from the sun in the form of electromagnetic radiation. This energy generated by the sun exceeds any known form of energy generated by man. The amount of incoming radiation, known as the *solar constant* (because it is almost invariable), measured by satellite at Earth orbit, is 1370 watts per square meter.

The sun radiates like all other hot bodies. When the sun's radiation reaches the Earth, it contains wavelengths ranging from invisible ultraviolet, which can cause skin sunburn and eye damage (0.2 to 0.38 micrometers), through the visible rainbow colors (0.38 to 0.75 micrometers) and up to invisible infrared, which we sense as heat (0.75 to 2.5 micrometers). Only low levels of ultraviolet and infrared rays reach the Earth's surface since they are strongly absorbed by the Earth's atmosphere.

It is believed that the sun generates energy by the nuclear process called proton-proton fusion in which four hydrogen protons are fused into a single helium alpha particle under conditions of extremely high temperature and pressure that exist within the sun's core. This process releases energy that we know as solar energy, along with two positive electrons and two neutrinos. The sun, as the main source of energy on Earth, delivers light and heat essential to the existence of life. Sunlight drives photosynthesis, an important biochemical process, in which plants, algae, and some bacteria convert solar energy into chemical energy. During photosynthesis, plants produce oxygen and nutrients while absorbing carbon dioxide, thus making Earth a vital, living, and breathing planet. Fossil fuels in the form of coal, oil, and natural gas also come from such plants. Warmth from the sun is essential to keep the water on Earth in its liquid state—hence, without the sun, the Earth would be an icy planet.

Solar energy is the driving force for most environmental processes on the Earth's surface and in the atmosphere. The Earth is heated by sunlight, and to maintain steady temperature it gives energy away to space, thus the Earth begins to radiate. The receiving and giving of heat is made possible by the flow of air, which influences spatial variation of temperature and pressure, thereby creating wind and moisture that determine weather and climate zones. The power of hurricanes is driven by the heating of water and subsequent heat release during condensation. In desert environments, wind power heaps sand into dunes. A portion of incoming solar radiation is reflected by clouds, scattered (making the sky appear blue and the clouds white or gray) and absorbed, e.g., ultraviolet radiation is almost completely blocked by the ozone (three-atom oxygen) layer.

According to Vien's displacement law of physics, since the Earth is cooler than the sun, it must re-emit energy with longer wavelengths than the sun emits, with the peak at far infrared (10 micrometers). Earth's re-emitted heat is absorbed by minor components of the atmosphere called greenhouse gases: carbon dioxide, water vapor, methane, nitrous oxide, and ozone, thus creating a blanket-like protection and keeping the ground warmer by about 33 degrees C than the Earth would otherwise be. Most scientists believe that this natural greenhouse effect has been enhanced by anthropogenic (human-caused) activities that contribute to global warming (the increase of average temperature on Earth). Carbon dioxide, a major greenhouse gas in the atmosphere, has increased significantly due to the burning of coal for electricity generation and heating, as a result of deforestation, and also in the form of emission of exhaust gases from vehicular engine combustion. Emission of gases from industrial processes, like perfluorocarbons, chlorofluorocarbons, halons, and agriculturally produced methane and nitrous oxide also contribute to global warming. Efforts are being made to limit their release into the atmosphere, but global warming is expected to continue since many of the greenhouse gases have a long lifetime in the atmosphere.

Ozone produced at high altitudes by the action of sunlight on ordinary two-atom oxygen is also a greenhouse gas, but importantly, it absorbs ultraviolet light and protects living beings from the damaging effects of ultraviolet light on genetic material. Recently concern has arisen due to the fact that gases escaping from refrigerators, air conditioners, and aerosols are broken up in the stratosphere by ultraviolet light, releasing chlorine that damages the ozone layer. These gases also persist in the atmosphere for many years. Because of the damage to the ozone layer, their use is being phased out.

SOLAR POWER

Over the past several decades, techniques for harnessing solar energy have been developed as people realize the environmental costs and limited supply of fossil fuels. The most popular output has been the photovoltaic cell, a light-absorbing device that delivers electricity. An array of many photovoltaic cells becomes a solar battery, also called a solar panel. Solar batteries have been used where other power supplies are absent, such as in remote locations with no access to electricity grids and on spacecraft. Use of solar panels is being encouraged in developing countries of south Asia and Africa, where the supply of electricity from national grids is often unreliable or unavailable for long durations.

New generations of power plants use solar heat for generator rotation to produce electricity. There are three main systems that concentrate solar power to the levels needed for power generation. The parabolic-trough system concentrates heat through long curved mirrors tilted toward the sun and focuses sunlight on a pipe that runs down the center of the trough. This heats oil flowing through the pipe. The hot oil boils water in a conventional steam generator to produce electricity. The dish/engine system uses a mirrored dish, which collects heat onto a receiver transferring the heat to the fluid within the engine. The heat causes the fluid to expand against a piston or turbine to produce mechanical power. The mechanical power is then used to run a generator producing electricity. The power-tower system uses a large field of mirrors to concentrate sunlight onto the top of a tower, where a receiver is mounted. This heats molten salt flowing through the receiver. The salt's heat is then used to generate electricity through a conventional steam generator. Molten salt retains heat efficiently, thus it can be stored for days before being converted into electricity, making it possible to produce electricity on cloudy days or after sunset.

Solar energy has simpler uses as well. Smaller thermal collectors consisting of a metal box with a mirror or focusing lens to collect heat are being used in solar cookers and ovens. On a sunny day it is possible to obtain temperatures of 150–200 degrees C in the solar cooker, enough to cook food or bake. Governments and humanitarian organizations around the world are encouraging people in rural areas without electricity to use solar cookers to help stop deforestation, since in many remote rural areas wood is the principal fuel.

Development of various methods of harnessing solar energy has also influenced modern architecture. Examples include sun-facing and roof-windows, movable awnings repositioned seasonally to create shadows in the summer and exposure to sunlight in the winter, thermal collectors for water heating, and photovoltaic solar panels on roofs. Solar collectors coupled with plastic optical fibers are used to send sunlight into the interior of buildings and to illuminate them.

The installation of solar panels is more expensive than the setting up of conventional electricity grids and the best locations for the conversion of solar power into electricity, such as deserts, are often far from places with high electricity demand. Also, during nights and cloudy days solar energy has to be stored. Additionally, DC to AC voltage converters are necessary to make photovoltaic solar panels compatible with electricity grid devices. On the other hand, the major advantage is that solar energy especially for electricity production is pollution free. With new technological developments

The parabolic-trough system concentrates heat through long curved mirrors tilted toward the sun.

making the conversion of energy more efficient, and legislation providing cheaper and easier access to unconventional energy sources, solar equipment is expected to become more affordable. For areas with a large number of cloud-free days, solar energy together with other forms of unconventional energy such as thermal and wind power holds great promise in alleviating dependence on fossil fuels and on foreign sources of energy.

SEE ALSO: Alternative Energy; Fossil Fuels; Greenhouse Gases; Renewable Energy.

BIBLIOGRAPHY. National Renewable Energy Laboratory, "Learning about Renewable Energy and Energy Efficiency: Concentrating Solar Power," www.nrel.gov (cited April 2006); T.J. Quinn, C. Fröhlich, "Accurate Radiometers Should Measure the Output of the Sun," *Nature* (v.401, 1999); Michael E. Ritter, *The Physical Environment: An Introduction to Physical Geography*, www.uwsp.edu/geo (cited April 2006); David. P. Stern, "From Stargazers to Starships," National Aeronautic and Space Administration, www-spof.gsfc.nasa.gov (cited April 2006).

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Solomon Islands

THE SOLOMON ISLANDS consist of seven major islands and 30 smaller islands, mainly islets, covering a land mass of 28,370 square kilometers. The main islands are predominantly high islands dominated by mountainous forests, though the country also includes a number of smaller outlying atolls. The Solomon Islands comprise a country rich in natural resources, especially forestry, minerals, and fisheries. The economy is primarily based upon timber, fisheries, palm oil, cocoa, and copra. However, these resources have been poorly regulated and managed and, in the face of one of the fastest population growth rates in the region (3.6 percent per annum on an estimated population in 2005 of 450,000), have not been translated into wealth. Consequently despite these natural resources, the Solomon Islands remain one of the poorest and most politically unstable nations in the Pacific. Average GDP per capita is currently U.S. $460, while the Solomon Islands are recorded as having one of the world's lowest human development indices.

The Solomon Islands have a rich endowment of forest reserves though this resource is under threat. Indeed, one of the key environmental threats facing the Solomon Islands is the unsustainable rate of logging exacerbated by loose controls and the granting of licenses to foreign logging companies in return for personal financial benefits. Forests cover approximately 80 percent of the country, but 80 percent of logging takes place on customary land where government monitoring (where it does exist) is weak. Unchecked logging is resulting in a rapid loss of forest cover, contributing to habitat destruction for a rich and diverse wildlife, soil loss, and sedimentation of catchments and lagoons.

Social and political tensions resulting from unsuitable resource use (concessions far exceed actual forest reserves) and over the impact of logging on communities is increasingly evident, as is corruption associated with timber extraction. The reopening of a gold mine in central Guadalcanal offers the prospect for greater wealth, but may also go the way of logging in terms of the limited social and economic benefit resulting from an extractive and environmentally damaging industry, as has been evident in neighboring Papua New Guinea. Improved environmental reporting and governance, especially in terms of capacity and willingness to deal with the management of natural resources, is vital if the Solomon Islands are to generate enough wealth for the growing, and predominantly poor, population.

Though the Solomon Islands remain an overwhelmingly rural society and economy, the principal city, Honiara (estimated population 45,000), faces problems of service delivery and basic infrastructure. Competition over scarce land and employment opportunities has not stopped considerable rural-urban migration since independence in 1978. Meeting the needs of increasing urban populations and lessoning their environmental impact will also be important in the country's future environmental sustainability.

SEE ALSO: Deforestation; Papua New Guinea; Soil Erosion.

BIBLIOGRAPHY. Central Intelligence Agency, "Solomon Islands," *The World Factbook,* www.cia.gov (cited April 2006); John Overton and Regina Scheyvens, *Strategies for Sustainable Development: Experiences from the Pacific* (Zed Press, 1999); World Bank, "Solomon Islands," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006).

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Somalia

LOCATED IN EXTREME northeast Africa, Somalia occupies the tip of what is known as the Horn of Africa. The country is divided into five general biophysical zones. The eastern highlands are dominated by the Karkaar mountains, where the comparatively high but scattered precipitation supports forest vegetation. Here incense and myrrh collection represent the primary vegetative resource. The central high plateau, or the Haud, straddles the Ethiopian-Somali border and extends more than 37 miles (60 kilometers) into Ethiopia, and south and eastward into central and southwest Somalia. This region is characterized by relatively dense bush vegetation and grasses making up some of the best grazing areas in the country. The central Mudug Plain is made up of smaller terrace-like plains rising gently between the Haud and the coastal plains.

The interriverine area lies between the only two perennial rivers in the country, the Shabelle and the Jubba, and is the country's major agricultural area due to favorable rainfall and soil conditions. Because of the perennial water supply, farmers inhabit many locations in this area permanently, and most Europeans settled here during the colonial era. This is also the region where the greatest interaction between pastoralists and agriculturalists occurs, and a large agropastoral sector exists in the south-central part of the country.

The coastal plains are characterized by coastal sand dunes, especially in the south, and fairly reliable year-round water resources. Although well water is saline in most locations along the coast and causes health problems for both humans and livestock, it is widely used, especially during the dry season. Throughout the country the rainfall pattern includes scarcity, poor distribution, and variability in the onset of the wet season and high variability in the amount of precipitation from year to year. Droughts occur about every four to five years.

Somalia possesses the greatest proportion of pastoralists in Africa. Prior to the war and famine of the early 1990s, approximately 65 percent of the national population participated in nomadic pastoralism, while 80 percent of the population engaged in livestock raising of some kind. The pastoral systems of Somalia are made up of cattle, camels, sheep, and goats. The focus of nomadic life and the mainstay of Somali pastoralism is the camel, which in the past served as the principal medium of exchange in many parts of the country. In times of famine camels have outlived less hardy livestock, providing the needed milk, meat, and transport that stand between the nomad and starvation.

Somalia has had no functioning central government since the early 1990s when the regime of President Siad Barre ended with considerable violence. Numerous attempts by various Somali factions and the international community have had little success in reconstituting an effective form of governance, and violence is ongoing. Meanwhile two areas in the north of the country have declared themselves autonomous—Somaliland and Puntland—and are assembling regional forms of governance; while the rest of the country continues in the hands of local militias. The turmoil in Somalia has had a debilitating impact on pastoralists and livestock herding activities. The decimation of herds and the impoverishment of nomads beyond the capacity of indigenous recovery mechanisms will compromise food production in the country for some time, while creating very large refugee populations.

SEE ALSO: Drinking Water; Drought; Famine; Livestock; Pastoralism; Poverty; Wars.

BIBLIOGRAPHY. M.N. Al-Najim and J. Briggs, "Livestock Development in Somalia—A Critical Review," *GeoJournal* (v.26, 1992); L.V. Cassanelli, *The Shaping of Somali Society* (University of Pennsylvania Press, 1982); J. Clark, "Debacle in Somalia," *Foreign Affairs* (v.72, 1993); A.A. Handulle and C.W. Gay, "Development and Traditional Development in Somalia," *Nomadic Peoples* (v.24, 1987); I.M. Lewis, *A Pastoral Democracy: A Study of Pastoralism and Politics among the Northern Somali of the Horn of Africa* (Oxford University Press, 1961).

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Somerville, Mary (1780–1872)

MARY SOMERVILLE, WRITER on science, was born Mary Fairfax on December 26, 1780, in Jedburgh, Roxburghshire, Scotland. She grew up in Burntisland, Fife, where she studied on her own, despite her father's discouragement. In 1804, she married her cousin, Samuel Greig (1778–1807). They moved to London, where Mary continued to study mathematics and took French lessons. She had two sons with whom she returned to Burntisland after Greig's death in 1807.

Now a widow of independent means, Mary used family connections to enter Edinburgh social and intellectual circles, receiving instruction by correspondence. In 1812, she married another cousin, William Somerville (1771–1860), an army doctor with an active interest in science who, unlike her first husband, encouraged her studies. In 1816 the Somervilles and their two daughters moved to London. Mary and her husband became active in scientific circles, and conversations with men of science greatly expanded her knowledge and understanding. She made contact with several French scientists by correspondence and on a visit to the continent in 1817–18 consolidated her understanding of the advanced mathematics being pioneered in France.

In 1827, Somerville was asked to prepare for publication a concise English version of Laplace's *Mécanique Céleste* [*The Mechanism of the Heavens*] (1798–1827), which laid out Laplace's nebular hypothesis of the solar system. Somerville consulted leading astronomers and mathematicians to produce the version in English (1831) which covered four of Laplace's five volumes. Her introduction was published separately as *Preliminary Dissertation to the Mechanism of the Heavens* (1832). *The Mechanism* was adopted in 1837 as a textbook at Cambridge University. Close contacts with scientists in France and England made Somerville's second book, *On the Connection of the Physical Sciences* (1834), an up-to-date account of astronomy and physics, with sections on meteorology and physical geography. Its accessible style made it immensely successful and its 10 successive editions acted as progress reports for the physical sciences.

From 1838, the Somervilles lived in Italy for William's health, but Mary continued her work. Her two-volume *Physical Geography* was complete by 1842 but remained unpublished until 1848 and was thus beaten to the press by the first volumes of Friedrich Von Humboldt's *Kosmos* (1845). It was, however, the first English-language textbook in the field and immediately successful, its publication coinciding with the establishment of geography at the universities of Oxford and Cambridge. Unlike earlier geographies, which confined themselves to describing the location of phenomena, often listing them country by country, Somerville was interested in causality, and this led her to locate phenomena with respect to physical regions rather than to nation states. Like the successive editions of *Physical Sciences,* the seven editions of *Physical Geography* (latterly edited by H.W. Bates) became something of a digest of current thinking in the field.

Mary Somerville was widely honored by scientific societies in Europe and the United States, though restrictions on women prevented her election to many of them. She died in Naples on November 29, 1872. She was not an original scientist, and her commanding contemporary reputation declined soon after her death. Recently her exceptional talents for synthesis and presentation, which brought scientific knowledge and understanding in several fields to a wide contemporary audience, have regained recognition, and in particular she is recognized as a pioneering woman in a field dominated by men. Somerville College, Oxford, (founded in 1879 as a women's college) commemorates her name.

SEE ALSO: Gender; Geography; Regions.

BIBLIOGRAPHY. Mary R.S. Creese, "Mary Somerville," in H.C.G. Matthew and Brian Harrison, eds., *Oxford Dictionary of National Biography* (Oxford University Press, 2004); Margaret Oughton, "Mary Somerville, 1780–1872," in T.W. Freeman, M. Oughton, and P. Pinchemel, eds., *Geographers: Biobibliographical Studies* (v.2, 1978); Elizabeth C. Patterson, *Mary Somerville and the Cultivation of Science, 1815–40* (Nijhoff, 1983); Marie Sanderson, "Mary Somerville: Her Work in Physical Geography," *Geographical Review* (v.64, 1974).

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Sonoran Desert

THE SONORAN DESERT is one of the largest North American deserts, over 120,000 square miles (311,000 square kilometers), occupying the coastal plain and low elevation basins to the north and northeast of the Gulf of California. It comprises a part of Arizona and California in the United States, western Sonora, and the southern two-thirds of the Baja California peninsula in Mexico. The physical features of the isolated mountains and outwash lowland plains place the region within the Basin and Range Province. The Sonoran Desert low to mid elevation mountains range from northwest to southeast in parallel to one another. The highest area, 3,957 feet (1,206 meters) in elevation, is in the western part of the ecoregion. The foothills of the western Sierra Madre Occidental dominate the southern part of the Mexican state of Sonora. The foundation of the Sonoran Desert basins is characterized by erosion and sedimentation processes. These valleys are identified as alluvial fans that are formed as rainwater streams wash weathered detritus minerals, eroded sands, and gravels from the mountain slopes.

The Sonoran Desert is characterized by an arid climate of extreme heat and extreme cold with an annual precipitation of about 3.9–5.1 inches (100–130 millimeters). The precipitation season is divided into two seasons. Winter rainfall with rains of Mediterranean type starts in November and continues with interruptions until March. Summer or monsoon rainfall lasts from July to September and has brief showers of tropical origin. Total precipitation in general increases from west to east. The Gulf of California is the major recipient of Sonoran Desert drainage. All major permanent streams of the Sonoran Desert originate outside the desert. The largest river with a permanent flow is the Colorado River. The Sonoran Desert soils are low humus and high salt content soils lacking a well-defined profile. The insufficient soil moisture and impaired drainage generate caliche hardpan, which reduces soil permeability and prevents root growth.

Unique features of the Sonoran Desert are the high species endemism and great species biodiversity that is well adapted to the harsh desert environment. The giant saguaro cactus is the most recognizable plant of the region. The region is known as an exceptional birding area, particularly for hummingbirds. Some of the desert mammals include species such as the mountain lion, bobcat, deer, and antelope.

Located on the Mexican-American border, the Sonoran Desert divides two countries with distinct cultures and contrasting levels of development. Transboundary conflict over Colorado River water rights and illegal immigration from Mexico into the United States are some of the political issues that arise between these two countries that have shared a border since 1848. Border-crossing migrants not only risk their lives when traversing the harsh desert environment but also create a threat to that environment by introducing invasive species, leaving garbage in wilderness areas, and being competitors to desert animals for scarce water resources. The different social, economic, and national goals of the two border countries, in addition to their technological progress and innovations, cause great pressure on indigenous cultures of the region. The largest environmental impact within the Sonoran Desert has resulted from anthropogenic activities to make the desert ecosystem a more human inhabitable place. The activities include irrigated agriculture, pasturing, grazing, development of military equipment, and off-road driving.

SEE ALSO: Climate, Arid and Semiarid; Colorado River; Desert; Mexico; United States, California.

BIBLIOGRAPHY. Arizona Roadside Environments, "Arizona Regional Geology," dana.ucc.nau.edu (cited December 2006); Chris Clarke, "The Battered Border," *Earth Island Journal* (v.21/4, 2006); Roger Dunbier, *The Sonoran Desert, Its Geography, Economy, and People* (University of Arizona Press, 1968); William G. McGinnies, "An Overview of the Sonoran Desert," alic.arid.arizona.edu (cited December 2006); World Wildlife Fund, "Sonoran Desert," www.worldwildlife.org (cited December 2006).

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South Africa

LOCATED AT THE southern tip of Africa, with a population of approximately 47 million, South Africa is a country known for both its racial division and its peaceful transition to democracy. Apartheid, or "separateness," was the official policy used by the white nationalist government to entrench racial discrimination in all areas of life in South Africa between 1949 and 1994. The 1950 Group Areas Act spatially segregated different race groups from each other, typically through forced removals of the black, Indian, and so-called colored populations into underdeveloped areas on the periphery of cities and towns or into designated rural areas called "homelands." Unequal access to educational and employment opportunities, restricted movement, and the criminalization of antiapartheid protest further divided the country.

Since the election of the African National Congress (ANC) as the country's first democratic government

Robben Island

Robben Island off the coast of Cape Town was originally called Robbe Eiland (seal island) and became a penal settlement in 1636. In 1658, Jan van Riebeck, the leader of the original expedition to South Africa, sent his interpreter there. At first the island was used for convicts who had committed offenses in Cape Town and nearby areas, but by the 18th century, it was used to house high-ranking princes and rulers from India and the Dutch East Indies who had offended the Dutch. A *kramat* was constructed in 1969 over the grave of an Indonesian prince, and it became a place of pilgrimage for Muslims. The South African Prison Service took over the island in 1960.

In 1963, Nelson Mandela and other black nationalist leaders were sent to the island and made to work on a lime quarry for six hours a day. Many, including Mandela, suffered damage to their eyesight. Work to construct a maximum security prison was completed in 1964, and gradually more political activists serving life sentences were transferred there. Mandela was released in 1990, and in the following year the island's last political prisoners were released. It has now become a major tourist attraction and has gained nomination by the South African Natural Heritage Programme owing to its significance as a breeding colony for Caspian terns and jackass penguins.

in 1994, South Africa has taken up the challenges of poverty reduction and the provision of basic services, housing, education, employment, and social services in historically disadvantaged communities. New problems such as dramatically high HIV/AIDS infection rates and rising crime present further challenges.

Programs such as the Reconstruction and Development Programme (RDP) and the Growth Equity and Redistribution (GEAR) macro-economic policy have been used to initiate change through either people-driven or economic growth–focused programs, respectively. Key legislative changes for postapartheid transformation were initiated by the introduction of the Constitution in 1996, which includes a widely acclaimed bill of rights. Extensive local government restructuring now ensures the prioritization of community-based development and reconstruction. A national policy for black economic empowerment attempts to address economic inequality. All policies and development planning tools emphasize public involvement so that communities are included in decision making.

Although the dominant focus of change in South Africa is people-centered, there is recognition that South Africa's rich natural resources and scenic beauty must be maintained and protected. Good environmental quality is recognized as key to improving citizens' quality of life and necessary for the growth of tourism and other industries. Many poor communities rely directly on the environment for their survival and have historically been located alongside polluting industry, such as in the South Durban Industrial Basin, causing conflict over the negative effects of pollution and access to resources.

Environmental problems such as overgrazing, soil erosion, and the pollution of local water supplies commonly arise from the impacts of overuse by poor communities with minimal basic services, little income, and insecure land tenure. The pressures of industry and sprawling urban development contribute to growing problems of air, water, and land pollution; loss of agricultural land; and decreasing biodiversity. Furthermore, South Africa suffers from a severe pressure on freshwater resources, especially as the most industrialized areas of the country have minimal natural water supplies and must have water supplied to them via elaborate interbasin transfer schemes. Historically, preservationist conservation practices excluded communities from having access to the natural resources that they have traditionally relied on for sustenance, medicine, and cultural practices.

In order to address these problems holistically, sustainability principles have been widely adopted within South Africa, beginning with the Constitutional right to a nonharmful environment. Recently many new environmental laws have been passed to update, expand, and consolidate the previously inadequate environmental legislation. Legislation such as the National Environmental Management Act of 2000 advocates the use of sustainability principles, dispute resolution, and community empowerment as key environmental management practices. Currently new community- and partnership-based conservation methods are being introduced to enable communities to benefit from protected areas. In 2004 the World Summit on Sustainable Development was hosted in Johannesburg, encouraging further steps toward sustainability and improved quality of life.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Justice; Overgrazing; Pollution, Water; Poverty; Soil Erosion; Water Demand.

BIBLIOGRAPHY. Patrick Bond, *Unsustainable South Africa: Environment, Development and Social Protest* (University of Natal Press, 2002); Roddy Fox and Kate Rowntree, eds., *The Geography of South Africa in a Changing World* (Oxford University Press, 2000); Alan Lester, Etienne Nel, Tony Binns, *South Africa. Past, Present and Future* (Prentice Hall, 2000); Susan Parnell, Edgar Pieterse, Mark Swilling, and Dominique Wooldridge, eds., *Democratising Local Government: The South African Experiment* (University of Cape Town Press, 2002).

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Soybeans

SOYBEANS, WHICH ARE called *soya* in the United Kingdom or *soja* beans elsewhere, are a highly nutritious legume that is one of the world's oldest crops. The beans grow on a bushy annual herb that has hairy trifoliate leaves. The flowers of the soybean plant are purple to pink in color. The soybean plant, native to Asia, is related to alfalfa, clover, and peas. Soybeans were probably first grown in eastern China over 5,000 years ago. The Chinese Emperor Sheng-Nung named five sacred plants in 2853 B.C.E.: rice, wheat, barley, millet, and the soybean. From that time soybean cultivation spread to Burma, India, Indonesia, Japan, Malaysia, Nepal, the Philippines, Thailand, and Vietnam.

When Europeans voyaged to the Far East during the Age of Discovery, they saw soybeans under cultivation. Soybeans were introduced into Europe through France in the 1700s; however, it was not until the 1900s that they were grown widely in Western countries.

In the late 1800s, farmers in the United States began to cultivate soybeans. In 1904, George Washington Carver conducted experiments on soybeans. He discovered that they were rich in protein and oil, and could withstand the hot dry summers of the southern United States. In the 1900s the U.S. Department of Agriculture (USDA) began to conduct tests on soybeans and to encourage farmers to plant the crop. In the late 1920s, William J. Morse of the USDA was a leader in the Dorsett-Morse Expedition to East Asia, where they collected over 10,000 varieties of soybeans. In the 1940s, soybean production in the United States boomed.

The United States is the leading producer of soybeans in the world, followed closely by Brazil, whose exports increase annually, often through the expansion of agriculture into forested lands. It exports about half of its annual crop. The economic impact of soybean production for farmers is great. Soybeans are the third largest of the crops grown in the United States, behind wheat and corn, and they are grown in over 30 American states. In 2004, production was 74 million metric tons of soybeans. The soybeans grown today are hybrids that have been produced to increase yields and for their insect and disease resistant qualities. The cultivated soybean is usually *Glycine max*, a legume of the pea family. A small percentage of soybeans are the vegetable variety; these may be eaten as a bean or used to produce bean sprouts.

The United States is the leading grower of soybeans in the world and produced 74 million metric tons in 2004.

Soybeans are an annual warm weather crop. They are planted in the spring after the danger of frost has passed and are harvested before frosts come in the autumn. They grow to about two to four feet tall. About eight weeks after planting, the soybean plant will issue small flowers. Many will produce pods with two or three beans per pod. The normal time from planting to harvest is three or three and a half months. Most soybeans are commercial soybeans that are used in making soy flour or oil. Until 1900 the main use of soybeans was for animal forage. Beginning in the early 1900s, they were processed into oil and meal. Until the 1930s, the meal was used as fertilizer. By the 1940s, soybean meal was being used to feed poultry and livestock. It also began to be used in some pet foods as well. After the 1960s, scientists developed a number of new soy products, including soymilk, spun soy, soy protein concentrate isolated soy protein, and other soy derivatives. Soymilk is often used to feed infants who are lactose intolerant.

Soybeans are an excellent source of protein. Soybeans will yield 10 times as much protein per acre as will cattle grazing. Most consumption of soybeans is after some processing into meal or oil. Grinding soybeans very finely produces soy flour that can be used in baby foods, breads, cereals, and low calorie foods. It is also used as a low-cost feedstock for fish, swine, cattle, chickens, and other animals. Other uses for soy flour include the manufacture of tofu and brewed soy sauce. In addition, some industrial products such as plastics, wood adhesives, and textile fabrics are made from soybeans. Soy grits are coarse-ground soybeans. They are used to produce products aimed at vegetarians that look like cuts of meat. Soybean oil is now the leading vegetable oil in the world. Soy oil is used in margarine, mayonnaise, and in salad dressing. It is also used as a carrier in some inks and paints and as an environmentally friendly lubricant in diesel engines.

SEE ALSO: Agriculture; Cash Crop; Legume.

BIBLIOGRAPHY. H.R. Boerma and J.E. Specht, *Soybeans: Improvement, Production and Uses* (ASA-CSSA-SSSA, 2004); Stephen Holt, *The Soy Revolution: The Food of the Next Millennium* (M. Evans, 1998); J.P. Houck, M.E. Ryan, and Abraham Subotnik, *Soybeans and Their Products: Markets, Models and Policy* (University of Minnesota Press, 1972); Keshun Liu, *Soybeans: Technology and Utilization* (Aspen Publishers, 1997); D.P. Verma and R.C. Shoemaker, eds., *Soybean: Genetics, Molecular Biology and Biotechnology* (CAB International, 1996).

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Space Program (U.S.)

AFTER THE LAUNCH of the Russian satellite Sputnik on October 4, 1957, the U.S. Congress met this Cold War challenge by greatly enhancing the space program of the United States. On July 29, 1958, President Dwight D. Eisenhower signed the National Aeronautics and Space Act (Public Law 85-568) creating the National Aeronautics and Space Administration (NASA). Organized as a civilian agency, it was given a mission of peaceful space research.

NASA has directed two kinds of space programs—unmanned flights to the solar system, and manned flights. Unmanned flights have included the Ranger space probes to photograph the Moon, the Surveyor probes that made the first American landings on the Moon, the Viking probes to Mars to study its soil, and the Pioneer probes to study Venus.

Voyager 1 flew by Jupiter and Saturn. Voyager 2 mapped Jupiter and Saturn, flew by Uranus in 1986 and past Neptune in 1989, and photographed active volcanoes on Io (a moon of Jupiter) and geysers on Triton (a moon of Neptune). The Magellan probe mapped the surface of Venus in 1990. The Pathfinder probe landed on Mars and sent out a land rover vehicle, Sojourner, to explore Martian surface chemistry. In January 2004, the Spirit rover landed at the Gusev Crater on the surface of Mars. In December 2004 the Cassini-Huygens mission visited Saturn's moon Titan to study its atmosphere and geology.

NASA's program of manned flights into space began in 1958. The Kennedy Space Flight Center was assigned responsibility for launching manned space flights; the Lyndon B. Johnson Space Flight Center in Houston was put in charge of managing space flights from lift-off to landing. America's space travel began with the Mercury program when Ham, a chimpanzee, accomplished an 18-minute flight in a Mercury capsule. On May 5, 1961, astronaut Alan B. Shepherd made a 15-minute sub-orbital flight in a Mercury capsule dubbed Freedom 7. In 1961, Presi-

Many advances have derived from NASA's experiments, including microspheres used to clean oil spills.

dent John F. Kennedy, in an address to Congress, called for a national goal—the landing of a man on the Moon "by the end of the decade" (the 1960s). To meet the goal a crash program was instituted.

Human exploration of space began to develop rapidly in the 1960s. On February 20, 1962, John H. Glenn, Jr., became the first American to orbit the Earth. Others followed him in the Mercury missions. On March 23, 1965, NASA sent astronauts Gus Grissom and John W. Young into space in Gemini 3, a larger capsule than the Mercury. In August 1965 the Gemini 5 mission was able to last eight days using fuel cells to generate electricity.

On December 21, 1968, NASA launched Apollo 8 on a mission to orbit the Moon. On Christmas Eve, they sent back television pictures of the Earth from lunar orbit. Apollo 8 returned safely to earth on December 27, 1968. Perhaps the greatest triumph came on July 20, 1969, when from the Moon's Sea of Tranquility the words, "Houston, the Eagle has landed," ended several seconds of deathly silence in which it was not known if the Eagle, from the Apollo 11 had survived its landing. The landing was followed by a moonwalk by astronauts as the world watched on television. After conducting a number of scientific experiments, the Eagle lifted off to rejoin Apollo 11. More manned flights to the Moon followed.

On May 14, 1973, NASA launched Skylab, a manned space laboratory, into earth's orbit. On April 12, 1981, NASA launched Columbia, the first of its fleet of reusable manned space shuttles that, after earth orbit, landed in California as if it were an ordinary airplane. In the more peaceful post–Cold War era, America's space program expanded to include well over a dozen countries. NASA today promotes interest in space exploration with tours of launch sites, interviews with astronauts, space camps, and other educational programs. NASA has experienced a number of dramatic launch and recovery failures that, under its publicly open policy, have been dramatically captured on television. Rockets have exploded on launch pads. Astronauts have been killed in tests and in the Challenger and Columbia shuttle disasters. Tragedy almost struck with the voyage of Apollo 13 to the Moon.

NASA has contributed to the advancement of knowledge of space and to the improvement of human life on earth. Great accomplishments in the fields of biology, medicine, engineering, management, robotics, foods, and materials have brought a vast number of products to the world. These include everything from Teflon, to Tang, to orange juice, to communications satellites, to ear thermometers, to space suit technology used in numerous medical situations. NASA has conducted many biological experiments.

From these have come microspheres that are used to clean oil spills and treat tumors. Great advances in plastics, foods, and firefighting equipment have come out of NASA's work. On January 15, 2004, President George W. Bush called for renewal of the goal of manned missions to the planets.

SEE ALSO: Gaia Hypothesis; Global Positioning Systems (GPS); Remote Sensing; Satellites; Science and Technology Studies; Spaceship Earth.

BIBLIOGRAPHY. David Aaron Baker, *Inventions from Outer Space: Everyday Uses for NASA Technology* (Random House, 2000); Andrew Chaikin, *Man on the Moon: The Voyages of the Apollo Astronauts* (Penguin, 1998); Gene Kranz, *Failure Is Not an Option: Mission Control from Mercury to Apollo 13 and Beyond* (Simon & Schuster, 2000); Roger D. Launius, *NASA: A History of the U.S. Civil Space Program* (Krieger Publishing Company, 2000); Frank Sietzen and Keith L. Cowing, *New Moon Rising: The Making of America's New Space Vision and the Remaking of NASA* (Apogee Books, 2004); Steven J. Strick, *The Living Universe: NASA and the Development of Astrobiology* (Rutgers University Press, 2004); Peter Douglas Ward, *Life as We Do Not Know It: The NASA Search for (and Synthesis of) Alien Life* (Penguin Group, 2005).

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Spaceship Earth

THE AMERICAN ECONOMIST Henry George first compared the Earth to a ship in *Progress and Poverty* (1879). George wrote, "It is a well-provisioned ship, this on which we sail through space," and analogized the planet to a naval craft in which resources in the ship's hold were abundant but unfairly distributed to passengers because of privatization by the ship's hands. The phrase "spaceship Earth," which was coined in 1963 by the futurist R. Buckminster Fuller, has since come to be associated more with a discourse of natural resource scarcity, unsound social planning, and resulting environmental crisis. Writing at the dawn of the space age, Fuller utilized the metaphor to picture the Earth as a form of rocket ship that had been created to provide life support for its inhabitants, but which required upkeep and an understanding of its ecological mechanisms in order to continue to function well.

Fuller envisioned the rise of a new global society in which people would recognize themselves as earthlings, and challenged people to lead more ethical lives as fellow passengers of a common planetary vessel. Though Fuller recognized that society could continue to travel the dystopic path of greed and imperial plunder, in accordance with a history of what he referred to as the "Great Pirates," Fuller was hopeful that modern science and technology could be deployed democratically in order to achieve necessary conservation of the environment and the creation of a holistic society based on integral understandings of existence. Widely popular at the time, Fuller's philosophy influenced many experts and public figures. In 1965 the U.S. ambassador to the United Nations (UN), Adlai Stevenson, drew upon Fuller's ideas in a speech made to the Economic and Social Council of the UN in which he called upon nations to recognize that they traveled together on a little spaceship, dependent upon its limited land and air.

In 1966, the economists Barbara Ward and Kenneth Boulding each adopted and popularized the metaphor of spaceship Earth to outline the need for new forms of political economy based on an increasing awareness of human dependence upon the natural limits to economic growth. Ward echoed Stevenson in picturing the Earth as a "small ship" in which all of humanity found itself employed as a crew, and she concluded that rational social planning that better distributed economic wealth and engaged with a conservationist ethic was necessitated for mass survival. In this way, Ward successfully attached the spaceship Earth image to nascent versions of sustainable development policy. Boulding, meanwhile, analyzed how the history of frontier economics had come to a close in an age when no new lands remained to be discovered. With illimitable growth no longer possible, he claimed, the "cowboy economy" of the past would have to be superseded by a "spaceman economy" based on an evolved knowledge of a world system in which material goods endlessly circulate and recycle. However, some have questioned whether the metaphor of a spaceship, which presupposes extraterrestrial voyage, appropriately conveys an end to human exploration patterns.

In the 1970s, environmental theorists such Paul Ehrlich and Garrett Hardin argued that exponentially increasing global population rates even further exacerbated the situation on spaceship Earth and that hard decisions about how best to live within the Earth's carrying capacity were required. Ehrlich went so far as to argue that spaceship Earth could not be saved without population control in the form of strong regulation on international aid and biological conception. Hardin agreed, further critiquing the metaphor of spaceship Earth as flawed in that no planetary captain or steering committee existed for the ship. This, he felt, left policy makers who utilized the metaphor in the position of assuming that people had spaceship rights without spaceship responsibilities. As a corrective, he offered the metaphor of the lifeboat.

Other environmentalists have since challenged the metaphor of Earth as spaceship, arguing that it overly relies on technological discourse and that organic metaphors such as the Earth as superorganism, or Gaia, are more appropriate. Yet, the idea of spaceship Earth has largely resonated with the environmental community. For instance, the AS17-22727 image of the planet taken from space during the Apollo 17 mission has become iconic for International Earth Day, adorning as a logo various flags, posters, shirts, and bumper stickers. Thus, the idea of spaceship Earth endures with those who champion a planetary view and sustainability, though its greatest popularity was doubtless during the 1960s and 1970s.

SEE ALSO: Common Law; Earth Day; Gaia Hypothesis; Lifeboat Ethics; United Nations.

BIBLIOGRAPHY. Kenneth E. Boulding, "The Economics of the Coming Spaceship Earth," in Henry Jarrett, ed., *Environmental Quality in a Growing Economy* (Johns Hopkins Press, 1966); Paul R. Ehrlich and Richard Harriman, *How to Be a Survivor: A Plan to Save Spaceship Earth* (Ballantine, 1971); R. Buckminster Fuller, *Operating Manual for Spaceship Earth* (E.P. Dutton & Co., 1963); Henry George, *Progress and Poverty* (Robert Schalkenbach Foundation, 1979 [1879]); Garrett Hardin, "Living on a Lifeboat," in Garrett Hardin and John Baden, eds., *Managing the Commons* (Freeman, 1977); Barbara Ward, *Spaceship Earth* (Columbia University Press, 1966).

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Spain

SPAIN IS A European state located in the Iberian peninsula in southwestern Europe. Its territory includes the Balearic Islands, in the Mediterranean, and the Canary Islands, in the Atlantic ocean. The total land area is 194,208 square miles (503,000 square kilometers), and in 2006, the estimated population was 44.3 million with an increasing proportion of African, Asian, and Latin American immigrants

Most of the country consists of a high plateau descending westward and surrounded by several mountain chains in the north, the east, and the south. Two large depressions occupied by the Ebro river in the north and by the Guadalquivir river in the south, and two peripheral high mountain chains (the Pyrenees in the north and the Baetic Sierras in the south, both with peaks above 9,843 feet [3,000 meters]) complete the physiography. The climate is Mediterranean with the exception of the northwestern and northern regions, where Atlantic conditions predominate. The central region features cold winters and hot summers. Droughts and floods are common features of the Spanish climate.

The environmental situation of Spain reflects its status as a developed economy with some distinctive traits related to its specialization in tourism and the relatively important role of intensive agriculture. Both sectors tend to concentrate along the Mediterranean coast (and tourism also in the islands) and exacerbate land and water management problems. Thus tourism appears to be the driving force of one of the highest rates of urbanization in Europe. In 2004, more new homes were built in Spain than in Germany, Italy, and the United Kingdom combined. In the Costa del Sol (Andalusia) alone, more than a half million homes and dozens of golf courses are planned for the near future. In 2005, the European Union (EU) issued a warning to the regional government of Valencia in response to that body's fostering urban development with little environmental controls, and in the same year, the government of Murcia in the southeast unclassified protected land for the construction of new urban and tourist resorts.

Water management to meet growing demands remains one of the more pressing problems faced by the country. About three-quarters of the water consumed is used for agriculture, for crops of both high value (e.g., irrigated fruit and vegetable orchards of the Mediterranean area and the Canary Islands) and low (maize and fodder crops in the central regions), but urban and tourist demand is rising fast, especially along the Mediterranean coast and in the islands. To meet growing water demand, in 2001 a New National Water Plan was launched by the conservative government. The main feature of this plan was a large water transfer from the Ebro river to the Barcelona region, and, more importantly, to Valencia, Murcia, and Almeria in the east and south to meet the growing requirements of agriculture and tourism. Due to a large social opposition in the Ebro basin, the transfer was halted by the socialist government in 2004 and water was to be obtained instead from desalinization plants.

Agricultural abandonment constitutes another cause of concern for the Spanish environment. More than 20 percent of agricultural land has been lost since the 1980s, exacerbating problems such as soil erosion, desertification, and forest fires. Regarding the latter, between 1995 and 2005, about 197,684 acres (80,000 hectares) burned annually. Fires in 2005 were especially tragic, with 264,402 acres (107,000 hectares) affected and 13 deaths. Because of its varied landscapes, Spain has one of the highest biodiversity rates in Europe. Protected areas (571 in 2003) represent approximately 10 percent of the land, and Spain was the fourth country in Europe to establish a system of national parks, which has been in force since 1918. Moreover, there are 20 Biosphere Reserves, which make up more than 2.4 million acres (one million hectares).

Recent urban and industrial growth has produced a substantial deterioration in urban air quality. More than 80 Spanish cities (12 million people) registered in 2005 concentrations of pollutants such as particulates, nitrogen dioxides, and ozone above EU standards, and carbon dioxide emissions have grown 53 percent since 1990 (according to the Kyoto Protocol, Spain was allowed to increase its emissions by 15 percent in 2008). Although most of its energy comes from natural gas, coal, and nuclear power plants, Spain has embarked on an ambitious program of renewable energies, especially wind: In 2005, the country ranked second in the world, after Germany, in installed capacity (10,000 megawatts or 20 percent of the world total).

SEE ALSO: Agriculture; Biodiversity; Biosphere Reserves; Desertification; Farming Systems; Fire; Irrigation; Pollution, Air; Soil Erosion; Tourism; Urbanization; Water Demand; Wind Power.

BIBLIOGRAPHY. Central Intelligence Agency, "Spain," *The World Factbook,* www.cia.gov (cited April 2006); United Nations Development Programme, "Human Development Report: Spain," hdr.undp.org (cited May 2006); World Bank, "Spain," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006).

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Species

SPECIES IS A definitional unit used by biologists and other life scientists to systematically classify the enormous numbers of life forms on the earth. The basic unit of classification is species, followed by larger groupings of related plants or animals. The term *species* was first used by the ancient Greeks. Taken from the Greek, the word *ideos* meant the shape or visible form of something—its form made it rationally comprehensible. Logically specifying the form of something as a specie of some species answered the question, "What is it?"

Millions of species have been identified and many more are discovered virtually every day. In general, a species includes all of the individual members of its natural population that are descended from common ancestors and that can breed indefinitely with each other. The interbreeding population share similar characteristics including appearance, genetics, and relatively recent ancestors. The factor of interbreeding is a very important defining characteristic. The interbreeding members of a species exchange hereditary material or genes with each other to produce offspring after their own kind, and a common gene pool is established within the species. Generally, differences between species prevent interbreeding through reproductive isolating mechanisms.

There are many species that are closely related to other similar species that do not normally interbreed. For example, wolves and dogs are closely related but do not normally interbreed, although in this particular case, they are capable of interbreeding. In some species, interbreeding produces hybrids, most of which are sterile and cannot breed. For example, horses and donkeys can and do interbreed, but the offspring are usually sterile mules produced by a male donkey and a female horse.

CLASSIFICATION

The term *species* is used in the scientific classification of plants and animals in order to provide a taxonomic system for organizing all plants and animals. The current system groups all individual plants and animals into a basic group called a "species." The individuals in a species are assigned two names in Latin, which are often derived from Greek or Latin words.

The Latin naming system is called a binomial system because it uses two names as identifiers assigned to a new species. The first name is the genus name of the species and the second name is the special identifying name of the species. The binominal system of nomenclature enables scientists to name the plants and animals in exactly the same standard way regardless of individual variations. The binomial nomenclature enables individuals to be grouped into a useful category everywhere around the world. For example, dogs, found everywhere, are classified as the species *Canis domesticus*. The *domesticus* refers to its ancient taming by humans and close association with human domiciles. The naming of species is done by scientific bodies. They may use a name that is descriptive of a characteristic of the species or that recognizes the discoverer of a newly identified species. To aid in the work there are now international codes of ontological and botanical nomenclature.

However, many biologists and other life scientists who regularly engage in taxonomic work doubt whether one single scheme of classification will fit all life forms. Among biologists and other life scientists the so-called "species problem" is a controversial subject. There is considerable disagreement about how best to identify species, what constitutes a useful name, what is a genuine species, and how it is to be distinguished from similar but apparently different species that are not really different species but just differences in individuals. For example, black- and blonde-colored cocker spaniels are not different species, but rather individuals with different characteristics. Such obvious differences are not always apparent among some of the more obscure forms of life.

DEVELOPMENT OF THE SYSTEM

Humans have been naming plants and animals from the beginning of human history. For example, Aristotle sought to develop a system for naming plants and animals. However, most names have been common names that are used locally and may change from one language to another. For example, the mountain lion, found throughout the Americas, is also called a cougar, puma, and panther. Its name varies in English, Spanish, Portuguese, and French. While its common name differs from language to language, its scientific name, *Felis concolor*, is always the same.

Without a standard method for naming plants and animals, neither science nor related economic or cultural practices can advance. For example, there are many plants used in medicines. Ancient and medieval medical or pharmacological books will name these, but there is often uncertainty about which plant is really designated by the names used. The making of compounds for consumption as medicines or for other purposes from plants that may be different but similar species could result in harmful or ineffective products. The practical nature of efficient and economical human life has not only warranted the development of terminology for biological taxonomic use, but has compelled it.

A Swedish botanist and physician, Carolus Linnaeus, first developed the naming system, or taxonomy, for scientifically classifying plants and animals that is used today. He worked in the mid-1700s at a time when the voyages of the Age of Discovery were bringing a growing volume of information about plants and animals from around the world. Great numbers of these plants and animals, such as kangaroos and black swans, had been previously unknown to European scientists. In other cases, the plants or animal resembled those already known.

The need for a rigorous system of classifying plants and animals presented Linnaeus with a challenge he met in two ways. First, Linnaeus used the resemblances between closely related plants or animals to place them into specific species; the specific species were put in categories of classification after a close study of the specific traits of the species revealed its diagnostic characteristics. Second, Linnaeus began the work of organizing groups of similar species into broader categories. Today, the system most widely used divides all living things into kingdom (plants or animals), phylum, class, order, family, genus, and species.

Since the 1960s, some biologists have sought to expand the number of kingdoms by adding three more kingdoms. The three additional kingdoms in this proposed scheme are: the kingdom Monera, which includes all bacteria and other Prokaryotic cellular forms of life; the kingdom Protista, which includes algae and single-celled Eukaryotes; and the kingdom Fungi, which includes all fungi, yeasts, and molds that are currently classified as plants.

Advances in transportation since the beginning of the 20th century have allowed scientists to penetrate into ever more remote areas of the world. This has also included the development of technologies that have allowed exploration of the ocean depths. As a result, newly discovered plants and animals have poured into scientific centers, where the task of defining them as species has become almost overwhelming. There are several reasons for this problem.

The classification of species requires detailed study of the characteristics of individual specimens. The study has to not only record a description of the individual's characteristics such as the color, number of feathers, type of feathers, beak characteristics, or other characteristics in a bird, but these characteristics then have to be compared with other similar species. There is no single standard way to do this kind of work.

Using observational characteristics does not automatically guarantee that the individuals in a new set of specimens being studied for classification as a new species will be seen as the same by all observers. The fact is that there are peculiarities in the individuals of a species. These individual characteristics may give rise to debates among biologists, ornithologists, or others depending upon the type of plant or animal in question. The debates could include issues about whether the characteristics are sufficient to create a different species, whether they make for subspecies, or whether the differences are unique at all.

SPECIATION

Speciation—the development of new species—proceeds with the breeding of members of subspecies. Interbreeding can, however, lead to the production of sterile males in significant numbers or it may be that all the male members of interbreeding subspecies are sterile. This will lead to the development of a second stage of speciation in which subspecies are distinguishable as incipient species. These semi-species no longer mate and produce offspring from the original gene pool. The natural selection process will have sorted the members of the original species into subspecies and then into semi-species and then into new species.

These new species may look very much alike in morphology and in behavior, but they will no longer mate and no longer share the same gene pool. When this happens, a new set of species will have evolved. It may be the case that the subspecies that evolves into a new species will survive, but the members of its "cousins" in the other subspecies from which it emerged will not survive as separate species because they were not successful in adapting to the changing environment. These older and nonadaptive species will die out or become extinct. Nature is filled with the fossils of extinct species from earlier times.

Speciation may occur because of geographic separation. The rise and fall of mountains, of islands, or the drifting of continents can lead to geographic separation in which the populations undergo changes into new species from original common ancestors. The process of adaptive radiation may also occur as new niches occur in the environment. The Galapagos Islands has finches that Charles Darwin and others have studied that exhibit changes because of adaptive radiation.

When a species undergoes a rapid process of development in reproductive isolation, chromosomal mutations may occur in one part of the isolated population. The mutant population may then interbreed with its original parent population. Their offspring can be successful as new species or in many cases will be hybrids that are sterile and are thus pruned from off of the evolutionary tree.

In plants, a quantum speciation can occur that creates the form of speciation called polyploidy. The effect is to create the beginning of a new species in just a few generations. It occurs because at the gamete state of cell division, abnormal cells develop four sets of chromosomes instead of the normal two sets inherited from two parents. Self-fertilization adds the additional sets of chromosomes in the flowering stage. The resulting hybrids will be able to be reproductively active, but will not be able to reproduce with the original parent species because the changes have made it reproductively isolated.

Extinction of species can also occur because the members of a species become too specialized in the foods they eat or in a behavior. Or they may not reproduce in sufficient numbers to sustain their population or may have lost a specialized habitat.

Besides the fossil evidence for speciation, there are now genetic studies that show species arise without great morphological changes. The use of DNA is enabling researchers to trace the genealogical linage of species back to often long-extinct common ancestors.

There are problems with the idea of speciation defined in part as a breeding population. There are life forms that are asexual or that engage in self-fertilization. These life forms violate the criterion of interbreeding. As a result, these species are defined in terms of their morphology or physiological resemblances to other members of their population group. There are also cases of populations of cross-fertilizing organisms. Their species cannot be determined experimentally and can only be recognized by characteristics. These forms of organisms are a challenge to the whole idea of using species as a unit of classification.

CONTROVERSY

Philosophical issues have been a part of the use of species as a basic classifying unit. Some of these issues arose among the Greeks and have gained new life in the modern world. For Plato and Aristotle, the species were fixed. The Platonic theory of forms or species was that they were eternal and unchangeable. They were ideas or the forms of things that were mixed with matter to create the visible objects in the visible world. To Aristotle, a philosopher who sought after the forms in the objects of the world by collecting specimens of shellfish at ancient lakes, forms were unchangeable and inherent in the visible objects of the world. Aristotle used the term *species* to designate natural species, which he studied and described in his natural history.

The idea of the fixity of the species was current in Europe prior to the publication of *The Origin of the Species* by Charles Darwin in 1859. A few decades previously, some theologians had adopted the Aristotelian idea of the fixity of the species as the correct interpretation of the meaning of the Biblical description in Genesis that says that God created each plant and animal "after its own kind." The idea of the changeability of the species through an evolutionary process was taken by many as a challenge to the veracity of scripture rather than a challenge to the thinking of Aristotle. The adherence to the idea of the fixity of the species has been a characteristic of fundamentalist and other Christian groups that have rejected an evolutionary model for describing the great biological diversity of the earth.

SEE ALSO: Aristotle; Darwin, Charles; Evolution; Extinction of Species; Linnaeus, Carl.

BIBIOGRAPHY. Michael T. Ghiselin, *Metaphysics and the Origin of Species* (State University of New York Press, 1997); Jody Hey, *Genes, Categories, and Species: The Evolutionary and Cognitive Cause of the Species* (Oxford University Press, 2001); Michael A. Huston, *Biological Diversity: The Coexistence of Species* (Cambridge University Press, 2002); Harold A. Mooney and Richard J. Hobbs, eds., *Invasive Species in a Changing World* (Island Press, 2000); Matt Ridley, *Genome: The Autobiography of a Species in 23 Chapters* (HarperCollins Publishers, 2000); Dov F. Sax, Steven D. Gaines, John J. Stachowicz, and Steven D. Gaines, eds., *Species Invasions: Insights into Ecology, Evolution, and Biogeography* (Sinauer Associates, Inc., 2005); Randall T. T. Schuh, *Biological Systematics: Principles and Applications* (Cornell University Press, 2000); David N. Stamos, *The Species Problem: Biological Species, Ontology, and the Metaphysics of Biology* (Rowman & Littlefield Publishers, Inc., 2003); Don E. Wilson and DeeAnn M. Reeder, *Mammal Species of the World: A Taxonomic and Geographic Reference* (Johns Hopkins University Press, 2005); Edward O. Wilson, *Diversity of Life* (W.W. Norton, 1999); Judith E. Winston, *Describing Species: Practical Taxonomic Procedure for Biologists* (Columbia University Press, 2005).

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Sport Utility Vehicles

SPORT UTILITY VEHICLES, or SUVs, are a popular vehicle type, particularly in the United States. They now constitute one-quarter of all new vehicle sales, with increases in sales expected to continue. They are often marketed to consumers as a way of returning to nature—advertisements depict families enjoying a drive in the mountains or navigating rough terrain. In reality, these vehicles are harmful to the environment, even more so than other passenger vehicles. They rarely serve the purpose depicted in advertisements, because only about 5 percent of SUVs are ever taken off road.

Many assert the U.S. government has set up a double standard in fuel efficiency regulations. The federal Corporate Average Fuel Economy (CAFE) standards were set in the 1970s. New passenger cars must achieve 27.5 miles per gallon (mpg). SUVs, however, were classified as light trucks, not passenger cars, and thus must only achieve 20.7 mpg, on average. Further, because this is an average, some SUVs are far less efficient than this standard, achieving only 12 mpg. When the CAFE standards were set in the 1970s, there were few SUVs and light trucks on the road and they tended to be used for farm or commercial enterprises, not passenger travel. Because the situation has changed dramatically, many have called on the federal government to raise the standard or to reclassify SUVs. In August 2005, the George W. Bush administration announced its new CAFE standards for light trucks. The new standards require new model light trucks to achieve 22.2 mpg by 2007 and 24 mpg by 2011. The new standards, however, exempt vehicles weighing from 8,500 to 10,000 pounds, which includes the Hummer H2, the Ford Excursion, and some models of the Chevy Suburban, prompting environmentalists to say the changes will have virtually no impact.

One of the biggest concerns about SUVs is their impact on global warming. All vehicles contribute to global warming, as they emit carbon dioxide when they burn fossil fuels. Every gallon of gasoline burned by a vehicle puts 20 pounds of carbon dioxide into the air. In 2001, the Intergovernmental Panel on Climate Change (IPCC) reported that about three-quarters of the carbon dioxide emitted by humans in the last 20 years has come from the burning of fossil fuels. This is expected to create warmer temperatures, heat waves, and more intense and dangerous storms over the next century.

The U.S. Environmental Protection Agency (EPA) says one of the most important ways to reduce global warming is by using more fuel-efficient vehicles. A fuel-efficient vehicle, such as a Volkswagen Beetle, will emit 54 tons of carbon dioxide over its lifetime. In contrast, an SUV that gets only 14 mpg, such as the Lincoln Navigator, will emit over 100 tons in its lifetime. The Ford Excursion, the largest SUV, gets only 3.7 mpg and will thus emit 134 tons of carbon dioxide in its lifetime. Even incremental change in miles per gallon can make a tremendous difference. Selecting a vehicle that gets 25 mpg instead of 20 mpg would prevent ten tons of carbon dioxide from being released over the lifetime of a vehicle. Despite the obvious need for manufacturers to create more fuel-efficient vehicles, the average new vehicle fuel economy fell in 2000 to the lowest level since the late 1970s. Much of this decrease in fuel efficiency can be attributed to SUVs.

Increasing the fuel efficiency of SUVs would increase their cost, although only marginally. According to the National Academy of Sciences (NAS), SUVs, light trucks, minivans, and pickup trucks could achieve 28–30 mpg for an additional $1,200–$1,300 per vehicle. This cost would either reduce the manufacturer's current profit margin (around $10,000 per vehicle), or be passed along to the consumer. The NAS concludes that this fuel efficiency standard could be achieved with no sacrifice to safety, however; in fact, it would likely make the vehicles safer. Greater fuel economy would also save the average driver in regard to gasoline costs. It is estimated that a car achieving 40 mpg would save the driver $2,200 in gas costs over the lifetime of the vehicle, offsetting any increased up-front expenditure.

In addition to carbon dioxide, SUVs emit higher levels of a number of pollutants, including carbon monoxide, hydrocarbons, and nitrogen oxides. In regard to air pollution, SUVs are considered to be the equivalent of two to three cars. Again, federal law allows a different standard for SUVs than passenger vehicles. SUVs can emit 30 percent more carbon monoxide and hydrocarbons and 75 percent more nitrogen oxides than passenger cars. These pollutants, which cause eye and throat irritation, coughing, nausea, dizziness, fatigue, confusion, headaches, and contribute to asthma and lung dam-

Increasing the fuel efficiency of SUVs would increase cost but the industry claims this would compromise safety.

age, are regulated under the 1990 Clean Air Act. This act allows the EPA to impose penalties on areas that do not reduce the number of these pollutants. The air in Washington, D.C., is estimated to get eight tons of nitrogen oxide per day over the limit of 162 tons set in 2005. Much of this is due to the number of SUVs on the road, which jumped from 15 percent of all vehicles to 25 percent of all vehicles in just the last three years.

SEE ALSO: Automobiles; Bush (George W.) Administration; Car Corporate Average Fuel Economy Standards; Carbon Dioxide; Clean Air Act; Global Warming; Greenhouse Gases; Intergovernmental Panel on Climate Change (IPCC).

BIBLIOGRAPHY. Keith Bradsher, *High and Mighty: SUVs—The World's Most Dangerous Vehicles and How They Got That Way* (PublicAffairs, 2002); "Bush Administration Announces Weak New Mileage Standards," Bush Greenwatch, August 24, 2005, www.bushgreenwatch.org (cited May 2006); "Environmental Double Standards for Sport Utility Vehicles," SUV Info Link, www.suv.org (cited May 2006).

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Spotted Knapweed

SPOTTED KNAPWEED (*Centaurea maculosa*) is an herbaceous, perennial plant in the Asteracae family with purple flowers. This plant is native to Central Asia and is considered a serious invasive species, especially in rangelands, fields, and roadsides of the western United States. Spotted knapweed has been in North America for over 120 years. Close relatives that are also invasive include Russian knapweed (*Acroptilon repens*), diffuse knapweed (*Centaurea diffusa*) and meadow knapweed (*Centaurea pratensis*). Studies show that infestations of spotted knapweed decrease plant diversity and increase both surface water runoff and soil sedimentation. Spotted knapweed is allelopathic, which means that it produces a substance that may inhibit the growth of nearby plants. Spotted knapweed is especially problematic on rangeland because large infestations can significantly reduce livestock forage. One study reported that spotted knapweed costs the State of Montana an estimated $42 million annually.

Species invasions may have many social impacts beyond economic trouble. In the case of spotted knapweed, species invasion has generated controversy over herbicide use on the one hand, and community involvement in species management on the other. In the Klamath Mountains of California, for example, members of the Salmon River Restoration Council, the Karuk Tribe of California, and the Forest Service are each affected by the presence of spotted knapweed in different ways, and have different notions of the best way to respond to the threat.

The Klamath region is considered to be biologically one of the richest temperate areas in the world, with high levels of both species diversity and endemism. As a Class A invasive species in California, spotted knapweed requires chemical treatment, yet 90 percent of community members oppose the Forest Service's plan to apply pesticides to plant populations. Members of the Karuk Tribe oppose spraying due to concerns over impacts on traditional basket weavers who chew native plant roots as part of the preparation process. Others oppose spraying on more conventional environmental grounds such as concern over damage to fisheries habitat, water quality, and riverside ecosystems. Behind the controversy lie issues of risk perception, past history and institutional trust, traditional environmental knowledge, and cultural sovereignty.

Community opposition to spraying led to an alternative program of intensive hand eradication that has become one of the most successful examples of invasive species management in the region. Although knapweed and other local invasive plants have the potential to cause significant damage, many community members describe positive effects of their work, including community cooperation and empowerment and increased ecological knowledge. While less "cost effective" in traditional economic terms, this approach appears to have significant social, political, and ecological benefits—including community education and empowerment, support of cultural tradition, and maintenance of pristine and significant fisheries. For people living along the Salmon River of California, digging knapweed appears to be about more than how to eradicate a Class A invasive species; it is also about community building, local autonomy, local land management, and connection to place. The Salmon River case may provide an alternative model applicable to other settings, including communities or watershed councils with similar social, cultural, and ecological conditions.

SEE ALSO: Invasions, Biological; Invasive Species.

BIBLIOGRAPHY. Steven Hirsch and Jay Leitch, "The Impact of Knapweed on Montana's Economy," *Agricultural Economics Report* (v.355, 1996); Jeffrey McNeely, *The Great Reshuffling: An Introduction to the Human Dimensions of Invasive Alien Species* (International Union for the Conservation of Nature, 2001); Beverly Ortiz, "Pesticides and Basketry," *News from Native California* (7, 1993).

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Sri Lanka

FORMING A TEARDROP island at the southernmost tip of south Asia, Sri Lanka has long been at the crossroads of religious, cultural, and colonial history. The population of 20,064,776 is more than 69 percent Buddhist. As Ceylon, the country achieved independence in 1948 from the British, who had taken over from the Dutch, who had superseded the Portuguese. In 1972 Ceylon officially became Sri Lanka. Ethnic tensions between the Sinhalese and the Tamil led to war in 1983 and to the deaths of tens of thousands of Sri Lankans. Approximately 200,000 Tamils emigrated to Western nations, and several thousand Sri Lankans sought refuge in other Asian nations. Under the leadership of Norway, a cease fire was negotiated in February 2002.

Bordering the Indian Ocean, Sri Lanka has an 831-mile (1,340-kilometer) coastline. The tropical monsoon climate produces a northeastern monsoon season that lasts from December to March, which is followed by the southwestern monsoon season that occurs between June and October. The mountains of Sri Lanka are confined to the south central area, with the flat terrain of the remaining area giving way to rolling plains. Sri Lanka experiences infrequent cyclones and tornadoes.

Sri Lanka was devastated by the tsunami of December 2004. Around 31,000 people died and another 6,300 were missing after this debilitating disaster. Another 443,000 people were displaced, and property damage was estimated at $1.5 billion. Of all the nations affected by the tsunami, Sri Lanka has been the slowest to rebuild. Consequently, some 250,000 of the poorest Sri Lankans continue to live in temporary refugee camps, and the infrastructure, including schools and medical facilities, is woefully inadequate to support the population. Poverty rates have dramatically increased among those who suffered the most severe losses, with residents of one village experiencing a 94 percent drop in personal income. The United Nations (UN) estimates that one in three people in seriously affected areas are living below the national poverty line of $14 a month. While only 9 percent of the population lack access to improved sanitation, 22 percent of the people do not have sustained access to safe drinking water. Overall, the UN Development Programme Human Development Reports rank Sri Lanka 93rd of 232 countries in quality-of-life issues.

There is great economic inequality in Sri Lanka, with the top 10 percent of the population holding 28 percent of the country's wealth. The per capita income of $4,300 places Sri Lanka 142nd in world incomes. Natural resources include limestone, graphite, mineral sands, gems, phosphates, clay, and hydropower. Despite the fact that less than 14 percent of Sri Lankan land is arable, 38 percent of the people are engaged in the agricultural sector. Since the late 1970s, the government has concentrated on promoting the export trade, which has grown to include food processing, textiles and apparel, food and beverages, telecommunications, and insurance and banking. Amounting to some $1 billion per year, remittances from the 800,000 Sri Lankans who work abroad, chiefly in Middle Eastern nations, are essential to the Sri Lankan economy.

Environmentally, Sri Lanka suffers from deforestation and soil erosion. With approximately 19 percent of the area currently forested, Sri Lanka is losing some 1.5 percent of its forests annually. The mangrove forests, for instance, have been severely damaged by mining and siltation. Industrial wastes and sewage runoff have led to severe pollution of freshwater resources. The salt intrusion that was a by-product of the 2004 tsunami continues to render agricultural land and water wells unusable. In the heavily industrialized city of Colombo, air pollution poses a major threat to general health and the environment.

In 2006, scientists at Yale University ranked Sri Lanka 67th of 132 nations on environmental performance, below the relevant income group but above the relevant geographic group. The lowest scores were assigned in the areas of air quality and biodiversity and habitat. Although the government has protected 13.5 percent of land area, poaching and urbanization have seriously endangered biodiversity. Of 88 endemic mammal species, 22 are endangered. Likewise, 14 of 126 bird endemic bird species are threatened.

The Ministry of Environment and Natural Resources has been charged with the promotion of sustainable development and conservation efforts in Sri Lanka through policy implementation and enforcement. In addition to the current six-year development plan for sustainable use of renewable resources, current environmental policy initiatives include the National Environmental Policy, the National Forestry Policy, the Forest Sector Master Plan, and the Biodiversity Conservation Plan. The Sri Lankan government has committed to the promotion of global responsibility by participating in the following environmental agreements: Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Ozone Layer Protection, Ship Pollution, and Wetlands. The Marine Life Conservation agreement has been signed but not ratified.

SEE ALSO: Colonialism; Deforestation; Drinking Water; Endangered Species; Hazards; Poaching; Pollution, Air; Poverty; Salinization; Soil Erosion; Tsunamis; Wars.

BIBLIOGRAPHY. Central Intelligence Agency, "Sri Lanka," *The World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); Ministry of Environment and Natural Resources, www.

Ceylon Tea

Traditionally one of the major exports of Sri Lanka (known as Ceylon until 1972) was tea, much of it marketed in Britain and the British Empire under the name "Ceylon Tea." Until the 1860s, the major cash crop grown on Sri Lanka was coffee. However, the crops were ravaged by a fungus—nicknamed Devastating Emily—and some of the plantation owners wanted to grow other crops. To this end, Scottish-born James Taylor (1835–92) came from North India to Ceylon in 1867 to oversee the establishment of the first tea plantation on the Indian Ocean island.

Taylor had worked on Indian plantations and his first venture into Ceylon tea was a great success. He only was able to get 23 pounds of tea in 1873, but prices at auction in London were sufficient for him to persist. By 1890, the plantations were producing 22,900 tons. Skepticism that had originally greeted Taylor's plans turned to praise. Sir Arthur Conan Doyle called it "one of the greatest commercial victories which pluck and ingenuity ever won." He added, "The tea-fields of Ceylon are as true a monument to courage as is the lion of Waterloo." With that quote in mind, it is interesting to note that the symbol of Ceylon Tea was a lion with a drawn sword, similar to that on the Sri Lankan flag.

By World War I, tea was the main cash crop for Ceylon. In 1971 the mostly British-owned tea companies gave way to locally-owned ventures with the Land Reform Act forcing foreign owners to divest. By that time Sri Lanka was exporting some £1 million of tea daily. With the fighting in Sri Lanka since the 1980s, many of the tea plantations have been destroyed, although some tea plantation bungalows have been turned into hotels and guest houses.

menr.lk (cited April 2006); United Nations Development Programme, "Sri Lanka," hdr.undp.org (cited April 2006); World Bank, "Sri Lanka," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Standing to Bring a Lawsuit

STANDING IS "STANDING to sue" someone in a court of law in order to redress an alleged wrong. The legal expression, "where there's a wrong, there's a remedy," assumes that someone has been wronged and that they will be able to gain justice. Standing is the interest or right that a "person" (whether a human being or a corporate personality) has in a controversy that entitles them to bring a suit or complaint into a court for adjudication.

The doctrine of standing has never been precisely defined in law. This is a benefit to judges because it allows them to accept or reject the cases they hear. To bring a case into a court of law for consideration, it is presumed that there is a real conflict between two or more parties over some real thing or some controversial matter. The controversy must not force the court into giving a moot decision over a question of curiosity. The American system of justice is adversarial and uses real conflicts to sharpen the matter to be decided in court.

Another feature needed for a case to gain standing is that the value in a controversy does not have to be great, just real and the cause of real harm. Cases have been brought into court involving only a dollar or two. To gain standing to bring a case into court it is not enough to have a general interest in a disagreement. Rather, a specific and personal or business interest must be at stake. To have standing in the case of an injury the injury must be real, personal, and not simply hypothetical or general. "Pocketbook" damages involving loss of money in a case make it easier for judges to determine the issue(s) in a case. In addition the plaintiff who brings the case must be able to show who is at fault for the alleged injury.

A test to determine standing is that all remedies have been exhausted. In the case of a court exercising original jurisdiction the parties to the case have been unable to reach a settlement. In the case of a court exercising appellate jurisdiction the remedies available in the lower courts have been exhausted. In the case of the U.S. Supreme Court a case will not be accepted or given standing before it unless all lower court remedies have been exhausted.

American courts in recent decades have broadened the kinds of cases to which they grant standing. In some cases individuals who have not been personally harmed, but who act on behalf of those who cannot act, can bring a case into a court. This approach has allowed an enormous number of class-action suits to be filed on environmental issues permitting the common law to develop rights for the treatment of the environment.

A central challenge for environmental law is that the environment itself cannot have standing in a legal case under common law. In this way an "aggrieved" ecosystem (ocean, stream, fish, animal, or tree) can only be represented in court if a human party with interest in the problem is affected and so has standing. Legal philosophers have challenged this point in recent years, however, and suggested that non-humans may in the future be accepted as having standing in court, changing their status as many historic parties have—including children, ships, and corporations, whose standing was only established by law and precedent. Christopher Stone has suggested that the evolution of liberal jurisprudence will eventually allow such environmental actors to hold rights.

SEE ALSO: Common Law; Litigation, Environmental; Love Canal; Martin vs. Waddell; Tragedy of the Commons.

BIBLIOGRAPHY. Harold Grillot and Frank Schubert, *Introduction to Law and the Legal System* (Houghton Mifflin, 1992); Christopher D. Stone, *Should Trees Have Standing?: Toward Legal Rights for Natural Objects* (W. Kaufmann, 1974); Steve M. Wise, *Rattling the Cage: Toward Legal Rights for Animals* (Basic Books, 1999).

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State-Transition (Approaches in Ecology)

STATE-TRANSITION REFERS TO a model of vegetation community dynamics that examines the interaction between processes and the multiple persistent communities that can arise from these processes. These models have been developed largely within the field or range management as a reaction to the shortcomings of the Clementian range succession (or range condition model), in which rangelands were viewed as a single climax community that was removed from that climax equilibrium state by stocking rate, grazing pressure, and precipitation, and was constantly in succession back toward that climax community. State-transition models differ from this approach by asserting that multiple persistent vegetation communities (states) can exist and that climatic factors, grazing, and stocking practices and vegetation autecology can cause these communities to shift between one state and other persistent alternative states (transitions). Transitions between states can be either reversible or nonreversible. Researchers have proposed the idea of transition thresholds to account for the reversibility of transitions. A given community can tolerate a certain amount of disturbance and still be able to transition back to its original state, but if the transition crosses a threshold, then the community will irreversibly transition to an alternative state.

From a theoretical point of view, state-transition models are considered to be nonequilibrium approaches to ecology. The classic range succession model is an equilibrium approach, because it proposes a single stable climax community that the grassland ecosystem would produce in the absence of grazing and drought; reducing grazing pressure thus causes succession back to this climax community under this model. That is, it views vegetation change along a single axis of change, where any disturbance initiates a linear path of succession back to climax. Succession, as a process of change, is essentially assumed to occur under negative feedback returning the system back to its homeostatic equilibrium state, without actually analyzing the interactions between the biota and environment that take place during this successional change.

Management under this perspective focuses strictly upon adjusting stocking rates to precipitation to keep the grassland as closely removed from the climax as possible. Nevertheless the range succession model was not able to explain or predict observed changes in community composition and other models were sought after. The state-transition approach, by contrast, is concerned with both process and pattern, and seeks to establish the causes of the transitions between persistent states. In identifying the causes, researchers must examine the intersection between disturbance, plant demography (reproductive and dispersal habits) as well as landscape heterogeneity (whether surrounding patches exert propagule pressure on a patch), in determining how a community shifts its species composition from one persistent state to another (if any). As such, it is best categorized as a dynamic nonequilibrium model. Furthermore, the model examines vegetation change along several axes of transition.

The state-transition model is considered to be an improvement on the range succession approach, but is better understood as a heuristic model and management tool rather than a comprehensive theory. The model is based on managerial criteria rather than ecological ones, and does not employ any historical criteria to define the desirable alternative states. Although it seeks to reconcile pattern to process, its method of inquiry does not extend beyond identifying alternate states and the causes of transition, without attempting to produce a formalized, theory of community change and stability.

State-transition approaches are utilized both as management tools and in research. Although rangeland management has been the field where state-transition approaches are predominantly applied, these models are becoming more common within restoration ecology as well. The general approach in management is first to identify the various alternative ecosystem states that are present in any given area of management, then to identify the causes of transition. Having identified the various alternative states, an assessment is then made for which states are acceptable for the given management strategy and which are not.

Having identified the causes for transitions between desirable and undesirable states, managers can then not only strategize rehabilitation of undesirable states, but can avoid the processes that cause desirable states to transition to undesirable alternative states. That is, state-transition models allow managers to be proactive in their management, rather than reactive, since, under the range succession model, the undesirable alternative states irrupt onto the landscape as unpredicted departures from the linear succession to climax. From a research perspective, the state-transition model is best understood as a heuristic device and a means of generating testable hypotheses. Neither the actual transitional processes nor thresholds are well examined empirically under this model and provide the focus for future research.

Some recent research that attempts to explain these transitions and thresholds seeks to reconcile alternative ecosystem state concepts with homeostatic ecosystem models. The approach proposes that each of the alternative states represent different stable homeostatic equilibria, arising through heterogeneity in the spatial distribution of various environmental factors. Transitions and thresholds are understood in terms of feedbacks, with positive feedback driving transitions across thresholds into alternative ecosystem states. Another similar approach employs chaos theory to describe these alternative states and the transitions between them. The alternative states are depicted as attractors, with the transitions between attractors arising as consequences of values the descriptive equations take. Complexity theory has also been applied to State-transition models, with the crossing of a transition threshold between alternate states analogous to a phase shift.

SEE ALSO: Climax Community; Disequilibrium; Ecosystems; Equilibrium; Restoration Ecology.

BIBLIOGRAPHY: D.D. Briske, S.D. Fuhlendorf, and F.E. Smiens, "State-transition Models, Thresholds, and Rangeland Health: A Synthesis of Ecological Concepts and Perspectives," *Rangeland Ecology and Management* (v.58, 2005); Randall D. Jackson, James W. Bartolome, and Barbara Alan Diaz, "States and Transition Models: Response to an ESA Symposium," *Bulletin of the Ecological Society of America* (v.83, 2002); Katherine N. Suding, Katherine L. Gross, and Gregory R. Houseman, "Alternative States and Positive Feedbacks in Restoration Ecology," *Trends in Ecology and Evolution* (v.19, 2004); Mark Westboy, Brian Walker, and Imanuel Noy-Meir, "Opportunistic Management for Rangelands Not at Equilibrium," *Journal of Range Management* (v.42, 1989); S.R. Wilkinson, M.A. Naeth, and F.K.A. Schmiegelow, "Tropical Forest Restoration within Galapagos National Park: Application of a State-transition Model," *Ecology and Society* (v.10, 2005).

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Statistics and Sampling

THE WORD *statistics* is derived from the Latin term *statisticum collegium,* meaning "council of state," and the Italian word *statista,* meaning "statesman" or "politician." In 1749, Gottfried Achenwall introduced *Statistik* for the analysis of data to be used by government and administration, signifying the "science of state" (then called "political arithmetic" in English). It acquired the meaning of the collection and classification of data in the early 19th century. It was introduced into English by Sir John Sinclair. Statistics found its way into other areas like public health, economics, and social sciences during the 20th century.

The mathematical methods of statistics evolved from probability theory in 1654 as indicated in the correspondence of Pierre de Fermat and Blaise Pascal. In the early 1700s, Jakob Bernoulli (*Ars Conjectandi*) and Abraham de Moivre (*Doctrine of Chances*) treated the subject as a branch of mathematics. Adolphe Quetelet in the 19th century introduced the notion of the "average man" (*l'homme moyen*) as a means of understanding complex social phenomena such as crime, marriage, or suicide rates.

Statistics is a mathematical science related with collection, analysis, interpretation, and presentation of data. It helps to understand data and make informed decisions. It has applications in every field of arts, sciences, and humanities. Business, government, medicine, and academia use statistics to make informed decisions.

In order to apply statistics, a process or population to be studied is required. The data could be the demographics of a population of a city, deforestation, defoliation, or flocks of birds. It could also be a process observed at various times, for example sea levels at various times of day. Such data is referred to as time series data. There are four different kinds of measurement: nominal, ordinal, interval, and ratio. Ordinal measurements consists of different categories, the order of which have a meaning, such as age groups. Nominal measurements also has categories that have no meaningful rank order among values, such as city names. Interval measurements have meaningful distances between measurements, but no meaningful zero value, such as height measurement. Ratio measurements, where both a zero value and distances between different measurements are defined, provide the greatest flexibility in statistical methods that can be used for analyzing data. The variables with ordinal and nominal measurements such as age groups or city names are referred to as categorical variables, and the variables with ratio and interval measurements are referred to as continuous variables.

Statistics can be divided into two groups—mathematical or theoretical statistics, and applied statistics. Applied statistics consists of descriptive and inferential statistics. Mathematical statistics is concerned with the theoretical basis of the subject. Descriptive statistics involves summarization or description of the data, for example the mean, standard deviation for continuous variables, count, and percent for categorical variables. It does not involve extrapolating the results to the population; it is a mere description of the study sample. Inferential statistics, on the other hand, involves modeling of the data that accounts for the randomness and uncertainty in observing data prior to drawing inferences (or conclusions) about the process or population under study. Some of the examples of inferential statistics are hypothesis testing, point or interval estimation, prediction, correlation, or regression. This involves drawing conclusions regarding the population based on the data collected on a sample.

Usually, it is not practical to collect data about the entire population or process; instead data is collected from a subset of population referred to as a sample. Data are collected on the sample in an experimental setting that is subjected to statistical analysis to describe the sample and draw inferences about the population. Sampling is concerned with the selection of individual observations intended to obtain knowledge about a population of concern, especially for the purposes of statistical inference. Pierre Simon Laplace was one of the first to use a sample to estimate the population of France in 1786. He also computed probabilistic estimates of the error. The sampling process consists of five stages:

1. Definition of the population of concern, such as the people of a city, birds, trees, or fish.
2. Specification of a sampling frame, representative of the population, a set of items or events that are possible to measure, such as the circumference of tree trunks.
3. Specification of sampling method for selecting items or events from the frame: simple random sampling, cluster sampling, two stage sampling, convenience sampling, systematic sampling, or quota sampling.
4. Sampling and data collecting: Following the defined sampling process, keeping data in time order, and recording comments and other contextual events as well as non-responses.
5. Review of sampling process: After sampling, the process followed in sampling should be reviewed for issues that might affect the final analysis.

Sampling methods can be classified as probability samples or nonprobability samples. In probability samples, each member of the population has a known nonzero probability of being selected. Probability methods include random sampling, systematic sampling, and stratified sampling. In nonprobability sampling, members are selected from the population in some nonrandom manner. These include convenience sampling, judgment sampling, quota sampling, and snowball sampling. It is possible to calculate sampling error only in probability sampling and inferences are often reported as plus or minus the sampling error.

The inferences and conclusions drawn from a sample can be extended to the population only if the sample is representative of the population. The biggest challenge usually lies in determining the extent to which the sample is representative of the population. As a result, much attention and research has taken place in the area of design of experiments that offers techniques to estimate and correct for randomness in the sample and in the data collection procedure. Another challenge in drawing the sample is determining the appropriate sample size that would be representative of the population and will help to draw conclusions controlling for type I as well as type II error rates. There are several tables available for determining the appropriate sample sizes for different tests (t-test, z-test, binomial test, ANOVA, regression) and criterion (one tailed, two tailed).

The statistical tests used to draw conclusions from data are categorized as parametric or non-parametric methods. Parametric methods involve assumption of the distribution of the data, most often data to be normally distributed. Some of the most common parametric tests used in statistics to draw conclusions are: Students t-test, Chi-square, ANOVA, and regression analysis. Non-parametric methods, on the other hand, do not make any such assumptions. Some of the non-parametric methods include the Mann-Whitney U test, Signed Ranked Test, Signed Tests, and Runs Tests.

Statistics collected and analyzed for understanding the environment and environmental change are numerous. Among many others, these include figures describing populations of animals and people, land cover areas, rates of expenditures on pollution controls, and estimates of carbon emissions, as well as basic environmental data, like sea surface temperature readings, tectonic movements, and water quality measures.

While the burgeoning growth of these statistical measures appears to bode well for increased understanding of environmental conditions and change, there are serious limits to, and problems within, socio-environmental statistics. At a global scale, most statistics are contributed to databases by individual nation states. In many cases, good data are simply not available for all environmental issues. In other cases, the methods of collecting or recording those data may vary dramatically between countries, making comparison or analysis questionable. In other cases, numbers are simply fabrications, stated for the protection and convenience of state interests. Many otherwise excellent databases, including those kept by the United Nations and the World Bank Group, are filled with data values that, even if reliable, must be treated with extreme caution in conducting any kind of comparison.

Many environmental problems, moreover, are not necessarily amenable to simple statistical analysis for explanation or management. While rates of pesticide use amongst consumers can be determined, and analyzed against housing values and incomes, truly explaining complex human environmental behaviors like these often requires more highly qualitative, interview-based exploration. Statistics are therefore essential to understanding environment and society problems but must be treated critically and will be most effective when coupled with other modes of analysis and forms of data.

SEE ALSO: Measurement and Assessment; Research Methods; Science and Technology Studies.

BIBLIOGRAPHY. W.G. Cochran, *Sampling Techniques* (John Wiley & Sons, 1977); J. Cohen, *Statistical Power Analysis for Behavioral Sciences* (Lawrence Erlbaum Associates, 1988); R.V. Hogg, Allen Craig, and Joseph W. McKean, *Introduction to Mathematical Statistics* (Prentice Hall, 2004).

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Steppe

THE STEPPE, A semiarid ecosystem, can be defined in terms of climatic conditions or vegetative land cover. In terms of climate, the steppe is considered semi-desert. According to the popular Köppen climate classification system, the steppe corresponds to the BSk (mid-latitude, cold, and semiarid) and BSh (low latitude, hot, and semiarid) climate types. The steppe in low latitude regions features yearly average precipitation typically between 15 inches (38 centimeters) and 30 inches (76 centimeters), while that in mid-latitude regions features typical yearly average precipitation between 10 inches (25 centimeters) and 25 inches (64 centimeters). The subtropical steppe (BSh) and mid-latitude steppe (BSk) climates are found fringing deserts in the far interior of large landmasses or in the distant reaches of the rain shadow of major mountain ranges. In both cases, the steppe receives slightly more precipitation than the bordering desert, but remains dry enough to be considered semiarid.

The steppe climates are primarily concentrated in central Eurasia (easily the largest geographical coverage), interior North America, and the Sahel region in Africa. Smaller concentrations of steppe climates are found in Argentina, southern Africa, and Australia.

A more geographically-limiting definition of the steppe corresponds to the major mid-latitude grassland biome. This region, featuring the dominant grass vegetation cover, stretches across the vast Eurasian continent and the interior of North America. Smaller areas of this biome exist in Argentina and South Africa. While this biome includes areas that receive sufficient precipitation to support tall prairie grasses, the steppe is limited to those drier areas that support only shorter grasses. While trees and larger vegetation can be found near rivers, the steppe also features barren landscapes with isolated tufts of bunchgrass.

While steppe regions exist in the western Great Plains of North America, the world's most expansive steppe stretches across mid-latitude Asia. The vast Eurasian Steppe stretches nearly 5,000 miles (8,000 kilometers) from eastern Hungary in the west to northeastern China in the east. The northern boundary of the Eurasian Steppe nudges into Russia's Siberia and Mongolia, while the southern reaches extend into Tibet (China's Xizang Autonomous Republic). Encompassed within are portions of Ukraine, Kazakhstan, Kyrgyzstan, Tajikistan, Uzbekistan, Afghanistan and Xinjiang (China's Uyghur Autonomous Republic).

Traditionally a region of nomadic pastoralism (grazing livestock on steppe grasses and moving from plain to plain with the seasons), the Eurasian Steppe gave rise to some of the most feared warriors and expansive empires in world history. Nomadic armies, wielding bow and arrow and riding on horseback, effectively conquered under-matched sedentary populations. During the 4th century C.E., Attila established the Hun Empire between the Ural and Carpathian Mountains and succeeded in mounting terrorizing raids into Europe. In the 13th century, Genghis Khan conquered the entire waist of the Eurasian continent, forming the vast Mongol Empire stretching from Ukraine and northern Turkey in the west, southeast through Iran and to the Indus River, and eastward through China to the Pacific Ocean. The 14th century witnessed the rise of Timur (Tamerlane), whose empire stretched from the Black Sea through the Caucasus and Persia, and eastward to the Tien Shan Mountains.

Today, the world's grassland steppe faces a number of environmental challenges, including overgrazing of livestock and subsequent desertification. Growth in human populations, increases in livestock numbers, and unsustainable grazing practices has devastated much of the steppe grasslands, resulting in the encroachment of deserts and fierce sandstorms.

SEE ALSO: Biome; Climate, Arid and Semiarid; Desertification; Grasslands; Overgrazing; Pastoralism; Sahel.

BIBLIOGRAPHY. René Grousset, *The Empire of the Steppes: A History of Central Asia* (Rutgers University Press, 1970); Robert Marquand, "Beijing Fends off Monsters on Its Steppes," *Christian Science Monitor* (v.94, 2002); Tom McKnight and Darrel Hess, *Physical Geography: A Landscape Appreciation* (Prentice Hall, 2002).

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Sterilization

STERILIZATION IS A surgical procedure performed to make a person incapable of reproducing. Another meaning (not treated here) refers to the killing of microorganisms. People in all parts of the world desire control of their fertility. Limiting the number of children allows each child more opportunity, and many women and families seek limits on their household size over their life course.

Limiting fertility is arguably also important for the environment. Population, exacerbated by affluence and consumption practices, especially in the developed world, has led to the appropriation of significant proportions of the biosphere, leaving diminishing habitat for other species. Under some calculations, humanity's ecological footprint has now overextended 23 percent beyond the planet's ability to sustain itself.

There are many techniques for both male and female sterilization. Male sterilization (vasectomy) interrupts the *vas deferens,* the tubes that transport sperm. It is usually performed with local anesthesia. Afterwards the man will be sore for a few days and should avoid strenuous work. There will still be sperm in his ejaculate for up to three months, so he should not rely on his sterility until a semen sample has been tested for sperm.

Because a woman's fallopian tubes are inside her abdominal cavity, most female sterilizations involve one or two abdominal incisions. The fallopian tubes are interrupted by tying (hence the common name "tubal ligation") or by coagulating with an electrical current. Clips or rings may also be used to block the tubes. Tubal ligation is effective immediately. General anesthesia is commonly employed, although the procedure can also be done with local anesthesia. A convenient time to perform female sterilization is shortly after the birth of a baby. Then the uterus is still large and a small incision through or near the umbilicus can be used to approach the tubes. With a cesarean delivery, the abdomen is already open, thus the tubes are readily accessible.

Female sterilization without incision is also possible. Essure® is already approved and available. It is a high-tech system that approaches the woman's tubes through hysteroscopy—a technique to visualize the inside of the uterus. Quinacrine sterilization has been performed on about 100,000 women worldwide, but is not yet approved in the United States. It uses seven small pellets of quinacrine that are inserted without anesthesia through the woman's cervix. Although this method is very inexpensive, its safety still needs to be proven.

Intrauterine devices (IUDs) offer a simple, reversible alternative to sterilization. Two are available in the United States: Mirena® is effective for five years, and Paragard® for at least 10. Both of these IUDs are comparable to sterilization in effectiveness. Other temporary methods of contraception are also available, but often with significantly less effectiveness than sterilization or IUD.

No contraceptive technique is completely effective. Sterilization failures can occur immediately, for instance if the man doesn't wait for his vasectomy to become effective, or if the surgeon missed one of a woman's tubes. Failures can also occur much later, if the vas or tube grows back together. Over a period of a decade the failure rate of tubal ligation may be as high as 2 percent.

Another shortcoming of sterilization is that it provides no defense against sexually transmitted diseases. Only condoms provide substantial protection against infectious agents, including HIV.

Some women will develop menstrual abnormalities as they get older. When a woman has had her tubes tied, then has heavy bleeding, she may blame the tubal ligation, but there is no evidence that tubal ligation leads to menstrual problems. Another concern has been about an increased risk of heart disease or prostate cancer in men who have had vasectomies, but studies have shown that there is no increased chance of these problems.

Sometimes people who have been sterilized will regret having had the procedure. This is sometimes due to divorce, other times due to the death of a partner or of a child. Furthermore, people change their ideas about their ideal family sizes. Regret is most common when people have sterilization done early in their reproductive lives. It is for this reason that no governmental agency will pay for a sterilization procedure if the person is under 21 years of age. The incidence of regret is twice as high if a woman has sterilization before age 30 than after.

There are two options for a woman who wishes to regain her fertility after tubal ligation. Tubal reanastomosis, or reconnecting the fallopian tubes, is effective about half the time. It is expensive and seldom covered by health insurance. In vitro fertilization bypasses the woman's tubes and is effective after a tubal ligation. For the vasectomized man there is surgery to put the tubes back together.

Although vasectomy is safer and less expensive than female sterilization, in most parts of the world tubal ligation is more common than vasectomy. Worldwide there are about 180 million women who have been sterilized (including a relatively small number by hysterectomy). In contrast, only about 43 million men have had a vasectomy. In the United States the finding is similar; 41 percent of women, but only 26 percent of men, have been sterilized. In New Zealand, Holland, and Bhutan, more men than women have been sterilized, but this outcome remains unusual. There are fundamental questions about the equity surrounding the gendered distribution of responsibility for reproduction worldwide.

Sterilization programs operating at a large (national and international) scale have had a mixed and often unfortunate history. Pressure on poor communities and tribal members during India's "emergency" of the 1970s, as a prominent but by no means unique example, led to involuntary and highly coercive sterilizations. Where women control their choices and their bodies, however, sterilization has helped millions of couples prevent unplanned pregnancies, and it remains the single most popular birth control choice in the world.

SEE ALSO: Biosphere; Birth Control; Ecological Footprint; Fertility Rate; Population; Zero Population Growth.

BIBLIOGRAPHY. Global Footprint Network, www.footprintnetwork.org (cited April 2006); Betsy Hartmann, *Reproductive Rights and Wrongs: The Global Politics of Population Control* (South End Press, 1995); R.A. Hatcher, et al., *Contraceptive Technology,* 18th ed. (Ardent Media, 2004); "Permanent Contraception," www.engenderhealth.org (cited April 2006); "Permanent Female Contraception," www.quinacrine.com (cited April 2006).

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Stewardship

THE *DICTIONARY OF FORESTRY* (1998) defines stewardship as "the administration of land and associated resources in a manner that enables their passing on to future generations in a healthy condition." A U.S. Forest Service dictionary on ecosystem management terms defines stewardship as "a land ethic for current and future generations that 1) encourages wise use and conservation of resources; 2) sustains and enhances productivity of resources; and 3) protects resources." State and provincial agencies charged with natural resource management of public resources have similar definitions. What these definitions have in common, and how the term is typically used in the resource management arena in the United States, especially in contradistinction to terms such as "protection" or "preservation," is that stewardship includes active manipulation or involvement of humans with the land or resource to be stewarded, with the presumption that natural resources are actively being used by society (for example for food, fiber, or scenery), but in such a way that these resources of importance are maintained indefinitely.

The goal of stewardship is the maintenance and provision of conditions and products that humans value or need in perpetuity—enforcing sustainability. Since agreement on what aspects of the environment are to be sustained is a human judgment, what constitutes stewardship (good or bad) is a value-based notion. Stewardship implies that humans are part of the natural world, and rather than a zero-sum relationship between humans and nature, implies a mutualism or positive relationship between humanity and the rest of nature. The term also implies that humans can improve the condition of natural systems beyond that attainable if nature is simply left alone, as is emphasized by terms such as *preservation*.

"Stewardship contracting" is an example of how the term is used by federal land management agencies in the United States, such as the U.S. Forest Service and Bureau of Land Management. Stewardship contracting is a government program that seeks to engage private and public entities and individuals in land restoration in concert with extracting economic resources such as timber.

As stated by the U.S. Forest Service, "stewardship contracting includes natural resource management practices seeking to promote a closer working relationship with local communities in a broad range of activities that improve land conditions." The U.S. Forest Service sees the results of stewardship as contributing "to the development of sustainable rural communities, restore[ing] and maintain[ing] healthy forest ecosystems, and provide[ing] a continuing source of local income and employment."

These policy applications of stewardship encompass the term's emphasis on human use of resources, as well as human communities being a part of ecological systems. This incorporation of positive human use of the environment within the term *stewardship* has also favored its use by many nongovernmental organizations, such as local groups who seek to have more involvement in decisions regarding the management of resources in the localities where they reside. Examples include the Northeastern Nevada Stewardship Group in the western United States, which seeks to maintain the traditional ranching economy with flourishing wildlife and native plant populations; the Land Stewardship Project, a private organization in the Midwest promoting sustainable agriculture and communities; and the Forest Stewardship Council, an international organization promoting the sustainable use of forests for timber and paper products.

The overall goal of what might be called the stewardship movement as articulated by practitioners and scholars is to foster an ethic that involves local people and communities in the sustainable management of local landscapes, as well as for the economic and social benefit of the local communities. This approach emphasizes the use of local knowledge and local control of resource decisions, rather than exclusive centralized management by public agencies or private corporations.

The application of stewardship must recognize that natural and human systems change over time, such changes are often outside the means of our control or management (such as floods, climate change, geologic change, and wars), and that what humans want or value from the resources or environment being managed will change through history. Over time, a value provided by stewardship in one era (or culture) may no longer be desired, and another potential value not previously considered because it was not socially important, may become the primary goal of stewardship.

Stewardship implies active involvement of humans with the environment to provide goods and services that people want. How stewardship is applied will depend on the needs and values of the people in control of the resource. What is considered good stewardship in one place or era may not be in another.

SEE ALSO: Bureau of Land Management; Forest Management; Forest Service (U.S.); Forests.

BIBLIOGRAPHY. Mark Baker and Jonathan Kusel, *Community Forestry in the United States: Learning from the Past, Crafting the Future* (Island Press, 2003); *A Draft Glossary for Ecosystem Management* (USDA Forest Service, Pacific Northwest Region, 1994); John A. Helms, ed., *The Dictionary of Forestry* (The Society of American Foresters, 1998).

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Stocking Rate

STOCKING RATE IS the amount of land that may be used to graze cattle or other herbivores for a specific period of time. The stocking rate varies due to factors such as the fertility of the land, the kind of vegetation that flourishes on it, the ability of the grazed vegetation to recover from grazing, the food value of the vegetation, and the long term damage that may occur. The stocking rate is a tool of grazing management. In the wild, herbivores move about a range so that their grazing does not systematically reduce whole areas. However, in animal husbandry operations grazing animals are confined to an area that can soon be overgrazed if management limits are not assigned to how long they stay in a particular pasture. Grazing management is an art that seeks maximum production returns from the balancing of land, labor, capital, the number of animals, and the amount of feed associated with stock production.

The goal of grazing management is to gain a profitable return of the investments made. At the same time the grazing land must either maintain or improve its productivity. There are several principles to grazing management, with probably the most important being stocking rates. Stocking rates are managed forms of carrying capacity. Grazing managers (ranchers, owners, and cowhands) must calculate the number of animals that can graze an area for a given period of time without creating grazing pressure. The relationship between the two is the ratio of forage demand to forage supply (carrying capacity). The concept of "animal unit month (AUM)" is widely used to determine the stocking rate. It provides the approximate amount of forage that a 1,000-pound cow with a calf will eat in one month. The amount of forage consumed in a month is 800 pounds of dry (not green) weight. This standard can be converted into an "animal unit equivalent." For a sheep the AUM is 20 percent of a cattle AUM. This standard measure allows grazing managers to calculate easily the number of animals that an area of rangeland can carry.

Forage supply is the vegetation that can be eaten, but which will still allow the plants on the pasture of range to quickly recover so that future forage production is not diminished. Future forage production includes such factors as the future species of plants that will be available. All grass or forage is not created equal. In the eastern United States the grasses grow lush compared to the skimpy grasses of the west. However, the food value of the mineral-rich western grasses is often much higher than the richer-looking, greener grasses of the east. In the eastern United States, the question of stocking rate is asked in terms of how many cattle to the acre. In the west, the stocking rate question is asked in terms of how many acres to a steer, bull, or cow.

Contemporary ecological science has raised questions about the straightforward measurement of stocking rates in recent years. A greater appreciation of the nature of grasslands suggests that they function in a state of disequilibrium, given to swift and unpredictable changes in condition or state with or without grazing, and a concomitant sense that there may be no meaningfully objective way to measure stocking rates at all. The management implications of these scientific insights, however, have not been fully embraced by regulators, who require clear and simple metrics to inform enforcement and decision making.

SEE ALSO: Cattle; Disequilibrium; Grassland; Grazing; Overgrazing; Ranchers.

BIBLIOGRAPHY. Ricard A. Battaglia, *Handbook of Livestock Management* (Pearson Education, 2006); R.H. Behnke and I. Scoones, eds., *Range Ecology at Disequilibrium: New Models of Natural Variability and Pastoral Adaptation in African Savannas* (Overseas Development Institute, 1993); Robert K. Lyons and Rich Machen, *Stocking Rate: The Key Grazing Management Decision* (Texas Agricultural Extension Service, 2001); Andre Viosin, *Grass Productivity* (Island Press, 1988).

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Subsidies

SUBSIDIES ENCOMPASS A wide range of policies that convey financial benefits to a specific industry or economic sector in order to achieve various policy objectives. They usually involve financial transfers from government to industry (termed explicit subsidies). However, they may also include indirect monetary transfers, such as lower tax and interest rates or provisions of social insurance that alter risk calculations and therefore have bearing on investment strategies and business activities within an industry (termed implicit subsidies).

A distinction can also be made between two broad general classes of subsidies: Consumer subsidies, which reduce prices below market levels for consumers; and producer subsidies, which benefit industries involved in production. The latter form of subsidy operates through several mechanisms, which generally include the reduction of fixed and variable costs or the support of prices and incomes. Some industries may also benefit from export subsidies, which apply only to products when they are exported. Subsidies given to one economic sector or to consumers may have the effect of creating a negative subsidy to another sector, an effect labeled "implicit taxation." On the other hand, governments may utilize both consumer and producer subsidies at the same time, absorbing the costs in order to control producer profits and consumer costs. The government of Mexico has utilized this approach for some agricultural products. Some types of producer subsidies, such as tariffs on imports, may even benefit the government by providing new sources of revenues.

Producer subsidies have been applied to a wide range of economic activities, including agriculture, natural resource-based extraction (such as forestry, fisheries, minerals, fossil fuels), and various industrial sectors. Subsidy programs are initiated and justified for a variety of reasons. Governments may seek to assist new and emerging industries by providing infrastructure and loan programs for capital construction, or they may seek to encourage firms to adopt certain business practices or technologies, including those that are environmentally beneficial. Governments may wish to subsidize businesses that are in danger of bankruptcy or that are weathering poor economic and environmental conditions. Local as well as national governments use subsidies to stimulate economic development and employment. They may also provide industries with a competitive edge in international markets. Although justified at one time, subsidies often become entrenched and end up serving the interests of a small group of stakeholders. As a result, beneficiaries often vociferously resist their proposed elimination.

The creation and elimination of subsidies are local political issues with national and increasingly international ramifications. The impacts of subsidies can be categorized in three broad areas: 1) economic or distributional impacts on trade, 2) environmental impacts on conservation or the sustainable resource use, and 3) social impacts. Subsidies, by their nature, are always associated with distributional effects. Thus, within a given country, some industries will benefit over others. Similarly, considered from the vantage point of international markets, industries subsidized by their governments have an advantage over unsubsidized competitors in other countries, thereby creating trade distortions. Some analysts believe that subsidies support the misallocation of economic resources, encouraging overproduction and impeding market exit. There is evidence to suggest that subsidies can impact the sustainable exploitation of resources by causing or exacerbating the conditions that lead to overcapacity or by stimulating increased capitalization within the sector.

However, as noted by some analysts, subsidies may have positive social effects. In developing countries, subsidies may play a role in reducing poverty, enhancing food security, and promoting community development. Different types of subsidies may have different consequences and different levels of impacts. The existence of a wide diversity among types of subsidy programs and the lack of transparency complicates the analysis of causality and consequences.

Some analysts believe that subsidies eventually undercut the economic health of the industries they are supposed to benefit. Subsidies that increase profits to an industry, either by enhancing revenues or by decreasing costs, tend both to increase production in the short term and capacity in the longer term. With diminished constraints on the industry, businesses will capitalize and new ones will enter the sector. This increased growth will eventually dissipate profits. Thus, the short-term increase in profits caused by subsidies may negatively impact the long-term economic viability of the industry. In industries involved in resource extraction this may have ramifications for both the sustained yield of the resource as well as the well being of the individuals engaged in production. On the other hand, some consider government-funded programs that engage in research and development, monitoring, enforcement, and management activities to be producer subsidies with positive environmental ramifications.

In the international arena, the General Agreement on Tariffs and Trade first addressed subsidies in 1948. The Agreement on Subsidies and Countervailing Measures (ASCM) emerged from the Uruguay Round of negotiations in 1984, the same round that led to the formation of the World Trade Organization (WTO). The ACSM contains a specific definition of subsidies, addressing the issue with a traffic light approach, prohibiting some (red light), specifying others that are actionable (yellow light), and identifying a third group of nonactionable subsidies (green light). The WTO has continued to work on the issue of disciplining subsidies as part of the 2001 Doha mandate, although recent negotiations have not met with success.

The issue of subsidies has also been taken up by the Convention on Biological Diversity (CBD) in its work on perverse incentives. These incentives include subsidies that, by lowering costs or increasing profits, encourage overexploitation of resources and thereby degrade biodiversity. At the 4th Conference of Parties in 1998, governments were urged to identify perverse incentives and to remove or mitigate their negative effects on biodiversity. The CBD continues to tackle the issue of subsidies through the work of the Subsidiary Body for Scientific, Technical and Technological Advice.

SEE ALSO: Convention on Biodiversity; Policy, Environmental; Trade, Fair; Trade, Free; World Trade Organization (WTO).

BIBLIOGRAPHY. John H. Jackson, *The World Trading System: Law and Policy of International Economic Relations* (MIT Press, 1997); Mateo Milazzo, *Subsidies in World Fisheries: A Reexamination* (World Bank, 1998); William E. Schrank, *Introducing Fisheries Subsidies* (FAO Fisheries Technical Paper, 2003); William E. Schrank and Walter B. Keithly, Jr., "The Concept of Subsidies," *Marine Resource Economics* (v.14, 1999); *World Trade Organization Agreement on Subsidies and Countervailing Measures* (LT/UR/A-1A/9).

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Subsistence

SUBSISTENCE USUALLY REFERS to obtaining the primary necessities for survival that may include water, medicine, clothing, and shelter as well as food. Typically, subsistence societies are traditional, small-scale, self-sufficient, rural and nonindustrial. Although such societies concentrate on the basic needs of the individual, household, and community, they may also engage in limited trade.

Geographer C. Daryll Forde, anthropologists Clark Wissler and Julian H. Steward, and many others have studied traditional indigenous subsistence economies since at least the early 20th century. Classic cases include those by Steward on Shoshoni and Paiute foragers (hunter-gatherers) in the western desert of the United States, Richard K. Nelson on Koyukon hunters in Alaskan forests, Fikret Berkes on Cree hunters and fishers in the eastern subarctic of Canada, Bernard Nietschmann on Miskito coastal fishers of Nicaragua, William J. Smole on Yanoama foragers and farmers of the Venezuelan Amazon, Richard A. Gould on Yiwara foragers of desert Australia, Roy A. Rappaport on Tsembaga Maring farmers of New Guinea, William H. Alkire on fishers of Lamotrek Atoll in Micronesia, Richard B. Lee on San foragers of the Kalahari desert in southern Africa, Stuart A. Marks on Bisa hunters of the Zambian savanna, E.E. Evans-Pritchard on Nuer herders in Sudan, Robert M. Netting on Kofyar swidden horticulturalists of Nigeria, and Harold C. Conklin on Hanunoo and Ifugao farmers in the Philippines.

Much of this research follows the cultural ecology developed by Steward wherein field research proceeds with first identifying the natural resources used by local communities at the individual and household levels; next by examining the technology and organization of labor to extract, process, and distribute these resources; and finally through considering how these factors in turn influence other components of culture as a system of adaptation to the natural environment.

Such research documents the fact that subsistence does not necessarily mean simple technology in a struggle for bare survival in a harsh environment. Traditionally, many subsistence societies actually enjoy a fairly high quality of life that is satisfying socially as well as nutritionally and includes considerable leisure time for other activities. Societies may focus on subsistence instead of the market to frugally pursue needs rather than greed, thereby in effect practicing voluntary simplicity. Such societies seek holistic paths to development, health, and happiness that contrast sharply with predatory capitalism and its accompanying consumerism. Consequently, studies of subsistence present challenges to the Western economic assumptions that scarcity, competition, and the profit motive are human universals.

A concentration on daily interaction with nature to satisfy life's basic necessities tends to promote a sustainable and green society that avoids irreversible depletion of the natural resources and degradation of the ecosystems in its habitat. This is motivated and guided by an ecocentric world view with its associated values, attitudes, and behaviors that are usually environmentally benign. Most traditional subsistence economies developed ways to relate society and environment that promoted relative adaptive success for centuries or even millennia. Thus, the contemporary world still has much to learn about developing a viable human ecology from such cultures.

SEE ALSO: Cultural Ecology; Farming Systems; Human Ecology; Livelihood; Smallholders.

BIBLIOGRAPHY. John H. Bodley, *Anthropology and Contemporary Human Problems* (Mayfield Publishing Company, 2001); Tim Ingold, *The Perception of the Environment: Essays in Livelihood, Dwelling and Skill* (Routledge, 2000); Gerald G. Marten, *Human Ecology: Basic Concepts for Sustainable Development* (Earthscan, 2001); Jim Merkel, *Radical Simplicity: Small Footprints on a Finite Earth* (New Society Publishers, 2003); Emilio F. Moran, *People and Nature: An Introduction to Human Ecological Relations* (Blackwell Publishing, 2006); Mark Q. Sutton and E.N. Anderson, *Introduction to Cultural Ecology* (AltaMira Press, 2004).

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Suburbs

ON THE OUTSKIRTS of every major city are large business and residential areas known as the suburbs, sometimes called industrial or residential suburbs. The term came from the Latin *suburbium*, with the first use in English by John Wycliffe referring to *subarbis* in 1380. A few scholars, such as Christopher Tunnard, saw it as a modern phenomenon, certainly in its present manifestation. However, others have argued for it having happened in ancient cities.

Since the building of the first cities, there have been suburbs created for various reasons. As the population in a particular area grew, there were many activities such as slaughterhouses and light industry (and later heavy industry) that many people did not want in the increasingly crowded city centers, and conversely the land became too valuable to occupy with such activities. Other places needed port areas. Many early cities chose to have cemeteries and burial grounds beyond the city walls. Furthermore, there were often people who were quite happy to live outside the city where they would

New rail and road systems allowed people to live farther and farther away from their places of work in the 20th century.

forgo the protection of the city walls to live in large residential areas with cheaper land, more space, and greater privacy. During long periods of peace, many cities quickly developed suburbs.

Many cities grew haphazardly over time, with shanty towns being common on the outskirts of Sumerian and other settlements. Sir Leonard Woolley felt that Ur had suburbs—with some important buildings as far as four miles from the city center. One of the earliest excavated totally planned cities was El-Amarna in Egypt—the capital of the Pharaoh Akhnaten in the 14th century B.C.E. The ceremonial heart of the city was carefully developed, with a small northern suburb and a much larger southern suburb—both being residential areas with houses for government officials and their retinues. Ancient Greek and Roman settlements also had suburbs. Rome itself had large numbers of suburbs, and when, following the defeat of Hannibal, it went six centuries before being attacked again, massive suburbs sprang up all around the city.

It was during the Middle Ages that some suburbs became divided into largely industrial areas with working class residences and other suburbs for wealthier residents. The former were often polluted, and the latter tended to be healthier and on better land. To help regulate this, zoning restrictions—albeit under other names, and sometimes haphazardly administered—were introduced. Some of the new housing and settlements tended to be on good agricultural land, often the reason for locating the city in a particular location in the first place. In this way much rich agricultural land around London has long been occupied by housing.

The growth of the suburbs changed the nature of many cities. Many people continued to work in city centers, but gradually many people found business opportunities in their own suburbs with the development of shops and service industries. Only the rich could afford to maintain a property in the city center and another in a suburb.

19TH AND 20TH CENTURY SUBURBS

During the 19th century, transport was developed to cope with the ever increasing suburbs. Train service easily brought large numbers of people from suburbs to cities, as did tram service, underground railways, metros, and buses later. The speed, regularity, and relative cheapness of using this transportation system saw people starting to live farther and farther from their places of work. Suburbs quickly sprawled as the tram or train lines were extended—and sometimes it was the other way around, with the suburb growing with the promise or expectation of an extension to the tram or train routes. The 20th century again led to many changes, and another large increase in suburbs. In the United States, Canada, Australia, parts of Latin America, and in other countries, vast road systems were constructed.

Large residential suburbs also arose in places such as England, where wealthy industrialists constructed thousands of houses, such as the Lever Brothers in Levershulme, and the creations of Slough and Milton Keynes, and the formation of Telford. This has also been true of France, where La Defense was created on the outskirts of Paris to move some government work and businesses from central Paris and to provide employment and housing in close proximity to each other.

The regulation of many suburbs also came about in the early 20th century. By this time some parts of particular cities became identified with specific residents or occupations. While medieval and early modern cities often had streets devoted to particular occupations—such as the scriveners at Paternoster Row in London, England, and the flower merchants, fishmongers, and tombstone makers in their particular streets in Hanoi, Vietnam, by the 20th century whole sections of cities tended to be occupied by people of similar racial or religious backgrounds or socioeconomic statuses. The Jewish ghettos in some European cities, as well as Jewish customs that involve the obligation to walk to a synagogue for a service, tended to concentrate Jewish communities in particular suburbs. Yangon (formerly Rangoon) in Myanmar (formerly Burma) has several distinct Muslim quarters in what is largely a Buddhist city.

Throughout the European colonies, many cities had a European Quarter, an Indian Quarter, and so forth. In many North American cities, certain sections are very heavily African American. Large numbers of cities around the world have Chinatowns. The most extreme system was apartheid in South Africa, which delineated particular areas as belonging only to particular races. The result was that the better suburbs tended to be well-resourced with good schools, easy access to hospitals and the like, whereas poor suburbs were poorly resourced, often with a smaller tax base unable to afford the facilities elsewhere.

During the 20th century large numbers of suburbs were purposefully created in European and American cities. Surbiton on the outskirts of London—standing for Suburban Town, is perhaps the best known British example. Developments in most North American cities were similar. Some large Canadian cities such as Calgary, Ottawa, and Winnipeg all sprawl into the surrounding countryside, as do many other large cities such as Buenos Aires, Melbourne, and Madras.

Officially, the largest suburb in the world is Inch'on, a part of Greater Seoul with a population of 2,466,388 people. Giza in Greater Cairo, with a population of 2,221,868, comes second, followed by Quezon City in Metro Manila, the Philippines, with 2,173,831 residents. The next few are Bekasi in Greater Jakarta, Indonesia; Ecatepec de Morelos in Mexico City, Mexico; and Kobe in Greater Osaka, Japan.

SEE ALSO: Cities; New Urbanism; Sustainable Cities; Transportation; Urbanization; Urban Sprawl.

BIBLIOGRAPHY. Anthony Flint, *This Land: The Battle over Sprawl and the Future of America* (Johns Hopkins University Press, 2006); Kevin M. Kruse and Thomas J. Sugrue, eds., *The New Suburban History* (University of Chicago Press, 2006); John J. Marcionis & Vincent N. Parrillo, *Cities and Urban Life* (Pearson Prentice Hall, 2007); Lewis Mumford, *The City in History* (Penguin Books, 1966); Roger Panetta, ed., *Westchester: the American Suburb* (Hudson River Museum, 2006); Trevor Rowley, *The English Landscape in the Twentieth Century* (Hambledon Continuum, 2006).

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Succession

EVERY PLANT AND animal species has a set of environmental conditions under which it will grow and reproduce most optimally. When the conditions are changed, the previously dominant species may fail and another species may become ascendant. This gradual and continuous replacement of plant and animal species by other species until eventually the community, as a whole, is replaced by another type of community is called succession. In other words, succession is the natural replacement of plant or animal species, or species associations, in an area over time. The replacement is often directional and sometimes predictable.

Successions are of two types: Primary and secondary. When the process of succession begins on a site not previously occupied by other communities, it is called primary succession. Newly formed sand dunes, volcanic ash, bare mineral soil, new islands, and bare rock surfaces are examples of such sites. The first group of plants to become established on such sites is called the pioneer community. Succession on sites in which vegetation existed before is called secondary succession. Examples of sites for secondary succession include newly ploughed agricultural fields, forest clearcut sites, shifting cultivation fallows, and fire-burn areas. Succession can also occur in fresh water and marine environments.

There are four main stages in succession, including invasion, early seral, late seral, and mature or climax. Each stage of succession creates the conditions for the next stage. During the process, temporary plant communities are replaced by more stable communities until a sort of equilibrium is reached between the plants and the environment. The stable end product of the successional sequence is called the "climax" community. The rate of succession at various stages is mainly dependent upon the type and degree of disturbance and the physical environment (climate and soil).

Successions result from the impacts established species have upon their own environments. Succession may also occur when the conditions of an environment suddenly and drastically change due to natural (such as fire, a windstorm, pests) or human-caused (such as agriculture and forest management activities) disturbance that alters the composition of communities and ecosystems and changes the physical environment and resources availability. These factors may also destroy species and thus alter the dynamics of the ecological community, triggering a scramble for dominance among the species still present.

Ecological succession is one of the most important concepts in natural resources management. The fact that nature is always changing is critical in appreciating management systems and natural processes. Successions are important in altering species diversity and maintaining the ecosystem. Secondary succession plays an important role in reestablishing destroyed ecosystems. Species richness and community stability generally increase as succession proceeds after disturbance but frequent and massive disturbances often lead to low levels of species diversity.

Understanding forest succession is very important when making forest management prescriptions. Plant species that occur in the early and late stages of the successional process have distinctly different growth rates, morphology, longevity, composition, and structure. These differences have tremendous impact on net primary productivity. Knowledge of succession, therefore, helps us form appropriate forest management strategies that provide for society's needs while maintaining healthy, sustainable ecosystems. For example, in some sites we can maximize the economic benefits by harvesting timber at the end of fast-growing period rather than waiting for the forest to reach its maturity. On some other sites it is often easier to work with the natural progression and maintain one of the late successional stages than it is to maintain an early stage. The progressive change in forest types also has a huge impact on the complement of wildlife species and understory plant species that live there. The forest type will also influence soil development, erosion potential, soil pH, organic matter volume, water retention, water quality, and similar forest characteristics. Successional sequence therefore presents possibilities and opportunities to forest managers.

Succession also has incredible time and monetary cost effects on humans. For example, the energy input by a farmer to control growth of weeds following the preparation of soil for planting is directly proportional to the energy inherent in the force of ecological succession. If we extrapolate this very small-scale scenario to all of the agricultural fields and systems on earth and visualize all of the activities of all of the farmers, we begin to get an idea of the immense cost in terms of time, fuel, herbicides, and pesticides that humans pay every growing season because of the force of ecological succession.

SEE ALSO: Biodiversity; Climax Communities; Ecosystems; Equilibrium; Forest Management; Invasions, Biological; Shifting Cultivation; Species.

BIBLIOGRAPHY. M.B. Bush, *Ecology of a Changing Planet*, 2nd ed. (Prentice Hall, 2000); J. Greenberg, "Mechanisms of Succession and Conservation Consequences in Tropical Rain Forests," www.cstars.ucdavis.edu (cited May 2006); P.W. Richards, *The Tropical Rain Forest*, 2nd ed. (Cambridge University Press, 1996).

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Sudan

FORMERLY KNOWN AS Anglo-Egyptian Sudan, the Republic of Sudan won its independence from Britain in 1956. The years since independence have been marked by two civil wars and ongoing political and civil unrest that have arisen from deep-rooted conflicts concerning the northern domination of southern Sudanese. After the end of the first civil war in 1972, there was a brief period of peace until war resumed in 1983. War and famine together subsequently caused the deaths of two million Sudanese and displaced another four million. The Naivasha Peace Treaty of 2005 granted a six-year period of southern autonomy, with a referendum scheduled on the issue of independence in 2011.

A separate conflict in the western region of Darfur that began in 2003 has led to the deaths of another 200,000 Sudanese and the displacement of close to two million people. In the spring of 2006, efforts to negotiate peace in the Darfur region resulted in a call for United Nations (UN) peacekeeping forces. Riots broke out even after an agreement was reached in May that negotiated a cease fire and paved the way for the deployment of UN troops. The Sudan continues to battle the residents of Chad, claiming that the Chadian government is helping to support guerilla warfare in the Sudan. Refugees from Chad and neighboring Ethiopia have strained the Sudan's environment and infrastructures. In April 2006, the Chadian government threatened to expel 250,000 black Sudanese who had fled to Chad to escape the genocide going on in the Sudan.

The Sudan's natural resources include: Petroleum, small reserves of iron ore, copper, chromium ore, zinc, tungsten, mica, silver, gold, and hydropower. Oil exports that began in 1999 have boosted the Sudanese economy, and the government has developed economic reforms using International Monetary Fund models. With less than seven percent of its land area fit for agriculture, however, 80 percent of the population are engaged in mostly subsistence agriculture. Unemployment currently stands at 18.8 percent. With a per capita income of $2,100, the Sudan is ranked 178th in world incomes. Forty percent of the population live in poverty, and 27 percent are undernourished. The UN Development Programme's Human Development Reports rank the Sudan 141 of 232 countries on overall quality-of-life issues.

The Sudan is the largest country in Africa, with a total area of 2,505,810 square kilometers. Bordering on the Red Sea, the Sudan has a coastline of 853 kilometers and 129,810 square kilometers of inland water resources, including the Nile River and its tributaries. The Nile is the feature that most defines the Sudan, for it provides a lifeline for subsistence farmers. The Sudan shares borders with the Central African Republic, Chad, the Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Kenya, Libya, and Uganda. Most of the land area of the Sudan is a flat, featureless plain. Land in the far south, northeast, and west is mountainous, however, and northern Sudan is dominated by desert. Elevations range from sea level to 3,186 meters at Kinyeti. The tropical climate of the south gives way to arid desert in the north. The rainy season differs according to region, lasting from July to September in the north and from June to November in the south. The entire country is subject to dust storms and periodic persistent droughts.

The environment of the poorest Sudanese places them at risk for contracting preventable diseases. Over 30 percent of the people lack sustained access to safe drinking water, and 66 percent of Sudanese lack access to improved sanitation. Thus, the population of 41,236,378 is at very high risk for contracting food and waterborne diseases such as bacterial and protozoal diarrhea, hepatitis A, and typhoid fever, the water contact disease schistosomiasis, and the respiratory disease meningococcal meningitis. In some areas, the population is also at risk for contracting vectorborne diseases such as malaria, dengue fever, and African sleeping-sickness.

Although the Sudan has escaped the high HIV/AIDS rates experienced by the poorest African nations, 400,000 Sudanese are living with this disease. Sudanese women produce an average of 4.4 children each, affecting their health and straining resources. Disseminating birth control and health information is made difficult by the literacy rate of 50.5 percent as compared with 71.8 percent for males.

The Sudan has a severe shortage of potable water, which poses health hazards for humans and impacts on water available for irrigating crops. A combination of human mismanagement and climatic conditions has created massive problems with soil erosion, and the desert is constantly encroaching on other lands. While nearly 26 percent of land area is forested, deforestation is occurring at a rate of some 504,000 hectares a year. Fires are destroying trees as well as vegetation. Coastal waters have been polluted by oil, industrial effluents, and raw sewage. With almost 40 percent of the population living in urban areas, solid waste disposal has become a major issue. The government has protected 5.2 percent of land area, but poaching is jeopardizing the wildlife population. Of 267 identified mammal species, 23 are endangered, as are six of 290 bird species. In 2006, a study by scientists at Yale University ranked the Sudan 124 of 132 countries on environmental performance, below the comparable income and geographic groups. Low scores were received in the categories of air quality, environmental health, and biodiversity and habitat.

The Minister of Environment and Physical Development holds the major responsibility for implementing and monitoring environmental laws and regulations in the Sudan. Other ministries with environmental responsibility include Health, Tourism and Wildlife, Irrigation and Water Resources, Agriculture and Forests, and Animal and Fish Resources. Sudan's first environmental law can be traced to the early 20th century with the first land management laws and efforts to stop desertification and deforestation. The first efforts toward protecting wildlife culminated in the establishment of the national park system in 1935.

Despite these early moves toward environmentalism, modern-day efforts are hampered by the lack of a comprehensive national environmental plan. Existing laws are not integrated, and they are often ineffective in accomplishing their goals. The public has not been sufficiently educated about individual responsibilities for the environment. The Sudan participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Deforestation; Desertification; Drinking Water; Fire; National Parks; Nile River (and White Nile); Subsistence; Wars.

BIBLIOGRAPHY. Central Intelligence Agency, "Sudan," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental*

Overview of Environmental Issues (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); Asim I El Moghraby, "State of the Environment in Sudan," www.iaia.org (cited April 2006); United Nations Development Programme, "Human Development Report: Sudan," hdr.undp.org (cited April 2006); World Bank, "Sudan," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Suez Canal

THE SUEZ CANAL is of the most important manmade waterways in the world. Crossing the isthmus that connects Africa and Asia, the Suez joins the Mediterranean and Red Seas, providing the shortest maritime route, 105 miles, between Europe and the Indian Ocean, Far East, and western Pacific. The canal diverts from the shortest route to include Lake Timsah and the Bitter Lakes. Traversing parts of the desert, the canal is lined with stone revetments and sheet-piles to prevent erosion. Along the canal are many settlements, including the major port cities of Port Said, Suez, and Ismailia, most of which arose with the canal's construction.

President Sa'id ordered the creation the canal in 1854, commissioning its construction and management to the French. Instead of helping Egypt modernize, the canal contributed to the country's bankruptcy. By 1875, Egypt had to sell its company shares to Britain, transferring control to France and Britain, making the canal an Egyptian symbol of European exploitation. Finding the canal key to accessing its empire and oil, Britain crafted its colonial policy in the Middle East and Africa in order to best control the canal. In 1956, Egyptian President Nasser nationalized the canal to gain independent revenue for development projects.

The Suez Crisis resulted when Britain, Israel, and France used military might to regain control, but withdrew under pressure from the United States and Soviet Union, illustrating Britain's decline as a superpower and establishing Nasser as a pan-Arab hero. After the June War of 1967, Israel won the canal in an easy victory. To regain revenues and restore national pride, Nasser started the war of attrition, which only harmed settlements along the canal. Egypt regained ownership in the 1973 October War.

Although narrow and shallow, without space for ships to pass side by side, the canal is a significant source of Egyptian revenues. In 1994 approximately 20,000 ships passed through the canal per year and 35 percent of the tonnage belonged to the oil industry. The canal was widened for supertankers, in the 1980s and 1990s.

The canal has significantly changed ecological patterns. Organisms can pass between the Mediterranean and Red Seas, allowing scientists to observe migration and colonization processes that usually take place over geological time. Primarily tropical floral has traveled from the Red Sea, in a process called Lessepsian migration. No species has disappeared, but there have been decreases in Mediterranean flora that have affected fishing patterns. The canal has occasionally been affected by systems around it. The canal was created to accommodate its surrounding geography and was expanded to accommodate economic needs, such as supertankers. As the canal becomes a part of the landscape, new political, economic, and ecological systems, such as desire for easier oil access and increasing sea levels, may dictate the future of the Suez.

SEE ALSO: Colonialism; Egypt; Mediterranean Sea; Sea Level Rise.

BIBLIOGRAPHY. William L. Cleveland, *A History of the Modern Middle East* (Westview Press, 2000); Daniel Golani, "Impact of Red Sea Fish Migrants through the Suez Canal on the Aquatic Environment of the Eastern Mediterranean," *Bulletin of the Yale School of Forestry & Environmental Studies* (Yale University, 1998); J.D. Griffiths, "Queueing at the Suez Canal," *The Journal of the Operational Research Society* (v.46, 1995); Keith Kyle, *Suez* (St. Martin's Press, 1991).

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Sugar

SUGAR IS A term for sucrose that occurs naturally and is commercially produced from sugar cane or sugar beet. The origin of the word appears to have come from India where the Sanskrit was *sarkara*. This became the Arabic *al sukkar*, and then Portuguese *açucar,* the Spanish *azu'ucar,* and then the Italian *zucchero*. The old French word *zuchre* later became the modern word *sucre*.

The derivation of the word also illustrates the origin of sugar; the production of sugar from sugar cane took place in ancient India. Soldiers from the armies of Alexander the Great tasted it, and it became more common in the Middle East; the Moors introduced it to Spain and Sicily. The Crusaders also brought back sugar to Europe where it remained a delicacy in many parts of the continent, although it became somewhate more common in ports such as Venice and Genoa, as can be seen by the deterioration in the conditions of teeth during the Middle Ages. By the 15th century, the Spanish and the Portuguese had begun establishing plantations in the Canary Islands, Madeira, and the Azores.

In 1506 the Spanish started cultivating sugar cane in the Caribbean, with plantations on the island of Cuba in 1523. Nine years later the Portuguese began their sugar cane plantations in Brazil. Gradually as many European countries started to establish colonies in the tropics, the production of sugar increased. This was helped by slave labor, although production was higher after the abolition of slavery than before. The British grew sugar in Barbados and other parts of the Caribbean, especially British Guiana (Guyana), later growing large amounts of sugar cane in Queensland in northern Australia.

At its height, sugar production made up some 95 percent of the exports of Barbados. The French established plantations on the islands of Guadeloupe and Martinique, as well as on Mauritius and in the Pacific. They had also established plantations on Saint Dominique (modern-day Haiti). For the Dutch, the island of Java proved to be good for growing sugar cane. The Spanish industry on the island of Cuba led the world in production. Some places became so associated with the production of sugar that they gave their names to particular types of sugar. The port of Demerara in Guyana is one such example.

The production of sugar from beet began in 1747 when the German chemist Andreas Marggraf experimented with the idea. A colleague, Franz Achard, built a sugar-beet processing plant at Cunern, Silesia, a territory recently seized by Prussia from Austria. This continued with the support of King Frederick William III of Prussia (reigned 1797–1840). Demand increased considerably during the Napoleonic Wars with France because of the inability to access West Indian supplies. The Cunern factory was destroyed late in the war, but by this time other factories had been built.

Sugar was used to sweeten drinks, especially tea, and was also used for confectionary and for the production of molasses and rum. It was also used for jams, processed foods, beer, and other drinks. In 1813 British chemist Edward Charles Howard developed a method of refining sugar that was particularly successful and was further developed by David Weston in Hawaii in 1852. It used a centrifuge to separate molasses from sugar. It was used in making soft drinks, in particular Coca-Cola, first manufactured in 1886, and Pepsi-Cola, first produced in 1898.

Some of the famous sugar producers in the world include Tate and Lyle (a British company), and Colonial Sugar Refining (C.S.R.) in the Pacific and Australia. The latter company was involved in developing the sugar industry in Fiji, as well as in New Zealand.

Although sugar considerably improved the diet in terms of taste, one of the early side effects was tooth decay. Archaeologists sometimes use the state of teeth to give an early determinant of the age of a skeleton—dating it to before or after the widespread eating of food with sugar. Many dieticians also connect overconsumption of products with sugar to obesity. Sugar cane has also been used for many other by-products, notably ethanol, which is used as a substitute for petrol in some countries

SEE ALSO: Colonialism; Crop Plants; Cuba; Fast Food; Fiji; Guyana; India; New Zealand; Obesity; United States, Hawaii.

BIBLIOGRAPHY. Henry Hobhouse, *Seeds of Change: Six Plants that Transformed Mankind* (Papermac, 1999);

A.G. Lowndes, ed., *South Pacific Enterprise: The Colonial Sugar Refining Company Limited* (Angus & Robertson, 1956); R.A. Quintus, *The Cultivation of Sugar Cane in Java* (Norman Rodger, 1923); Wendy A. Woloson, *Refined Tastes: Sugar, Confectionary and Consumers in Nineteenth Century America* (Johns Hopkins University Press, 2002).

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Sulfur Dioxide

SULFUR DIOXIDE IS a gas consisting of oxygen and sulfur. It is produced in natural phenomena such as volcanic eruptions and also as a result of various industrial activities. The gas irritates the lungs and has a smell reminiscent of rotting eggs. The presence of sulfur dioxide in the air has negative health impacts and the production of acid rain as a result of the presence of the gas in the atmosphere has contributed to environmental degradation. Industrial processes release sulfur dioxide into the air and produce acid rain in remote locations, owing to atmospheric circulation. The acid rain falls on important forested areas leading to climate change.

The burning of coal, an inefficient process that releases particulates into the air, commonly causes acid rain. When the rain falls, its leads to the acidification of standing water and water sources on the ground. This has an impact on the local environment that may be long-term in nature, since even when levels of acidification are reduced, residual effects can remain. In countries such as China, where the use of coal for industrial purposes continues to increase, the prevalence of sulfur dioxide in the atmosphere also increases. The presence of alkaline dusts and substances, which are often found in desert regions, can help to reduce the impact of acidification.

All forms of carbon-based fuel production, even those labeled "clean," produce significant amounts of particulates into the air, including sulfur dioxide. Consequently, those who support sustainable development tend to oppose use of such fuels completely. Air pollution can lead to asthma and respiratory diseases that are estimated to cause approximately three million deaths per year. Up to one million excess deaths are caused by such pollution in Asia annually and up to half that amount in sub-Saharan Africa. It is very difficult to isolate the impact of sulfur dioxide from other atmospheric pollutants since they so often occur together, especially in cities that have multiple sources of pollution. The combination of sulfur dioxide with other particulates helps stimulate the prevalence of new diseases and syndromes, often those affecting the vulnerable urban poor.

Acid rain deriving mostly from British industrial activity harmed lakes in Scandinavia and had negative impacts on surrounding forests. Such events can have causal effects on subsequent climate change. Attempts to nullify the acid with massive application of alkaline agents may have unanticipated effects.

SEE ALSO: Acid Rain; China; Coal.

BIBLIOGRAPHY. Thorjorn Larssen et al., "Acid Rain in China," *Environmental Science and Technology* (v.40/2, 2006); Kiran D. Pandey et al., *The Human Cost of Air Pollution: New Estimates for Developing Countries* (World Bank, 2003); Michael G. Sanderson et al., "Present and Future Acid Deposition to Ecosystems: The Effect of Climate Change," *Atmospheric Environment* (v.40/7, 2006).

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Superfund Sites

SUPERFUND SITES ARE areas of land in the United States that are identified by the U.S. Environmental Protection Agency (EPA) as contaminated by abandoned hazardous waste. As of 2006, there were over 12,000 Superfund sites listed in EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS). Just over 1,200 of these sites were also included on EPA's 2006 Final National Priorities List

(NPL), which consists of the CERCLIS sites deemed the most dangerous to human health and the environment. Sites on the National Priorities List are eligible for long-term remediation under the federal Superfund Program, created by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 and renewed by the Superfund Amendments and Reauthorization Act (SARA) of 1986.

DEFINITIONS AND PROCEDURES

There are some common confusions and ambiguities surrounding the usage of the term *Superfund site*. First, the term is often used to refer only to sites on the NPL, but NPL sites are simply the Superfund sites that EPA has designated as having highest priority for cleanup. Second, many U.S. states have their own hazardous waste remediation programs, some of which are also called Superfund programs. State Superfund lists include thousands of sites, many of which are not in EPA's database. In addition, Superfund sites do not include all hazardous waste sites; the total number of contaminated sites that remain officially unidentified is unknown.

Anyone from EPA's own inspectors to local officials and ordinary citizens can report hazardous waste sites or releases of chemicals as potential Superfund sites. After entering an identified site in the CERCLIS database, EPA uses existing information about the site to conduct a Preliminary Assessment (PA) designed to determine if it warrants further investigation. At a site that potentially poses serious threats to human health or the environment, EPA carries out a more extensive Site Inspection (SI). This inspection typically includes sampling and analysis to detect and measure contamination in soil, groundwater, surface water, and air. Based on this inspection, sites that present potential risks receive a Hazard Ranking System (HRS) score between zero and 100, with higher scores indicating higher risks. Sites that receive scores above 28.5 become eligible for inclusion on the NPL.

Superfund sites are eligible for two kinds of cleanup. The first is the removal action or emergency response, which addresses immediate, short-term threats to human health or the environment. The second is the remedial action, which addresses long-term threats at sites on the NPL. At a site designated to receive remediation, contractors for EPA, the state, or the organization deemed responsible for the contamination (called the potentially responsible party, or PRP) carry out an extensive Remedial Investigation (RI) to generate a more complete scientific characterization of the site and a more precise estimate of potential exposures and risks from the site. This investigation is usually combined with a Feasibility Study (FS), which identifies and evaluates different alternatives for cleaning up the site. If these studies suggest that remedial action is necessary, EPA selects one of the alternatives in a Record of Decision (ROD) and subsequently oversees its design, construction, operations, and maintenance. This series of steps typically takes years—or even decades—to complete.

CONTAMINANTS AND CLEANUP OPTIONS

Superfund sites are contaminated by a wide variety of chemicals, and in many cases we still know little about how much risk they pose to human health or ecosystems. Among the more common contaminants found at Superfund sites are commercial solvents like benzene and toluene, pesticides like DDT and aldrin, chlorinated compounds like polychlorinated biphenyls (PCBs) and dioxins, and metals or transition metals like chromium and mercury. In the face of uncertainties about the health and environmental effects of many of the chemicals found at Superfund sites, some argue that EPA should take a precautionary approach and insist on the most stringent cleanups possible, while others contend that expensive remedial actions are often unwarranted.

In the early years of the Superfund program, there were few technological options for cleaning up hazardous waste sites. EPA often selected relatively impermanent alternatives, such as excavating waste and placing it in lined and covered (or "capped") on-site landfills. However, the SARA of 1986 established a preference for selecting more permanent solutions and for treating contaminated media instead of leaving the chemicals in toxic forms. In the past two decades a number of new technologies have emerged or are emerging to meet this need. For example, bioremediation uses bacteria or other microorganisms to break down petrochemical contamination at Superfund sites, and nanotechnology uses microscopic particles to neutralize toxic wastes.

CLEANUP PACE AND SITE DISTRIBUTION

Although only a small number of sites were cleaned in the first decade of the Superfund program, the pace of cleanup has increased considerably in the past 15 years. In the first four years of the program, EPA cleaned only six sites, and it had completed remediation at only 41 sites by the end of the 1980s. But by the end of the 1990s, EPA reported 676 "construction completions" at sites on the NPL, and by the end of 2005 the number had risen to 970.

The dramatic increase in cleanups during the 1990s reflects several factors, including the length of time it takes to remediate complex sites, the growth and maturation of the hazardous waste remediation industry, and administrative reforms initiated in the Superfund program under the Bill Clinton administration. Since most sites are cleaned up by potentially responsible parties themselves, cleanup activities continue at many sites despite the recent bankruptcy of the federal Superfund trust fund. However, many argue that the expiration of the special tax that supported this fund threatens the continued remediation of sites in the future.

All but one state (North Dakota) currently have at least one Superfund site on the NPL, but Superfund sites are concentrated in regions of the country with long histories of industrial activity. As of 2006, over 30 percent of the sites on the Final NPL were located in four states: New Jersey (113 sites), California (94), Pennsylvania (94), and New York (86). The most famous Superfund site is undoubtedly the Love Canal site in Niagara Falls, New York, which first brought national attention to the problem of abandoned hazardous waste in the late 1970s. Other well-known Superfund sites include the Woburn Wells G & H site in Massachusetts, which was the subject of the book and movie *A Civil Action*; the Times Beach site in Missouri, which caused the relocation of an entire town in the mid-1980s; and the General Electric Hudson River PCBs site in New York, which covers approximately 200 miles (322 kilometers) of the river extending north from New York City.

SEE ALSO: Clinton, William Administration; Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); DDT; Dioxins; Environmental Protection Agency (EPA); Love Canal; Mercury; Polychlorinated Biphenyls (PCBs).

BIBLIOGRAPHY. Harold C. Barnett, *Toxic Debts and the Superfund Dilemma* (University of North Carolina Press, 1994); Thomas W. Church and Robert T. Nakamura, *Cleaning Up the Mess: Implementation Strategies in Superfund* (Brookings Institution, 1993); James T. Hamilton and W. Kip Viscusi, *Calculating Risks: The Spatial and Political Dimensions of Hazardous Waste Policy* (MIT Press, 1999); John A. Hird, *Superfund: The Political Economy of Environmental Risk* (Johns Hopkins University Press, 1994); Richard L. Revesz and Richard B. Stewart, eds., *Analyzing Superfund: Economics, Science, and Law* (Resources for the Future, 1995); U.S. Environmental Protection Agency, "Superfund," www.epa.gov/superfund (cited May 2006).

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Supreme Court

PRIOR TO THE rise of the environmental movement and the great increases in regulation of the environment by the U.S. Congress through its statutory authority as administered by the Environmental Protection Agency (EPA) and other bureaucratic agents, the U.S. Supreme Court was involved in environmental regulation. With its constitutional authority it exercised judicial review in regard to the constitutionality of legal issues in environmental cases. However, most of the cases involved tort law and principles of the common law. Some of the types of cases the Supreme Court reviewed included cases of water rights and a growing number of matters involving conservation. Other cases involved interpretations of federal and state laws. Some involved constitutional issues arising from federal laws, regulations, or actions; some involved the constitutionality of state laws. Other cases arose in response to conservation laws and later environmental laws passed by Congress in increasing numbers after the 1960s.

Prior to the 1960s, federal laws concerning the environment were focused on conservation. A number of Supreme Court cases came up as Americans began to seek to protect the last buffalo or the last stands of virgin timber or other natural resources endangered at the time. An important case involving conservation was *Missouri v. Holland, U. S. Game Warden,* 252 U. S. 416 (1920). Legally the case involved the inherent powers of the government of the United States in foreign affairs.

Missouri is located on one of the great migratory flyways. Every autumn vast flocks of birds flying south for the winter transit Missouri. Water fowl, especially geese and ducks, flying in their V-shaped wedge formations, annually silhouette the sky with skein after skein stretching as far as the eye can see. By the early 1900s, the State of Missouri, like all American states, had established hunting regulations to allow the hunting of migratory birds. One of the reasons for Missouri's hunting regulations was a concern for conservation. However, another reason was the interest in the money generated by hunting and hunting licenses.

Conservationists at the time were very concerned about hunting that could exterminate some species. However, in response to conservationist concerns Congress also passed a law in 1913 to regulate the hunting of migratory birds. Two federal district courts declared the law to regulate the hunting of migratory birds based on the commerce clause to be unconstitutional because there is nothing expressed or implied in the Constitution to authorize the regulation. The cases were not appealed.

On July 3, 1918, Congress passed the Migratory Bird Treaty Act as legislation to implement the Migratory Bird Treaty of December 8, 1916, with Great Britain acting on behalf of Canada. Missouri sued to stop Ray P. Holland, a federal game warden, from enforcing the law. Missouri argued that the law and hence the treaty were not authorized by the constitution; that the treaty infringed upon Missouri powers, reserved to it by the Tenth Amendment; and that once the birds entered Missouri air space they became the property of the State of Missouri.

Justice Oliver Wendell Holmes, in a short, cryptic opinion, concluded that the Government of the United States did, in foreign affairs, have the authority "under the Constitution" to make treaties and to implement them under the necessary and proper clause: Article I, Section 8. He also concluded all treaties are the law of the land (Article VI) so the claims of Missouri could not limit the treaty-making power of the federal government. Justice Holmes also dismissed Missouri's claim to a property interest in migrating birds by noting that they were wild and the property of no one.

Cases appearing before the Supreme Court have arisen in a number of ways. Some cases have involved the ownership of eagle feathers, possession of animals, water pollution, and other issues. However, most Supreme Court cases have decided issues arising from environmental regulatory legislation adopted by Congress since the 1960s. Most important have been the Clean Air Act, the Clean Water Act, the Natural Environmental Policy Act, the Resource Conservation and Recovery Act, and other similar legislation.

Some cases appearing before the Supreme Court have been brought against an independent agency of the United States. These cases may involve polluting practices endangering the public's health such as the Rocky Mountain Flats Facility operated by the Atomic Energy Commission, or by the Tennessee Valley Authority over an endangered snail darter in the Tellico Dam case, *TVA v. Hill* (1978).

Cases also arise from the regulatory bodies administering federal environmental protection legislation. Of major significance in the administering of federal environmental and conservation legislation has been the EPA. Other federal agencies have a role in the same area. It is also important to note that all of the 50 states have their own environmental regulatory laws and regulatory agencies. From these rules and regulations cases have arisen to the Supreme Court. Cases have also involved industries or businesses that have sued for relief from what are considered burdensome regulations. Some businesses have engaged in countersuits in an effort to fight back against litigious environmental groups. The Supreme Court decides which cases it will hear as its own gatekeeper. The number of cases reaching the appellate courts of appeal has grown enormously in the last 25 years. This includes environmental cases that now number in the thousands.

The operations of the EPA have been a regular issue on the Supreme Court's docket. The numerous cases involving the EPA demonstrate the monetary value of winners and losers in the court's decisions. At stake may be vast sums of money or, from the point of view of environmentalists, the preservation of irreplaceable nature that, if exploited, will disappear forever. Cases involving the EPA appearing before the Supreme Court have presented many issues. In a case in March 2001 the Court rejected the legal arguments of industry groups seeking a ruling that would force the EPA to use cost-benefit analysis in setting clean air standards.

In *Whitman v. American Trucking Association, Inc.* (2001), the Supreme Court held that the EPA must set ambient air quality standards without regard to the cost of implementing those standards. The Court examined the legislative history of the Clean Air Act and concluded that Congress set the standards in outline and did not view the cost of abiding by the standards as a factor that was to be considered. The cost for clean air would be whatever the payments had to be.

Another very regular defendant appearing before the Supreme Court is the Army Corps of Engineers. It has been involved in clearing rivers and streams of obstacles to navigation since the beginning of the Republic. It also operates levees and other flood control systems. Its decisions as to what is a wetland, and therefore what can and cannot be filled in even when a wet area is on private land, is a matter of great consequence to the public and an issue that has appeared in Supreme Court cases involving not only the Corps but also the EPA.

The Constitution gives the Congress the authority to regulate the navigable waters of the United States. Deciding which waters of the United States are supervised by the Corps of Engineers has been contested in various ways. In a 2001 case, *Solid Waste Agency of Northern Cook County v. U.S. Army Corps of Engineers*, a divided Court struck down the Army Corps' migratory bird rule because it was lacking a substantial definition of the "navigable waters" governed by the Clean Water Act. Historically the courts in the United States have taken a broad view of the meaning of "waters of the United States."

In 2006 the Supreme Court in *Rapanos v. United States* and in a companion case, *Carabell v. U.S. Army Corps of Engineers,* decided that the term "waters of the United States" and "navigable waters" in the Clear Water Act do not apply to streams that have only intermittent flows. The decision overturned a decision by the 6th Court Circuit of Appeals. In effect the Court said that the Clean Water Act does not protect isolated intra-state wetlands that are more often dry.

Other kinds of environmental decisions made by the Supreme Court involve such matters as the legal responsibility of federal agencies or the division of powers between the states and the federal government in the enforcement of environmental laws. In the case of the *S. D. Warren Company v. The Maine Board of Environmental Protection* the Supreme Court decided that a federally licensed hydroelectric facility must have a water quality certification issued by the State of Maine. The opinion of the Court made federally licensed facilities subject to state jurisdiction when the issue was the discharge of effluents into the watershed. The Court's decision centered on the meaning of the term, "discharge" used in the Clean Water Act.

At the end of 2006, the Supreme Court was hearing a case, *Massachusetts v. Environmental Protection Agency* (EPA), involving whether or not citizens and environmental groups could sue to stop what they consider to be the contributors to global warming. The Supreme Court's decision will probably involve standing to sue and also whether or not the issue of global warming is judicable. Also involved in the case are 12 states that are suing the EPA.

Their suit claims that the EPA has failed to limit harmful gas emissions that are believed to be causing global warming. The court will have to decide if there is indeed global warming. The suit claims that the government, in this case the George W. Bush Administration, has not been serious about global warming. The state governments involved are claiming to take global warming seriously and are seeking judicial relief that will force the EPA to follow their interpretation of the Clean Air Act.

Some parties to an environmental case join through the filing of amicus curia briefs. These "friend of the court" briefs present claims that are supposed to help the court in making a decision. In the global warming case the Aspen Ski Company of Aspen, Colorado, joined through an amicus curia brief that supports the side of the conservation groups and the 12 states over carbon dioxide emissions being responsible for global warming.

SEE ALSO: Army Corps of Engineers (U.S.); Clean Air Act; Clean Water Act; Environmental Protection Agency (EPA); Litigation, Environmental; Martin vs. Waddell; Snail Darter and Tellico Dam; Standing to Bring A Lawsuit.

BIBLIOGRAPHY. Charles A. Lofgren, "Missouri v. Holland in Historical Perspective," *Supreme Court Review* (1975); Robert Meltz, *Constitutional Bounds on Congress' Ability to Protect the Environment* (Nova Science Publishers, 2003); U.S. Congress, *SWANCC Supreme Court Decision*: *Impact on Wetlands Regulations: Hearing before the Subcommittee on Fisheries, Wildlife, and Water of the Committee on Environment and Public Works*, United States Senate, One Hundred Eighth Congress, First Session (U.S. Government Printing Office, 2004); *U.S. Supreme Court Limits Federal Regulation of Wetlands: Implications of the SWANCC Decision* (California Research Bureau, 2002).

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Suriname

LOCATED IN THE Amazon basin, Suriname (the former colony of Dutch Guinea) won its independence from the Netherlands in 1975 only to fall under a military regime in 1980. The military retained power even after democracy was nominally restored in 1987. Since 1991 free elections have improved the condition of democracy for the country.

The population of 438,144 resides mostly along the coast in an area of 63,039 square miles (163,270 square kilometers), an area roughly the size of the U.S. state of Georgia. Suriname's natural resources include timber, hydropower, fish, kaolin, shrimp, bauxite, gold, and small deposits of nickel, copper, platinum, and iron ore. Less than 1 percent of Suriname's land is arable.

Exports are chiefly tied to the alumina industry, which provides 70 percent of export revenue. Around 70 percent of Surinamese live below the poverty line; but with a per capita income of $4,700, Suriname is ranked 139th in world incomes. Around 98 percent of the population have access to safe drinking water, and 97 percent have access to improved sanitation. Typhoid is a major threat in Suriname, and the population is regularly exposed to incurable tropical diseases transmitted by insects. The intense heat and high humidity also play havoc with general health. The HIV/AIDS virus is an additional threat. With a prevalence rate of 1.7 percent, some 5,200 people have contracted the disease, and approximately 500 have died. The United Nations (UN) Development Programme Human Development Reports rank Suriname 86th in the world on general quality-of-life issues.

Bordering on the North Atlantic Ocean, Suriname has a coastline of 386 kilometers and an inland water area of 1,800 square kilometers. The tropical climate is moderated by trade winds. Except for a swampy coastal plain, the terrain of Suriname is hilly, with elevations ranging from two to 1,230 meters. Rich in biological diversity, the tropical rain forest is the defining feature of Suriname's geography. Only French Guinea and the Solomon Islands have healthier rain forests than the one that covers 90 percent of Suriname's land area. In response to the demand for tropical timber, logging companies targeted Suriname in the 1990s. However, conservationists intervened, and the forests were left virtually intact. Mining and other extractive industries continue to present a threat to the Suriname Amazon.

Some 76 percent of the population are urbanized, and the pollution of inland waterways by mining companies is of major environmental concern. This situation is likely to accelerate as the gold mining and petroleum industries launch activities in Suriname. The government has protected nearly 5 percent of total land area, which is home to wildlife that ranges from diamond-head and Bush master snakes to jaguars and harpy eagles. Eight different species of monkeys live in the rain forest. Of 180 mammal species endemic to Suriname, 12 are endangered, but only one of 234 endemic bird species is threatened. In a 2006 study conducted by Yale University, Suriname was ranked 48th of 132 nations on environmental performance, in line with the relevant geographic group and above the relevant income group. The lowest score was received in the category of sustainable energy.

Suriname's environmental policies are designed to comply with the UN Agenda 21 for Sustainable Development. The Minister of Labor, Technological Development, and Environment works with the Council for the Environment and other ministries to develop policy in Suriname.

The Environmental Management Agency is responsible for monitoring and control of all relevant laws and regulations. In addition to adopting the National Environmental Action Plan, the Surinamese government also established a National Strategy on Biodiversity and a Methodology for Ecological Economic Zoning. Suriname has signed the following international agreements in support of global environmentalism: Biodiversity, Climate Change, Desertification, Endangered Species, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 94, and Wetlands.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Agenda 21; Biodiversity; Mining; Petroleum; Pollution, Water; Rain Forests; Timber Industry; Typhus.

BIBLIOGRAPHY. Central Intelligence Agency, "Suriname," *The World Factbook,* www.cia.gov (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Latin America and the Caribbean: A Continental Overview of Environmental Issues* (ABC-CLIO, 2004); Alanna Mitchell, *Dancing at the Dead Sea: Tracking the World's Environmental Hot Spots* (University of Chicago Press, 2005); Michael Painter and William H. Durham, eds., *The Social Causes of Environmental Destruction in Latin America* (University of Michigan Press, 1995); United Nations Development Programme, "Human Development Reports: Suriname," hdr.undp.org (cited April 2006); World Bank, "Suriname," *Little Green Data Book* (cited April 2006); lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Sustainability

THE TERM *sustainable development* was first used in the World Conservation Strategy in 1980. The language of sustainability, however, emerged during the 1970s and became popularized in 1987 as "sustainable development" by the World Commission on Environment and Development (WCED; also known as the Brundtland Commission). The concept is much older, and has similarities to the definition of "conservation" produced by Gifford Pinchot in 1901. The origins of this concept in forestry and resource security can be traced to the German forestry of the 18th century and even further back to the Duke of Saxony in the early 18th century and Louis XIV in France in the 17th century, with his efforts to ensure a reliable supply of timber for the French navy.

The release of the WCED report in 1987 was crucial in promoting the idea of sustainable development. In this report, commonly known as the Brundtland Report after its Norwegian chairperson Gro Harlem Brundtland (and published as *Our Common Future*), sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This approach was important in marginalizing Neo-Marxist critiques and "limits to growth" arguments that claimed there were irreconcilable tensions between environment and society in modern capitalist (and socialist) states.

The WCED report (1987) did not reject economic growth—in fact it advocated increasing economic growth by a factor of between five and 10. The arguments for economic growth were that it was necessary to overcome poverty in developing countries, richer countries needed to continue growing in order to facilitate trade with the developing countries, and it was possible to make economic growth more environmentally and socially benign, therefore benefiting development. Herman Daly has distinguished between "growth" as a quantitative concept that can be measured, and "development" as improvements in quality. In the sustainability literature, there is often slippage in terminology (as in "sustainable growth," which many environmentalists consider to be an oxymoron) or in the use of terminology such as "development" to mean "growth."

There are different ways of conceptualizing sustainable development vis-à-vis sustainability. Mark Diesendorf presents the relationship as "sustainability" and "sustainable futures" being the "goals or endpoints of a process called 'sustainable development.'" In contrast, Phil McManus presents sustainable development as more of a reformist approach, whereas an emphasis on sustainability, and particularly ecological sustainability, raises more radical questions about structures that perpetuate unsustainable practices. In Australia, the term *ecologically sustainable development* (ESD) emerged as a unique approach largely due to the power of major environmental groups in Australia in the early 1990s. In 1992, ecologically sustainable development was defined by the Commonwealth of Australia as "using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future, can be increased." This definition incorporates economic, social, and environmental considerations, but importantly it acknowledges that life depends upon ecological processes and these must be maintained. There are numerous definitions of sustainability, but the key question to be asked in relation to sustainability is: What is to be sustained?

Many of the differences in various concepts of sustainability can be attributed to the relative weight given to economic, social, cultural, and environmental components of sustainability. The differences are also caused by the perception of how these components fit together. For example, are economic, sociocultural, and environmental factors going to be *balanced* as in the intersection of three circles of equal sizes, or is the economy a part of society that in turn is part of the environment?

Variations in the models of sustainability, or sustainable development, are generally variations upon a model of hierarchy or of balance. The hierarchy may vary between models, but it often includes ecological considerations at its base, followed by society, because there would be no society without an environment, and then the smallest circle is the economy, because there would be no economy if there was no society. Variations may include the use of thermodynamic processes to support biochemical cycles that allow ecosystems to flourish, which eventually reach human social and individual scales. In the case of models predicated on the notion of balance, the sense of balance may be maintained but there may be different terminology used or another circle of culture may be added.

Many of the initial attempts to implement the idea of sustainable development often seemed to be an extension, or perhaps a repackaging, of what used to be called "environmental management." The "environment" was often equated with the "natural environment" or "nature." Sustainable development was easily associated with trees, mountains, rivers, and oceans, but less so with cities. If the concept did include cities, it was often thought of in terms of the environmental quality or the environmental assets of cities. Once it became increasingly accepted that in order to achieve sustainable development of rural, marine, and bush areas, it was necessary to limit or modify the impacts of cities, then the focus shifted to thinking about sustainable cities.

SEE ALSO: Brundtland Report; Conservation; Economics; Intergenerational Equity; Pinchot, Gifford; Sustainable Cities; Sustainable Development.

BIBLIOGRAPHY. Commonwealth of Australia, *National Strategy for Ecologically Sustainable Development* (Australian Government Publishing Service, 1992); Herman Daly, *Beyond Growth: The Economics of Sustainable Development* (Beacon Press, 1996); Mark Diesendorf, "Sustainability and Sustainable Development," in Dexter Dunphy et al., eds., *Sustainability: The Corporate Challenge for the 21st Century* (Allen and Unwin, 2000); Phil McManus, "Contested Terrains: Politics, Stories and Discourses of Sustainability," *Environmental Politics* (v.5, 1996); Phil McManus, "Histories of Forestry: Ideas, Networks and Silences," *Environment and History* (v.5, 1999); Peter Sand, Review of Alan Boyle and David Freestone, eds., *International Law and Sustainable Development: Past Achievements and Future Challenges,* in *European Journal of International Law* (v.11, 2000); Derek Wall, *Green History: A Reader in Environmental Literature, Philosophy and Politics* (Routledge, 1994); World Commission on Environment and Development, *Our Common Future* (Oxford University Press, 1987).

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Sustainable Cities

URBAN ENVIRONMENTALISM IS at least as old as environmentalism outside of the cities. The origins of urban planning in squalid industrial cities, the rise and decline of the Green Bans in Australia during the 1970s, and the contemporary Environmental Justice Movement in the United States are examples of urban environmental action that challenges environmentalists to rethink notions of the environment, environmentalism, and how we construct boundaries and define cities and nature.

The concept of sustainable cities has increased in popularity since the early 1990s. Some authors tend to emphasize one aspect of sustainable cities, such as transport (Peter Newman and Jeffrey Kenworthy), energy (Roberta Capello, Peter Nijkamp, and Gerard Pepping), or eco-partnerships (Takashi Inoguchi, Edward Newman, and Glenn Paoletto).

The sustainable cities idea emerged from a discourse of sustainability that was formed at the global level. The concept of a sustainable city is both appealing and oxymoronic. William Rees claimed that strictly speaking, a city cannot be sustainable. Phil McManus writes about moving "toward sustainable cities"; Andre Sorenson, Peter Marcotullio and Jill Grant titled their book "towards sustainable cities"; while in Australia the House of Representatives Standing Committee on Environment and Heritage favored "'a vision for a sustainable city' and a pathway to sustainability."

Mike Douglass highlights the links between world cities and livable cities in relation to Pacific Asia. Improving "amenities" is seen as a viable strategy to create livable cities, which attract economic growth because "catering to the lifestyle needs of investors has become a critical consideration to be added to providing production-related facilities for their companies." This approach of the livable city, where environmental quality is seen as a way of enhancing international competitiveness, may give minimal attention to environmental issues from a sustainability perspective.

The dangers of such an approach are highlighted by the ecological footprint analysis, as expounded by Mathis Wackernagel and William Rees and by the notion of a "vortex city" reported by Phil McManus. In both cases, the issue of boundaries is crucial. Cities import and export resources and wastes from surrounding areas (hinterlands) and increasingly from distant parts of the planet. Can a city be more sustainable within its built area, or political boundary, and do so without exporting the impacts of unsustainable practices to its hinterland or other parts of the planet? The issue of measuring the sustainability of cities is dependent on how sustainability is defined. These questions are being considered in relation to the prospects of sustainability for world cities and include the use of concepts such as the ecological footprint.

Moving toward sustainability, or away from unsustainable cities, is a big challenge. Applying the idea of sustainability to cities requires recognition of local context and cultures. What is considered sustainable or unsustainable may vary, and the processes of achieving sustainability are also specific to the cultural and political-economic contexts of a city. Some cities, such as Leicester in England, promote themselves as green cities. Other cities throughout the world have adopted various aspects of sustainability, including the city of Melbourne's "Triple Bottom Line" of economic, social, and ecological framework for decision making. Examples of particular actions to promote sustainability (whether making purchasing decisions, organizing conferences to promote the concept, initiating major projects to show what is possible, or development control that constrains unsustainable practices) can be found in many cities around the world.

The significance of agriculture in or near cities and its contribution to sustainability is often overlooked in urban planning. Land used for urban agriculture, the rural-urban fringe, peri-urban land, or areas described by similar terminology have often been seen by developers and others as land waiting to be developed for housing, industry, and other uses associated with cities. Despite its economic importance, much of the remaining agriculture in cities will be lost unless we change our geographical imaginations about cities. This loss in agriculture is likely to lead to food traveling over even greater distances from its production to its consumption. The provision of healthy, sustainably produced food close to where it is being consumed is an important part of sustainable cities. Sustainable food production is, however, only one part of a sustainable city.

Throughout the world there are various awards given in recognition of the efforts of some cities to move toward sustainability. Winning such an award is recognition of effort and success in at least one activity, but it does not mean that the city can be considered sustainable in every aspect of its operations. The award recognizes one step in a journey toward sustainability. There is a need for participation so that moving toward sustainable cities becomes an agenda for many people, not the exclusive realm of trained urban planners, engineers, and other design professionals.

The importance of participation is highlighted by Rees, who recognized that "the best-designed and most sensitively administered city cannot be sustainable if its inhabitants live unsustainable lifestyles." Sustainable living programs, as a way of moving toward sustainable cities and promoting sustainability generally, are becoming increasingly important. The moves toward sustainable cities require issues such as infrastructure investment, urban planning, governance, lifestyles, and education to be integrated and aligned toward sustainability for successful implementation to occur.

SEE ALSO: Cities; Ecological Footprint; Farmers' Markets; Justice; Slow Food Movement; Sustainability; Sustainable Development; Urban Planning.

BIBLIOGRAPHY. Australian House of Representatives, *Sustainable Cities* (House of Representatives Standing Committee on Environment and Heritage, 2005); Roberta Capello, Peter Nijkamp, and Gerard Pepping, *Sustainable Cities and Energy Policies* (Springer-Verlag, 1999); Mike Douglass, "From Global Intercity Competition to Cooperation for Livable Cities and Economic Resilience in Pacific Asia," *Environment and Urbanization* (v.14/1, 2002); David Goode, "Environmental Strategies for London," in Julian Hunt, ed., *London's Environment: Prospects for a Sustainable World City* (Imperial College Press, 2005); Julian Hunt, ed., *London's Environment: Prospects for a Sustainable World City* (Imperial College Press, 2005); Takashi Inoguchi, Edward Newman, and Glenn Paoletto, eds., *Cities and the Environment: New Approaches for Eco-Societies* (United Nations University Press, 1999); Phil McManus, *Vortex Cities to Sustainable Cities: Australia's Urban Challenge* (UNSW Press, 2005); Peter Newman and Jeffrey Kenworthy, *Sustainability and Cities: Overcoming Automobile Dependence* (Island Press, 1999); Kent Portney, *Taking Sustainable Cities Seriously: Economic Development, the Environment, and the Quality of Life in American Cities* (MIT Press, 2003); William Rees, "Is 'Sustainable City' an Oxymoron?" in *Local Environment* (v.2/3, 1997); Andre Sorenson, Peter Marcotullio, and Jill Grant, eds., *Towards Sustainable Cities: East Asian, North American and European Perspectives on Managing Urban Regions* (Ashgate, 2004); Mathis Wackernagel and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (New Society Publishers, 1996).

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Sustainable Development

SUSTAINABLE DEVELOPMENT IS most generally defined as development that meets the needs of the present without compromising the ability of future generations to meet their needs. However, the long history of this concept has embraced different definitions of both needs and development, making it a remarkably pliable term. This conceptual flexibility, coupled with new challenges raised by the analytical needs of those asking questions about the sustainability of particular development efforts, leaves those working in this area of inquiry with several difficult issues to resolve.

ORIGINS

While the resource conservation ideas behind sustainable development can be traced back more than a century, the current focus on this concept coalesced in the 1960s around the work of scholars and researchers such as Rachel Carson and Paul Ehrlich. Carson's *Silent Spring* (1962), while focused on the issue of toxic pesticides in the environment, highlighted the important connections between human well-being and the environment. Ehrlich's *Population Bomb* (1971) brought attention to the growth of the global population and the ways in which that population's resource needs were leading to unsustainable uses of the environment. Perhaps most incendiary, though, was the Club of Rome's *Limits to Growth* (1972), which took the messages of Carson, Ehrlich and others and predicted a bleak future for humanity if contemporary growth rates were not slowed. Each of these works focused on sustainability as it related to natural resources and the environment. The responses to these challenges, which included the United Nations (UN) Conference on the Human Environment in 1972 and the subsequent establishment of the UN Environment Programme (UNEP), therefore tended to focus on the protection and preservation of the environment as a path to sustainability.

The publication of *Our Common Future* (1987), often called the Brundtland Report, reoriented the conversation about sustainability from an environment-first perspective to a more holistic perspective that considers social, cultural, economic, and environmental issues as highly interwoven. This change in the understanding of human-environment relations in the context of development was, at least in part, linked to ongoing development and aid efforts. For example, aid workers dealing with issues such as famine in the mid-1980s began to argue that society, perception, and knowledge had much more important roles in food outcomes than was previously imagined. In the case of the Ethiopian famine, many argued that food shortage was not a product of an absolute lack of food, but an outcome of particular networks of access and production, both of which related to social roles and status. From these concerns emerged efforts to understand the linkage among environment, development, and human well-being through livelihoods, especially sustainable livelihoods. Thus the Brundtland Report captured, at the broad policy level, the changing ideas of not only policymakers but also those working in and researching issues of sustainability on the ground.

The changing focus of sustainable development from an environment-led issue to one that embraced a wide range of issues culminated in the 1992 UN Conference on Environment and Development (UNCED), often called the Earth Summit. At this meeting, leaders of more than 100 nations agreed to a global action plan, called Agenda 21, to deal with linked issues of environment and development. The UN Commission on Sustainable Development (UNCSD) was convened in the wake of this meeting to ensure appropriate follow-through on the Agenda 21 items. But even as "sustainable development" entered common parlance as an idea desirable to virtually everyone, it also regressed into a consideration of environmental issues as the driving force behind sustainability. For example, some of the focal outcomes of UNCED, such as the Convention on Biological Diversity (CBD), were environment-first concerns that were post-hoc linked to issues of human well being to suit the changing institutional goals of organizations such as UNEP. Thus, while environmental assessments became a common part of development planning in the 1990s, the linkage of environmental issues to development, or to wider social, economic, and political concerns within development remained poorly articulated and therefore a central problem for sustainable development.

VARIETIES OF EXPRESSION

The popularity of the idea of sustainable development (in part a product of its flexibility), coupled with the lack of a commonly accepted, systematic means of linking the environment to development and human well-being, has created a situation in which the contemporary use of the term *sustainable development* encompasses a range of definitions, foci, and methods of evaluation. While the effort to broaden the definition of sustainable development by the Brundtland Commission was an important step in widening the conversation about sustainability, several constituencies have since tried to capture the concept of sustainable development for their own purposes.

For example, while some environmental groups insist on an environment-first approach to sustainable development, other business groups argue that development is what is to be sustained, even at an environmental cost, through mitigation efforts less costly than conservation efforts. Even when narrowed to those approaches that consider environmental conservation an important part of sustainable development, this concept is employed by a range of approaches to sustainability, including those anchored in environmental processes and indicators to complex systems approaches that attempt to evaluate linked human-environment systems.

What coherence the term *sustainable development* maintains in this intellectual context is drawn from the ways in which these approaches focus on two key points: the importance of environmental conservation and the idea of intergenerational equity. Some approaches to sustainable development continue the long tradition of focusing on the preservation of particular resources for future use. However, ongoing research into sustainability, especially in the human-environment foci of geography, anthropology, and economics, has illustrated the complexity of conserving even a single resource because of the ways in which these resources are parts of dynamic systems. Thus, sustainability has, for many in the contemporary literature, come to mean the preservation of dynamism in the system under investigation.

ECOSYSTEM FOCUS

Efforts to understand systematic dynamism and preservation/conservation appear to be bringing us closer to a rigorous understanding of the relationship among development, human well-being, and the environment. For example, the Millennium Ecosystem Assessment (MA), an effort to evaluate the sustainability of current human use of ecosystems, seeks to explicitly link environmental issues with economic, social and political issues through an understanding of the state and trends of the world's ecosystems. Recognizing that the preservation of ecosystem function was a complex question, as one particular function of an ecosystem, such as the provisioning of food, might increase dramatically while another function, such as carbon sequestration, declines, the MA had to identify a means of capturing the dynamism of these ecosystems and the threats to that dynamics. The MA does this through ecosystem services, the goods and services ecosystems provide to human beings. This approach necessitated an understanding of consumption, the politics of conservation, and global political economy that shapes both the values human beings assign to ecosystems, and the patterns of environmental resource use these values would create in the future. In the *Scenarios* volume of *Ecosystems and Human Well-Being,* the MA presented evidence that current economic, social, and political trends in the use and management of ecosystems were leading to unsustainable degradation of these resources. This report thus reinforces the messages of sustainable development heard since the 1970s, but does so in a nuanced manner with a greater understanding of how environment, development, and human well-being are linked than in many previous reports of similar scope.

FAIRNESS AND EQUITY

The idea of preservation in sustainable development is usually justified through some idea of intergenerational fairness, where the current generation bears some responsibility for the condition of the earth, and therefore the quality of life, for future generations. This idea of fairness is often very general and does easily account for the tradeoffs inherent in conservation efforts. Natural systems change over time, and choosing to preserve such a system in its current state limits potential future uses of different states that the system might evolve into. Further, even in those approaches that seek a conservation of dynamism, the practical result of such efforts are policies targeted at a very few resources or processes, which means that other aspects of the system might be allowed to decline or degrade.

The fairness and equity issues embedded in the idea of sustainable development were given clear voice when, in 2000, the UN General Assembly passed the UN Millennium Declaration, in which the delegates laid out a set of global targets for development. These targets addressed both social and environmental issues. This declaration has since been condensed into eight major goals, called the Millennium Development Goals (MDGs). The MDGs, while specifically targeting things like literacy and gender equality, also include ensuring environmental sustainability as the seventh goal.

In 2002 on the 10-year anniversary of the Earth Summit, the World Summit on Sustainable Development (WSSD) reaffirmed the global concern with issues of environment, society, and development, this time including concerns for globalization in the equation. The major outcome of the WSSD was a 64-page plan of implementation for the summit that addressed goals and targets for everything from water quality at the global scale to the different needs of particular regions.

FUTURE DIRECTIONS

As the establishment of clear connections among human well-being, development, and environment change became more pressing, the study of sustainable development has begun to develop a new approach and methods. This is the result of a pressure that has developed within sustainability studies as it becomes clear that existing efforts based upon conventional scientific inquiry cannot answer all of the questions raised by the issue of sustainable development.

One recent occurrence in sustainable development has been the emergence of sustainability science, an approach to the interconnections between nature and society focused on the identification and mitigation of vulnerability in human populations. As this vulnerability involves interlinked biophysical, social, and economic stresses that take on different organizations at different scales and have different impacts on various social actors, sustainability science has begun to focus on place- or regional-specific configurations of these stresses. Sustainability science acknowledges that conventional scientific approaches are often ill suited to the study and evaluation of sustainability, because sustainability is the end result of complex systems subject to nonlinear changes across varying time scales. As a result, this approach to sustainability seeks to integrate quantitative and qualitative data and case study methods to create sound understandings of the factors that influence sustainability. Recent efforts to put sustainability science into practice are expressed in Gerhard Petschel-Held et al.'s "syndromes of global change" approach.

Sustainable development remains a dynamic field with tremendous institutional support. Whether it can meet the needs of the present without compromising the needs of future generations rests upon not only how we define this term, but also on our ability to identify new methods and methodologies that better link the environment to development and human well-being, and through such linkages help us better understand and address the issues that sustainability raises.

SEE ALSO: Agenda 21; Brundtland Report; Carson, Rachel; Club of Rome; Conservation; Ecosystems; Ehrlich, Paul and Anne; Famine; Intergenerational Equity; Livelihood; Preservation; Sustainability; Sustainable Cities; United Nations Conference on Environment and Development (Earth Summit, 1992).

BIBLIOGRAPHY. Steve R. Carpenter, Prabhu L. Pingali, Elena M. Bennett, and Monica B. Zurek, eds. *Ecosystems and Human Well-Being: Scenarios,* vol. 2 (Island Press, 2006); Rachel Carson, *Silent Spring* (Houghton Mifflin, 1962); Paul R. Ehrlich, *The Population Bomb* (Ballantine Books, 1971); Frank Ellis, *Rural Livelihoods and Diversity in Developing Countries* (Oxford University Press, 2000); Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, and William W. Behrens, *The Limits to Growth* (Earth Island Limited, 1972); Gerhard Petschel-Held et al., "Syndromes of Global Change: A Qualitative Modelling Approach to Assist Global Environmental Management," *Environmental Modelling and Assessment* (v.4, 1999); World Commission on Environment and Development, *Our Common Future* (Oxford University Press, 1987).

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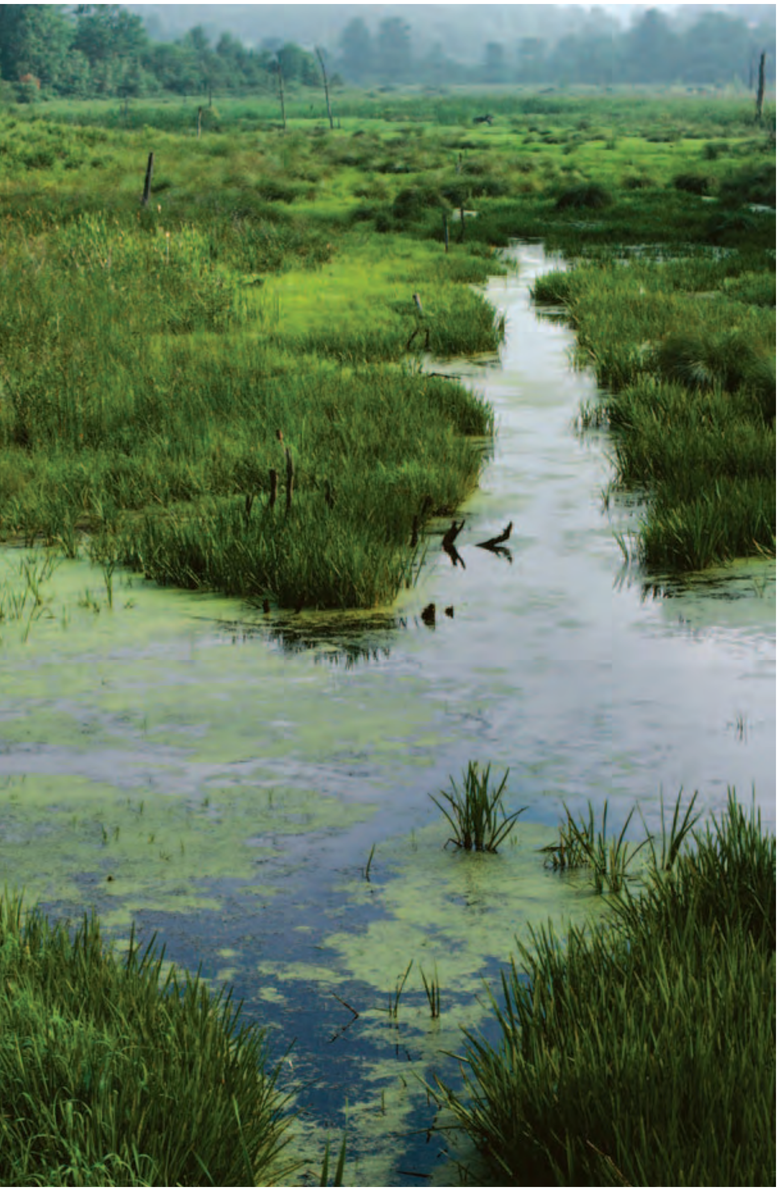
Swamp Lands Acts

THE THREE SWAMP Lands Acts were passed in 1849, 1850, and 1860 to facilitate the development of "swamp and overflowed lands"—known today as wetlands—by transferring their title to 15 individual states. "An Act to aid the State of Louisiana in draining the Swamp Lands therein" was passed by the U.S. Congress on March 2, 1849, and required that the state appoint a surveyor to define "all the swamp lands therein which are subject to overflow and unfit for cultivation," that would pass from federal to state ownership. The condition of transfer was that the proceeds from state land sales should be used to aid development of the land by funding public drainage works and levees. The following year, an act was passed extending this program to Arkansas and "each of the other States of the Union in which such swamp and overflowed



The U.S. government is still paying the price for having given away 64,895,415 acres of wetlands in the 1800s.

lands … may be situated," though responsibility for identifying such lands was transferred to the Secretary of the Interior, perhaps in an attempt to avoid states being over-generous to themselves in their surveys. The 1860 act applied the same program to the new states of Minnesota and Oregon.

The first act was stimulated by Louisiana's financial inability to recover from the devastating Mississippi floods of 1849, and the need to build flood control structures. But together, the acts had the larger aim of funding the large-scale drainage and development of wetland landscapes such as the Mississippi Delta, Indiana's Kankakee Marsh, and the Florida Everglades. The program of disbursing federal land to individual settlers through the General Land Office had failed to populate such landscapes because individual settlers lacked the resources to build the massive works necessary to effectively drain them. Under the Swamp Lands Acts, it was hoped that states would charge settlers rates low enough to make settlement appealing, with the added promise that states would use the funds to assist in the drainage of the land. Prices had to be high enough to adequately fund state reclamation activities, and a minimum of $1.25 an acre was set. The acts were, in fact, an integral part of the larger project of colonization, nation building, and citizen making, through the removal of geographic barriers.

In total, 64,895,415 acres (26,262,243 hectares) of land was ceded by the federal government to the states of Alabama, Arkansas, California, Florida, Illinois, Indiana, Iowa, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Ohio, Oregon, and Wisconsin (these were the states in existence by 1860 that were not originally crown colonies, and were thus composed largely of federally-owned land). Because the act contained no guidelines concerning how "swamp and overflowed lands" were to be identified, it was open to rampant abuse as local surveyors used their own notions of what the federal government should cede to the states. It offered only the utilitarian criteria of "unfit for cultivation"; federal guidance on defining wetlands would not come until nearly a century later, using duck habitat as the primary criterion. Even though it is known that unscrupulous surveyors included many non-wetland areas in their surveys, claiming fertile uplands as state land, the amount ceded still represents up to 30 percent of the estimated 220 million acres (89 million hectares) of wetlands present in the United States at the time of American independence.

The states disposed of the land in various ways. In Iowa, land was given to the counties, who bartered it for public works construction, or offered it as enticement for settlement. The Florida experience is illustrative of the problems faced by states in developing wetlands acquired through the act. Florida received 20.3 million acres (8.2 million hectares), nearly a third of the total land transferred through the acts. Land sales were dominated by giveaways to politically favored development consortia, and the general fund established to finance drainage works was thus perennially broke. The developers marketed Everglades land throughout the United States and Europe, repeating the solemn promise of the State of Florida to drain the land. Since the funds for drainage did not exist, settlers arrived to find their land uninhabitable, and the developers pocketed the money. More than a century later, "land in Florida" is still a byword for such swindles and scams.

Although the acts caused much of the wetlands of the United States to pass into private hands, they did not immediately accomplish much drainage. The technology required for effective drainage (steam dredges and tile systems) would not mature until around World War I, and required the concerted action of large corporate interests and collective organizations such as drainage districts. The federal government, largely acting through the U.S. Army Corps of Engineers, has been forced to spend enormous amounts of money on protection from floods that have been exacerbated by wetland drainage, and on the reacquisition of some of the original ceded wetlands for conservation purposes.

SEE ALSO: Everglades; Floods and Flood Control; Policy, Environmental; Water; Wetlands.

BIBLIOGRAPHY. Hugh Prince, *Wetlands of the American Midwest: A Historical Geography of Changing Attitudes* (University of Chicago Press, 1997); Ann Vileisis, *Discovering the Unknown Landscape: A History of America's Wetlands* (Island Press, 1997).

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Swaziland

SWAZILAND IS A small, mountainous, landlocked country located between South Africa and Mozambique. Home to about 1.1 million people, its total land area is just over 17,000 square kilometers. The country is divided into four geographic regions: The Highveld, The Middleveld, The Lowveld, and Lubombo. The Highveld, in the west, has an average altitude of about 1,300 meters. This region receives the most rainfall in the country and has the coolest temperatures. The Middleveld has an average elevation of 700 meters and is warmer and drier than the Highveld. The Lowveld, with an average elevation of 300 meters, is the center of sugar cane production, the nation's main industry. The fourth region, the Lubombo, is an escarpment along the Lowveld with variable climate and agricultural land use.

Historically, the Swazi people migrated into the area from Mozambique in the 1750s. When faced with the Zulus to the south, the Swazis settled to the north in present-day Swaziland, and consolidated under King Mswati, who gave them their name. By 1902 the British had assumed control of Swaziland. The British planned to join South Africa and Swaziland, but due to the racial segregation policies of South Africa, Swaziland stayed a separate unit; in 1968 Swaziland gained independence from Britain. It is still a Commonwealth country.

Swaziland is one of the few monarchies left in Africa. King Mswati III holds supreme executive, legislative, and judicial powers, although in practice an elected House of Assembly and appointed cabinet help delegate government decisions.

Swaziland has one of the strongest economies in Africa with a total Gross Domestic Product (GDP) of $2.8 billion, or $1,891 per capita income. Swaziland's largest industry is sugar, which accounts for 24 percent of its GDP and 51 percent of its agricultural production. The major markets for the sugar are the European Union (EU) and the United States, and only a small percentage of the sugar is sold on the domestic market. Swazi sugar had preferential status in the European market, but this reliance on one crop—which is sold primarily to two markets—may hurt Swaziland's economy in the short-term. In 2005, the EU began to reform its sugar market, and it is expected that by 2009 the price of Swazi sugar could fall by 38 percent.

The falling sugar prices combined with the HIV/AIDS pandemic may prove disastrous for the country. Swaziland has one of the highest rates of HIV in the world. It has a prevalence rate of 38 percent, which is second in the world only to Botswana. The country's productive labor force has been severely impacted as the majority of deaths occur among young people aged 15–49. Due to the HIV epidemic, life expectancy at birth has dropped from 51 years in the mid-1990s to 39.4 in 2005.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Colonialism; South Africa; Sugar.

BIBLIOGRAPHY. A.R. Booth, *Historical Dictionary of Swaziland* (Scarecrow Press, 2000); E. Kalipeni, S. Craddock, J. Oppong, and J. Ghosh, eds., *HIV & AIDS in Africa: Beyond Epidemiology* (Blackwell Publishing, 2004); R. Levin, *Uneven Development in Swaziland: Tibiyo, Sugar Production and Rural Development Strategy* (Geoforum 1986).

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Sweden

THE KINGDOM OF Sweden is considered to have the sixth highest standard of living in the world, according to the United Nations Development Programme Human Development Reports. This high ranking is likely due to the mixture of a strong market economy harnessed in support of substantial social welfare programs. The population of 9,001,774 enjoy a per capita income of $29,600. In 1995 Sweden joined the European Union (EU), but in 1999 the Swedish people voted against adopting the euro. Sweden is rich in natural resources, with timber, hydropower, and iron ore providing substantial trade revenue. Other resources include lead, zinc, gold, silver, tungsten, uranium, arsenic, and feldspar.

Bordering on the Baltic Sea, the Gulf of Bothnia, the Skagerrak (an offshoot of the North Sea), and Kattegat (a bay of the North Sea and a continuation of the Skagerrak), Sweden's coastline runs for 3,218 miles (5,181 kilometers). In the south, the climate is temperate with cold winters and cool summers. In the north, the climate is subarctic. In the winter, ice floes, particularly in the Gulf of Bothnia, pose a maritime threat. Except for the mountains in the western section of the country, Sweden is generally flat with gently rolling lowlands.

Sweden's industries produce acid rain that damages soils and lakes. Industry is also responsible for the pollution found in the North and Baltic Seas. Despite these problems, a 2006 study by Yale University ranked Sweden second of 132 countries in environmental performance, well above the averages for the relevant income and geographic groups. Sweden's lowest rankings were in the areas of air quality and biodiversity and habitat. Over 83 percent of the Swedish population live in urban areas. With 452 cars per 1,000 people, Sweden produces 0.2 percent of the world's carbon dioxide emissions. The Swedish government has protected 9.1 percent of the land. Only two of 259 bird species endemic to Sweden are endangered, but seven of 60 endemic mammal species are threatened with extinction.

The Environmental Protection Agency (EPA) was created in 1967 to implement Sweden's Environmental Code. Under the EPA, the Enforcement and Regulations Council is in charge of compliance. As specified in the Environmental Code, there are five special environmental courts that issue permits for activities that affect the environment. Generally, administrative orders and individual fines are sufficient to assure compliance. Any criminal activities affecting the environment are enforced by the Public Prosecutor's Office.

In 1999, the Swedish government established 15 environmental goals based on five principles: Promoting human health, preserving the cultural environment and cultural heritage, preserving biological diversity and the natural environment, preserving the long-term productivity of ecosystems, and wise management of natural goals. Fifteen specific areas were targeted, and Sweden committed itself to meeting the goals for all 15 areas by the middle of the 21st century. The country's EPA issued a Status of the Environment Report in January 2002 assessing Sweden's progress (1996–2001) toward achieving the long-term goals. Significant progress was made in improving air quality, reducing acidification levels, protecting the ozone layer, protecting wetlands, sustaining forests, varying agricultural land, and slashing the rate of eutrophication to zero. However, little progress was made in improving the balance of the marine environment. Pollution rates in

Adolf Erik Nordenskiöld

Adolf Erik Nordenskiöld, the founder of the concept of national parks, was the son of a mineralogist and was born in 1832 in Helsinki, Finland, then a part of the Russian Empire. He studied chemistry at the Imperial Alexander University in Helsinki, writing his thesis on graphite and chondordite, and then working in the mineralogy department at the university. During the Crimean War, he was a political activist who was in favor of an end to Tsarist rule and Sweden taking control of Finland. This led to him being dismissed from his university post and going first to Berlin and then to Stockholm, Sweden.

While Nordenskiöld was in Stockholm, he became involved in a number of expeditions to the island of Spitsbergen in 1858, 1862, and 1864. In 1868, Nordenskiöld went on an expedition to the furthest north any vessel had been in the Eastern Hemisphere. He visited Greenland in 1870, and in the following year returned to Spitsbergen, where he stayed throughout the Arctic winter, nearly running out of food. Seeking the Northeast Passage, Nordenskiöld took part in several well-funded expeditions. In 1875 he traveled in Siberia; he then went to the United States the following year and took part in the Centennial Exhibition in Philadelphia. In 1878, Nordenskiöld finally was able to sail his vessel, the *Vega*, through the Northeast Passage from Scandinavia to the Bering Straits. He returned to much acclaim in Stockholm and in 1880 suggested the idea of establishing national parks to preserve the natural habitat. He died in 1901 in Sweden. His map collection is now held at the University of Helsinki and is included in the Memory of the World Register of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

other areas such as providing a nontoxic environment and protecting lakes and streams remained relatively stable.

Sweden's strong commitment to the global environment is demonstrated by participation in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling.

SEE ALSO: Acid Rain; Carbon Dioxide; Pollution, Water.

BIBLIOGRAPHY. Central Intelligence Agency, "Sweden," *The World Factbook,* www.cia.gov (cited April 2006); Winston Harrington et al., *Choosing Environmental Policy: Comparing Instruments and Outcomes in the United States and Europe* (RFF Press, 2004); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Swedish Environmental Protection Agency, *de Facto 2001* (Elanders Gummessons, Falköping, 2002); United Nations Development Programme, "Human Development Reports: Sweden," hdr.undp.org (cited April 2006); United Nations Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Sweden," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Switzerland

OFFICIALLY NAMED THE Swiss Confederation, Switzerland has traditionally been known for its neutrality and only became an official member of the United Nations (UN) in 2002. While maintaining its neutral position, Switzerland has continued to take an active role in international politics and economics. Although the country is landlocked, it has 569 square miles (1,520 square kilometers) of inland water. With the Alps in the south and the Jura in the northwest, much of Switzerland's terrain is mountainous. The central plateau is made up of rolling hills interspersed with plains and large lakes. The temperate climate produces variations according to altitude, varying between the highest point at Dufourspitze (15,203 feet [4,634 meters]) and the lowest point at Lake Maggiore (640 feet [195 meters]). Generally, winters are cold in Switzerland with both rain and snow, and summers are cool to warm with intermittent showers. Switzerland is vulnerable to avalanches, landslides, and flash floods.

With a per capita income of $35,000, Switzerland is the 10th-richest country in the world, chiefly due to the prosperous, stable market economy combined with a highly skilled labor force and low unemployment. Switzerland's only natural resources are timber, salt, and hydropower potential, but liberal banking laws have made the country a haven for domestic and international investors. The UN Development Programme Human Development Reports rank Switzerland seventh in the world in overall quality-of-life issues.

In industrial areas, air pollution from vehicle emissions and open-air burning creates a major environmental dilemma. Nearly 68 percent of the population of 7,489,370 live in urban areas. With 507 cars per 1,000 people, Switzerland produces 0.2 percent of the world's carbon dioxide emissions. Acid rain threatens the forests and agricultural runoff pollutes the waters. Consequently, Switzerland is experiencing significant ecological damage. In 2006 a study by scientists at Yale University ranked Switzerland 16th of 132 countries in environmental performance, in line with the relevant income and geographic groups. Switzerland's ranking on biodiversity and habitat protection was abysmally low (28.6). Despite this poor showing, the Swiss government has protected 30 percent of the land area. Of 199 bird species endemic to Switzerland, only two are threatened; and five of 75 endemic mammal species are threatened.

Responsibility for implementing environmental laws and regulations in Switzerland resides with the Department of the Environment, the Swiss Agency for the Environment, Forests and Landscape (SAEFL), and the Federal Office for the Environment (FOEN). Since the 1970s, the Federal Assembly has passed a body of environmental laws. On the principle that industries and individuals are more likely to comply with flexible standards that are easily understood, the Swiss government has adopted a policy of promoting sectoral agreements designed to meet specific targets. Research and development and international cooperation are also key tools in Switzerland's environmental policies.

Air pollution is a significant threat to the Swiss because of high concentrations of fine dust particles, nitrogen oxides, and ozone depletion. The government estimates that 3,000 deaths occur each year from air pollution, which also costs billions of francs annually. Likewise, water pollution drains the country of both human and economic resources. Swiss soil has been polluted from overfertilization and past indiscriminate use of pesticides and damaging fertilizers that remain in the soil.

Over the last three decades, extensive development and agricultural expansion and modernization have led to significant depletion of wetlands, hedgerows, copses, and orchards. Switzerland has paid a heavy price for its economic prosperity, with a legacy of 50,000 contaminated sites. In November 1986, for instance, a fire at the Sandoz chemical company in Schweizerhalle produced a cloud of toxic gases that polluted the surrounding area for miles. Additionally, the runoff from the water used by firefighters polluted the Rhine River, leading to a ban on drinking water and to the loss of large numbers of marine life. Residue from the accident remains in the soil and cleanup costs over the coming decades will be astronomical.

Switzerland's commitment to the global climate is evidenced by participation in the following international agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 85, Air Pollution–Sulfur 94, Air Pollution–Volatile Organic Compounds, Antarctic Treaty, Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Marine Dumping, Marine Life Conservation, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, Wetlands, and Whaling. The Swiss government has signed, but not ratified, the Law of the Sea agreement.

SEE ALSO: Acid Rain; Biodiversity; Carbon Dioxide; Fertilizer; Habitat Protection; Pesticides; Pollution, Air; Quality of Life; Rhine River and Valley; Runoff; Urbanization.

BIBLIOGRAPHY. Central Intelligence Agency, "Switzerland," *The World Factbook,* www.cia.gov (cited April 2006); Department of the Environment, *Environment Switzerland 2002* (SAEFL, 2002); Winston Harrington et al., *Choosing Environmental Policy: Comparing Instruments and Outcomes in the United States and Europe* (RFF Press, 2004); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); United Nations (UN) Development Programme, "Human Development Reports: Switzerland," hdr.undp.org (cited April 2006); UN Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, "Switzerland," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Symbiosis

SYMBIOSIS REFERS TO an arrangement between two species that live together very closely and may have co-evolved. The living arrangement may be beneficial, neutral, or harmful to either or both of the creatures. Those involved are called symbionts and their relationship may be one of mutualism, parasitism, or commensalism. Mutualism represents positive benefits for all creatures concerned, commensalism represents benefits for one partner, and parasitism leads to benefits for one partner at the expense of the other. Examples include the birds that pick food from the teeth of crocodiles, or ticks from buffaloes, receiving protection from the larger animals for their efforts. Other examples include the many bacteria that find homes inside human beings and other creatures. Evidence suggests that the eukaryotic cells that make up the basis of multicellular life are themselves examples of symbiosis between less sophisticated cells. The biologist Lynn Margulis has been instrumental in demonstrating the importance of microbial life in causing evolutionary changes that have enabled complex forms of life to develop. In some ways, it is possible to consider the birth and growth of babies in the uterus as being a form of symbiosis, since the babies rely upon their mothers for nutrition and the provision of a suitable living environment.

The Gaia thesis first articulated by James Lovelock may be seen as a form of symbiosis. The Gaia hypothesis states that all creatures live in an interlocking system with the earth and that no members of nature can exist without the other members of the system. Consequently, all members of the system may be said to be symbionts of all others. The creation of eukaryotic life depended initially on a symbiotic relationship between bacteria and mitochondria and they formed and evolved into an all-encompassing biosphere that is dependent on all members of it.

The Gaia hypothesis therefore calls for efforts to be made to retain all forms of living creature, since extinction of any one is likely to have a negative impact upon every other symbiont, including the earth itself. Proponents of the hypothesis will resist the exploitation of the resources of the world when this puts at risk the extinction of any species because such an extinction would have an incalculable effect on the rest of the system. This viewpoint is opposed by those who believe in humankind's right to exploit the resources of the world as required, and in the scientific ability to overcome any problems brought about by resource exploitation.

An additional form of symbiosis is mimicry, in which one organism will attempt to present itself as the member of another species in order to gain the benefits available to that other species. Harmless creatures passing themselves off as venomous or otherwise dangerous creatures are one example of mimicry. It is possible to create artificial substitutes of mimic creatures in some cases in order to reap the benefits that such symbiosis provides. The concept of symbiosis has been used by people in different fields trying to create forms of positive synergy through combining two different units or institutions. This has led to the creation of industrial parks and research networks, among other things. There is speculation that a subsequent stage of evolution will see human-machine symbiosis, in which the physical and mental capabilities of people may be augmented.

SEE ALSO: Biocentrism; Biodiversity; Biosphere; Gaia Hypothesis; Parasites.

BIBLIOGRAPHY. Douglas Angela, *Symbiotic Interactions* (Oxford University Press, 1994); James Lovelock, *Gaia: A New Look at Life on Earth* (Oxford University Press, 1979); James Lovelock, *The Revenge of Gaia: Why the Earth Is Fighting Back—and How We Can Still Save Humanity* (Allen Lane, 2006); Lynn Margulis and Dorion Sagan, *Slanted Truths: Essays on Gaia, Symbiosis, and Evolution* (Copernicus Books, 1997).

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Syphilis

SYPHILIS IS A sexually transmitted disease (STD) caused by the bacterium *Treponema pallidum*. In most cases, syphilis infection is caused by the transmission of the organism during sexual contact. It can also be passed from mother to infant during pregnancy, resulting in congenital syphilis. Because the symptoms of syphilis are diverse and resemble those of many other diseases, the infection is often referred to as the Great Imitator.

Common early signs and symptoms include painless ulcers on the genitalia and fever. Syphilis can be cured with penicillin in the early stages of infection, while untreated syphilis can progress to cause severe and permanent damage to the cardiovascular and nervous systems, resulting in disability and sometimes death. Advances in clinical screening and treatment combined with ongoing public health programs have greatly decreased the occurrence of late-stage syphilis in developed countries. New cases of syphilis continue to pose a public health burden throughout the world.

The World Health Organization (WHO) estimates that in 1999, there were 11.76 million new cases of syphilis among adults worldwide, down from 12.22 million in 1995. Syphilis incidence increased in eastern Europe, central Asia, sub-Saharan Africa, Latin America, and the Caribbean. The largest increase occurred in Latin America and the Caribbean, where new cases more than doubled from 1.26 million in 1995 to 2.93 million in 1999. At least half a million babies are born with congenital syphilis each year, while another half million are stillborn or miscarried due to maternal syphilis.

In response to these alarming statistics, the WHO has made elimination of congenital syphilis one of its global health priorities. In less developed areas, syphilis screening and clinical diagnosis can be difficult and imprecise without laboratory testing, and the infection must be treated with medication to prevent transmission. These clinical resources are not available or accessible for many millions of people throughout the world. Tracking syphilis in an effort to focus on elimination programming is challenging, because no single organization conducts syphilis surveillance globally.

While there is emerging evidence that some form of syphilis may have existed in Europe prior to the 15th century, the major societal impact of syphilis dates back to contact with the Americas after 1492, when the disease made its way back to Europe and swept across the continent. Over the past 500 years, views of syphilis have evolved with society's changing morals and beliefs about sexuality and gender, pushed along in the 20th century by improved understanding of infectious diseases. In more recent years, much attention has been given to the parallels between the social and political histories of syphilis and the HIV/AIDS epidemic.

The direct social impact of syphilis in the United States came to light in the early 1970s, with the Tuskegee Study (1932–72). Originally commissioned to document the progression of untreated syphilis in poor African-American males, participants were told by researchers that they were being treated for "bad blood," and were provided free medical examinations and burial insurance. Although penicillin was declared the drug of choice for syphilis in 1947, researchers—with support from professional medical and health services organizations—continued documenting the ravages of untreated syphilis. Fallout from the Tuskegee Study significantly impacts the way clinical research is conducted today, including careful oversight of research proposals and mandated informed consent.

Current and ongoing eradication and reduction efforts, along with ever-changing societal beliefs and knowledge of STDs and sexuality, will determine the future global impact of syphilis.

SEE ALSO: Disease; Sexually Transmitted Diseases; World Health Organization.

BIBLIOGRAPHY. National Institute of Allergy and Infectious Diseases, "Syphilis," www.niaid.nih.gov (cited December 2006); Claude Quétel, *The History of Syphilis* (Johns Hopkins University Press, 1992); U.S. Centers for Disease Control and Prevention, "Syphilis," www.cdc.gov/std/Syphilis (cited December 2006); World Health Organization, "Eliminating Congenital Syphilis," www.who.int (cited November 2006); World Health Organization, "Syphilis," www.who.int (cited December 2006).

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Syria

AFTER THE OTTOMAN Empire broke up during World War I, Syria came under the domination of France, following a League of Nations mandate, until independence in 1946. A series of military coups subsequently occurred, followed in 1956 by the union of Syria and Egypt into the United Arab Republic. Three years later, Syria broke away and reformed the Syrian Arab Republic. The ensuing period of political stability was marred by the loss of the Golan Heights to Israel during the Arab-Israeli War and by dissension with Lebanon over Syria's purported peacekeeping presence in Lebanon between 1976 and 2005.

An estimated 18,448,752 people make their home in Syria, including approximately 40,000 who live in the contested areas of the Golan Heights. With a per capita income of $3,500, Syria is ranked 154th of 232 countries in world incomes. Approximately one-fifth of the population live below the national poverty line, and a similar number of Syrians are unemployed. The Syrian standard of living is also negatively affected by high infant mortality (29.53 deaths per 1,000 live births) and fertility (3.5 children per female) rates and a low female literacy rate (64 percent). The United Nations Development Programme (UNDP) Human Development Reports rank Syria 106th in the world in overall quality-of-life issues.

In addition to a coastline of 120 miles (193 kilometers) along the Mediterranean Sea, Syria lays claim to 436 square miles (1,130 square kilometers) of inland water, which includes 500 square miles (1,295 square kilometers) of water located inside contested territory occupied by Israel. With a terrain composed of semiarid and desert plateaus interspersed with narrow coastal plains that give way to mountains in the west, Syria's climate is dictated by the desert. Between June and August, the weather is dry and sunny, and mild, rainy winters mark the period between December and February. In the area around the capital city of Damascus, snow and sleet may occur during winters. Dust and sand storms are frequent. Rich natural resources include petroleum, phosphates, chrome and manganese ores, asphalt, iron ore, rock salt, marble, gypsum, and hydropower. Over a fourth of the 71,498 square miles (185,180 square kilometers) of land area is arable, but the salinity of the soil is destructive to crops. Barely half the population of Syria live in urban areas.

Detrimental agricultural practices have led to overgrazing and soil erosion. Desertification and land degradation are consequences of both human and climatic activities. Extensive water pollution in Syria has resulted from oil spills and from the practice of dumping raw sewage and refinery wastes directly into water sources. Only 2.5 percent of Syrian land area is forested, chiefly in the southeast. The rate of deforestation has been accelerated by farming, livestock grazing, and the indiscriminate use of forest lumber for fuel and development. Of 63 endemic mammal species, four are endangered, as are 8 of 145 endemic bird species.

In 2006, a study conducted by scientists at Yale University ranked Syria 97th of 132 nations in environmental performance, well below the relevant income and geographic groups. The lowest scores were assigned in the categories of biodiversity and habitat, sustainable energy, and air quality. More than one-fifth of the population lack sustained access to safe drinking water, and that access declines to 64 percent in rural areas. Around 23 percent of Syrians do not have access to improved sanitation. These factors contribute to the spread of diseases that result from contact with contaminated food and water.

Syria took the lead among Arab nations by establishing the Ministry of State for Environmental Affairs and charging it with the implementation of the Syrian National Environmental Action Plan (NEAP), which evolved from the UNDP-sponsored National Project for Strengthening the Capacity of Environmental Affairs in Syria. The 10-year NEAP plan was designed to check the contamination and depletion of water resources, promote sustainable development, slow down the processes of land degradation and desertification, improve air quality, and control the disposal and storage of wastes. Other targeted areas include educating the public on environmental issues, improving oversight of industrial practices that affect the environment, and preventing further coastal degradation.

Syria participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Ozone Layer Protection, Ship Pollution, and Wetlands. The government has signed but not ratified the agreement on Environmental Modification.

SEE ALSO: Desert; Desertification; Drinking Water; Fertility Rate; Infant Mortality Rate; Land Degradation; Oil Spills; Overgrazing; Petroleum; Pollution, Water; Poverty; Soil Erosion; Waste, Solid.

BIBLIOGRAPHY. Central Intelligence Agency, "Syria," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of State for Environmental Affairs, "The Syrian National Strategy Report for Sustainable Development," 2002, www.johannesburgsummit.org (cited April 2006); United Nations Development Programme, "Human Development Report: Syria," hdr.undp.org (cited April 2006); World Bank, "Syria," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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2,4-D

2,4-D (2,4-DICHLOROPHENOXYACETIC ACID, CAS No. 94-75-7) was first synthesized by Robert Pokorny of the C. Dolge Company of Westport, Connecticut, and patented during World War II by the American Paint Company as one form of the halogenated phenoxy monocarboylic aliphatic acids. 2,4-D saw its first widespread production and use in the late 1940s, coinciding with the introduction of weed science as a scholarly discipline. 2,4-D is used as a selective, systemic, hormone-type herbicide to control sedge and broadleaf weeds in cereal crops such as rice, wheat, corn, sorghum, and barley; as well as range/pasture lands, turf areas, lawns, rights-of-way, aquatic sites and forestry applications; and as a growth regulator for citrus and potatoes. Trade names include Aqua Kleen, Demise, Esteron, Weed-B-Gone, and Weedone.

The annual global market is estimated to be over $300 million and the main producers are Agrolinz (Austria), Atanor (Argentina), Dow (United States), AH Marks (United Kingdom), Nufarm (Australia), Polikemia, Rhone-Poulenc (France), Sanachem (South Africa), Sinochem (China), Ufa (Russia), and four other producers in Turkey. Dow is the largest producer at 20,000 tons. Rhone-Poulenc is the largest European producer at 7,000 tons, followed by Agrolinz at 4,000 tons. The United States, South America, Europe, and the former Soviet Union are major markets for 2,4-D, and global use is predicted to grow over the next decade. Annual U.S. 2,4-D usage is approximately 21,000 tons, with 14,000 tons (66 percent) used by agriculture and 7,300 tons (34 percent) used in nonagricultural settings. Most nonagricultural use is due to homeowners, who apply it to their lawns (18 percent), and landscape maintenance contractors (seven percent). 2,4-D is also used widely in developing countries; for example, India used 1,300 tons in 1994–95.

Arguably the most infamous use of 2,4-D occurred during the Vietnam War (1962–71), when U.S. military forces sprayed a 50:50 mixture of 2,4-D and 2,4,5-T, dubbed "Agent Orange," over Vietnam to destroy crops, strip the thick jungle canopy that helped conceal opposition forces, and clear vegetation from the perimeters of U.S. base camps. Approximately 30 years later, the Department of Veterans Affairs published a notice in the Federal Register (January 1994) that stated, "there is a positive association between exposure to herbicides used in the Republic of Vietnam and the subsequent development of respiratory cancers." During the time that Agent Orange was being produced, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), now classified as a Group 1 Human Carcinogen by the International Agency for Research on Cancer, was an unintended contaminant formed in the production of 2,4,5-T.

Human exposure data exist to estimate 2,4-D exposures from dietary ingestion of residues, nondietary ingestion of contaminates in soil and dust, inhalation of contaminated indoor and outdoor air, and dermal penetration. Little or no data exist for exposures of young children, prenatal, and neonatal infants. Several human studies have suggested an association between exposure to 2,4-D (and other herbicides) and an increased incidence of tumor formation. However, it is not clear whether this represents a true association, and, if so, whether it is specifically related to 2,4-D. On August 8, 2005, the U.S. Environmental Protection Agency (EPA) released its comprehensive assessment of 2,4-D under the agency's reregistration program. The EPA's document concluded that 2,4-D does not present risks of concern to human health when users follow 2,4-D product instructions as outlined in the EPA's 2,4-D Reregistration Eligibility Decision (RED) document.

SEE ALSO: Agent Orange; Herbicides; Vietnam War.

BIBLIOGRAPHY. Environmental Protection Agency, www.epa.gov (cited September 2006); *Generic Pesticides—the Markets*, (PJB Publications, 1994); Robert Pokorny, "New Compounds: Some Chlorophenoxyacetic Acids," *Journal of the American Chemical Society* (v.63/1768, 1941); *Veterans and Agent Orange: Length of Presumptive Period for Association Between Exposure and Respiratory Cancer* (Board on Health Promotion and Disease Prevention, Institute of Medicine, 2004).

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Taiwan

OFFICIALLY KNOWN AS the Republic of China, and located on the island of Formosa, Taiwan has long struggled with the People's Republic of China for recognition as an independent nation. Some two million Chinese sought refuge on the island after the Communist takeover of China in 1949. The issue of whether or not Taiwan will eventually be unified with China continues to dominate Taiwan's politics. Bordering on the East China Sea, the Philippine Sea, the South China Sea, and the Taiwan Strait, Taiwan has a coastline of 971 miles (1,566 kilometers). Mountains cover the eastern two-thirds of the islands, giving way to plains in the west. Tropical and marine climates produce a distinct monsoon season in the southwest from June to August, and extensive clouds cover Taiwan for much of the year. Home to 23,036,087 people, the islands are prone to earthquakes and typhoons.

With a per capita income of $26,700 and healthy foreign investments throughout southeast Asia, Taiwan is the 34th-richest nation in the world. In recent years, many banks have been transferred from government to private hands as private industries have grown in response to the growth of the export industry. Taiwan has the third-largest trade surplus in the world, and China and the United States are the major trading partners. Natural resources include small deposits of coal as well as natural gas, limestone, marble, and asbestos. Roughly a fourth of the land is arable, but only 6 percent of the workforce are engaged in agriculture.

Extensive industrialization has led to major problems with air and water pollution, and supplies of drinking water have been threatened by pollution that includes the release of raw sewage into fresh water sources. Improper disposal of radioactive waste has created low levels of radiation. A study by scientists at Yale University in 2006 ranked Taiwan 24th in the world in environmental performance, well above the relevant geographic group and slightly below the relevant income group. The lowest rating was received in the category of air quality. The high overall ranking is due to government efforts to promote sustainable development and conserve natural resources that have received priority in Taiwan for several decades.

While a number of agencies bear responsibility for protecting the environment, the Environmental Protection Agency (EPA) is the only agency that is solely dedicated to environmentalism. Departments that work under the EPA include Comprehensive

Planning, Air Quality Protection and Noise Control, Water Quality Protection, Waste Management, and Environmental Sanitation and Toxic Substance Management. In order to combat the extensive air pollution that has accompanied industrialization, the legislature enacted the Air Pollution Control Act of 1975. The law was revised in 2002 to increase the power of the EPA and the Taiwan Area Air Quality Monitoring Network to strictly enforce environmental laws. Because Taiwan's independent status is not universally recognized, the country does not participate in international agreements on the environment.

Current land development policies in Taiwan have been formulated under the Challenge 2008 National Development Plan that promotes the upgrading of agriculture by encouraging farmers to employ improved technologies and land use, including switching from land cultivation to agricultural tourism. In 2004, Taiwan was hit by several typhoons. Extensive land development in the mountains led to heavy flooding and massive landslides during the typhoons. This devastation subsequently provided the momentum for a new program of conservation under the National Land Planning Act of 2004, combining public education with strict enforcement. Additionally, the Soil and Water Conservation Bureau was charged with overseeing the construction of a number of water catchment facilities designed to improve access to safe drinking water.

Taiwan has one of the richest ecosystems in the world. Constituting 1.5 percent of all identified species, 150,000 separate life forms have been identified on the islands. Around 30 percent of these life forms are endemic to Taiwan. The government first began a conscious effort to protect this biodiversity with the passage of the Cultural Heritage Preservation Act of 1981 and followed it up with the Wildlife Conservation Act of 1989. Taiwan is home to 70 species of mammals, 500 species of birds, 90 species of reptiles, 30 species of amphibians, 18,000 species of insects (including 400 butterfly species), and 2,700 species of fish. Some 1,955 species of rare fauna have also been identified. Among the 3.9 million acres (1.57 million hectares) of Taiwan's forests, 72 percent are nationally protected, and Taiwan has 16 wildlife refuges, 19 nature reserves, and an extensive national park system.

SEE ALSO: Biodiversity; Ecosystems; Industrialization; Pollution, Air; Pollution, Water; Radioactivity; Sewage and Sewer Systems.

BIBLIOGRAPHY. Central Intelligence Agency, "Taiwan," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Asia: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Michael Howard, *Asia's Environmental Crisis* (Westview, 1993); *Taiwan Yearbook 2005* (Government Information Office, 2005); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Tajikistan

TAJIKISTAN IS A landlocked country located in Central Asia. It has an area of 55,251 square miles and a population of 6.8 million (2005 estimate). The capital of the country is Dushanbe, with an approximate population of 700,000. Tajikistan is bordered by China, Afghanistan, Uzbekistan, and to the north, both Uzbekistan and Kyrgyzstan. Over 90 percent of the land is mountainous, with most of the population located around river valleys that flow from glaciers in the Pamir and Fan mountain ranges westward into the Aral Sea Basin. The majority of the population is Tajik, a group strongly tied to the Tajiks of northern Afghanistan and to Iranians, with a sizeable Uzbek minority and small Russian and Kyrgyz minorities. Although the official language of the country is Tajiki—a language closely related to Farsi in Iran—the government also recognizes Uzbeki and Russian for educational and judicial purposes. The country is largely Sunni Muslim; however, there is a small minority of Shi'a Ismailis in the East.

Historically, the land now comprising the country of Tajikistan was lightly settled with the majority of the people living in the Hisor/Qaroteghin Valleys (now bisected by Dushanbe) and along the Zerafshan River, which flows to the historic cities of Samarqand and Bukhara. Prior to Russian advances in the region, the economy of the area was based on agriculture and transhumance pastoralism. This changed only slightly with the advent of the Soviet Union's hold over the region and most people remained either farmers or herders, though on collectivized farms. Industry was little developed outside of aluminum smelting (that took advantage of the hydropower in the region) and the necessary production around cotton, the republic's main agricultural crop.

With the collapse of the Soviet Union, Tajikistan obtained independence on September 9, 1991. Nascent tribal and Islamist feelings exploded in the southern Vakhsh Valley and triggered a debilitating civil war lasting until 1997. The Russian-backed winners, represented mostly from the cities of Kulob and Khojand, have governed ever since under the leadership of Emamoli Rahmanov. The Rahmanov regime has attempted to bring stability to the country by holding multi-party elections and having one of the few legislatures in the region with an opposition party represented in the parliament. Continued destabilization caused by opium-financed warlords who provide the transport of opium products from Afghanistan, however, threatens this still fragile country.

Like most former Soviet countries, Tajikistan's infrastructure is heavily tied to the other former Soviet republics. At independence, all of its roads, railroads, and pipelines led only toward Russia and the other former Soviet republics. Agriculture has remained the largest employer and cotton remains the most important economic indicator. The Tajik government, however, has maintained a monopoly on the cotton trade. Afghanistan's instability and the sheer height of the mountains within and around Tajikistan have hampered the country in its ability to increase economic activity with neighboring countries. Recently, however, the government has expanded trade with a new bridge now linking Tajikistan to Afghanistan, and ultimately on to South Asia and their ports; and more importantly, a new road to China through the Pamir Mountains has already dramatically increased trade into the country.

SEE ALSO: Cotton; Russia (and Soviet Union); Wars.

BIBLIOGRAPHY. Shirin Akiner, *Tajikistan: Disintegration or Reconciliation?* (Royal Institute of International Affairs, 2001); Mohammad Reza Djalili, Frédéric Grare, and Sharin Akiner, *Tajikistan: The Trials of Independence* (St. Martin's Press, 1997); Richard N. Frye, *The Heritage of Central Asia: From Antiquity to the Turkish Expansion* (Markus Wiener Publishers, 1996); Colette Harris, *Gender Relations in Tajikistan* (Pluto Press, 2004); Martha Brill Olcott, *Central Asia's Second Chance* (Carnegie Endowment for International Peace, 2005).

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Takings

THE "TAKINGS" CLAUSE of the Fifth Amendment of the U.S. Constitution requires the government to pay compensation to owners of private property when their land is appropriated for public uses such as building roads. In early cases, only the physical invasion of private property for public use was considered a just taking. For example, in 1871, in the case of *Pumpelly v. Green Bay Co.*, the court ruled that when dam construction flooded private property, the loss of property was considered a taking. Conversely, regulatory action that affected the economic value of the property, such as rezoning legislation that forced an operating business to close, was not considered a taking.

A major shift in takings jurisprudence occurred in 1987 when the Supreme Court had to rule on three cases in the same term. The 1992 case of *Lucas v. South Carolina Coastal Council* is also an important case study supporting the claim that loss of economic value on private property due to governmental regulations constitutes a taking that requires just compensation. In 1986, David Lucas paid $975,000 for two residential lots on the Isle of Palms in South Carolina with the intention to build single-family homes on the properties. In 1988, the South Carolina Legislature enacted the Beachfront Management Act, which barred Lucas from building on his two parcels. Because the legislation had a significant economic impact on Lucas, rendering the lots practically "valueless," the court ruled that this accomplished a taking and required compensation. As a result of this and similar cases, regulatory takings have since been asserted whenever a regulation has reduced the value of private property.

"Takings" has received a secondary definition under the Endangered Species Act (ESA) of 1973, which has significantly challenged both the freedoms Americans attach to private property and the legal understanding of what constitutes a taking. An important provision of the ESA prevents the "taking" of endangered species on both public and private land. In the context of the ESA, the definition of taking is expanded to mean to "harass, harm, pursue, shoot, wound, kill, trap, capture, or collect" a listed species.

As a result of the ESA, a legal debate has emerged: If a take of an endangered species is illegal on private property, does the prohibition against taking endangered species constitute a taking of the private property under the Fifth Amendment? This question poses a major concern to both environmentalists and landowners. Even if most Americans wish to prevent the extinction of endangered species, that does not establish that individual landowners should be compelled to pay for (or bear the burden of) their preservation. Many have argued that if the government fails to compensate landowners for providing a habitat for endangered species on their land, then a landowner is better off killing and burying the plant or animal than potentially losing the rights generally associated with private property.

The shift from focus on species protection under the ESA to protection of their habitats has resulted in further broadening of the applications of the takings clause. In 1978, the Supreme Court's famous snail darter decision resulted in the temporary halting of the construction the nearly completed, multimillion-dollar Tellico Dam because it jeopardized the only known habitat of the endangered snail darters.

Another case involved logging in the Pacific Northwest, which was halted in the 1990s to protect the threatened spotted owl and its old-growth habitat, resulting in the loss of thousands of timber-related jobs in rural Oregon and Washington. The spotted-owl controversy has become an emblematic case in the takings debate, pitting the need for jobs against the protection of animals.

The application of the takings clause in respect to the ESA and private property has created much debate as Americans grapple with the conflicts between economic and ecological priorities in land use. Legal scholar Carol Rose has argued that in the United States environmental protection seems to be in conflict with the concept of private property when burdens are placed on particular individuals who are asked to preserve wetlands or endangered species. However, both secure private property rights and effective environmental protection share a common goal—the enhancement of the overall social well-being, both private and public. Rose believes that the current friction exists as new understandings of environmental harms and what constitutes a taking confront preexisting property laws. Because the legal community is still defining the boundaries of this modern usage of taking under the ESA, further modifications of the law through court cases are expected.

SEE ALSO: Endangered Species Act (ESA); Habitat Protection; Northern Spotted Owl; Private Property; Property Rights; Snail Darter and Tellico Dam; Timber Industry.

BIBLIOGRAPHY. Lynn E. Dwyer, Dennis Murphy, and Paul Erlich, "Property Rights Case Law and the Challenge to the Endangered Species Act," *Conservation Biology* (v.9/4, August 1995); Robert Percival et al., *Environmental Regulation: Law, Science, and Policy* (Aspen Publishers, 2003); Carol M. Rose, "Property Rights and Responsibilities," in Marian Chertow and Daniel Esty, eds., *Thinking Ecologically: The Next Generation of Environmental Policy* (Yale University Press, 1997); Barton Thompson, Jr., "The Endangered Species Act: A Case Study in Takings and Incentives," *Stanford Law Review* (v.49, 1997).

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Environmental Studies

Tanganyika, Lake

LAKE TANGANYIKA IS the largest of a chain of lakes in the Great Rift Valley in eastern Africa. Geologic processes have formed the extraordinary lakebed. Lake Tanganyika measures 673 kilometers by 15–90 kilometers, covers 32,900 square kilometers, and is the longest lake in the world. With a maximum depth of 1,470 meters, Lake Tanganyika is the second deepest lake in the world next to Lake Baikal. The lake is, therefore, considered the largest freshwater reservoir in Africa. It is also one of the most diverse freshwater ecosystems in the world, with several hundred endemic species.

The lake catchment is relatively small at 220,000 square kilometers, due to the structure of the Great Rift Valley's steep mountainous ridges. Two main rivers flowing into the lake are the Rusizi, draining Lake Kivu and entering Lake Tanganyika from the north, and the Malagarasi, which enters the lake in the east, draining western Tanzania. In addition, many smaller rivers drain the slopes of the surrounding mountains. There is one major outflow, the Lukuga River, which leaves Lake Tanganyika as a tributary to the Congo River in the west. However, due to the tropical climate, Lake Tanganyika loses most water to evaporation.

The countries of Burundi, the Democratic Republic of Congo, Tanzania, and Zambia share Lake Tanganyika. Of the lake's shoreline perimeter, 43 percent is in the Democratic Republic of the Congo, 36 percent in Tanzania, 12 percent in Zambia, and 9 percent in Burundi. An estimated one million people live on the shores of Lake Tanganyika. The main settlements are Bujumbura (400,000 people), the capital of Burundi; Uvira (100,000) in the Democratic Republic of the Congo; Kigona (135,000) in Tanzania; and Mpulungu (70,000) in Zambia. Economic activity in these urban areas includes industrial plants (such as paint, brewery, textile, soap, and battery plants), cotton processing, sugar production, and industrial fishing. Kigoma is the largest transit point for goods and people entering and exiting the lake region. Lake Tanganyika, with its well-developed shipping routes, is one of the most important inland traffic and communications links in eastern Africa.

Crop and livestock production and processing, and mining (tin, copper, coal), are the main industries in the catchment of Lake Tanganyika. Commercial, as well as small-scale fisheries are particularly important to the local economy and local livelihoods. The fast rate of urbanization is creating severe problems of lake pollution through urban wastewaters. Moreover, overfishing in the coastal zone and habitat destruction are increasing concerns. High rates of soil erosion in the catchment have increased lake sedimentation rates.

The appropriate utilization of natural resources in the catchment has become a priority, particularly since it plays a major role in regional poverty reduction strategies. After centralized systems failed, decentralization of government structures and empowerment of local governments to manage local resources for improving livelihoods is a new policy change in recent years. Commercial water provision, for example, has become a major strategy to improve water coverage. However, partial privatization of urban water providers largely failed, since municipalities and private investors often do not agree on how to pre-finance the investments into a deficient system.

SEE ALSO: Baikal, Lake; Congo, Democratic Republic of the; Lakes; Rift Valley.

BIBLIOGRAPHY. G.W. Coulter, *Lake Tanganyika and its Life* (Oxford University Press, 1991); G. Hanek, E.J. Coenen, and P. Kotilainen, *Aerial Frame Survey of Lake Tanganyika Fisheries* (Food and Agriculture Organization, 1993); A. Mills, *Pollution Control and Other Measures to Protect Biodiversity in Lake Tanganyika* (United Nations Environment Programme, 2000).

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Tanzania

AFTER GAINING INDEPENDENCE in 1964, Tanganyika and Zanzibar merged into the United Republic of Tanzania. The next three decades were characterized by one-party rule, which ended in 1995 with democratic elections. Zanzibar has retained a semi-autonomous status that has contributed to hotly contested elections and charges of voting irregularities. With a per capita income of only $700, Tanzania is the seventh poorest country in the world. Some 36 percent of the population live in abject poverty. Only four percent of the land area is arable, yet 80 percent of Tanzanians are engaged in the agricultural sector, which provides around half of the Gross Domestic Product and 85 percent of all exports. The United Nations Development Programme's Human Development Reports rank Tanzania 164 of 232 countries on overall quality-of-life issues.

Industries are generally involved with processing agricultural productions or in producing light consumer goods. Natural resources include: Hydropower, tin, phosphates, iron ore, coal, diamonds, gemstones, gold, natural gas, and nickel; Tanzania has recently begun exploiting these resources. The World Bank and the International Monetary Fund are working with the government to reduce poverty and rehabilitate the economic infrastructure.

Bordering the Indian Ocean, Tanzania has a coastline of 1,424 kilometers and inland water resources of 59,050 square kilometers. The total area of 945,987 square kilometers includes the islands of Mafia, Pemba, and Zanzibar. Tanzania shares land borders with Burundi, the Democratic Republic of the Congo, Kenya, Malawi, Mozambique, Rwanda, Uganda, and Zambia. The coastal plains of Tanzania give way to a central plateau and to northern and southern highlands. While the coast enjoys a tropical climate, the highlands are temperate. Tanzania is subject to drought, and flooding may occur on the central plateau during the rainy season. Elevations range from sea level to 5,895 meters at Mount Kilimanjaro along the Kenyan border. Kilimanjaro, which is Tanzania's most distinctive geographic feature, is the highest point in all of Africa. The world-renowned mountain is bordered by Lake Victoria, the second largest freshwater lake in the world, Lake Tanganyika, the second deepest lake in the world, and Lake Nyasa.

Like many of Africa's poorest countries, Tanzania's population of 37,445,392 is vulnerable to a number of environmental health hazards. With an adult prevalence rate of 8.8 percent, the HIV/AIDS epidemic has claimed 160,000 lives since 2003. Another 1.6 million people are living with the disease. While 73 percent of the population have access to safe drinking water, only 46 percent have access to improved sanitation. Therefore, Tanzanians are at very high risk for contracting food and waterborne diseases that include bacterial diarrhea, hepatitis A, and typhoid fever and the water contact disease schistosomiasis. In some areas, the population is at high risk for contracting vectorborne diseases such as malaria, Rift Valley fever, and plague. Consequently, Tanzanians have a lower-than-normal life expectancy (45.64 years) and growth rate (1.83 percent), and higher-than-normal infant mortality (96.48 deaths per 1,000 live births) and death (16.39 deaths/1,000 population) rates. The fertility rate of five children each places women at great risk and taxes strained resources.

Tanzania is experiencing extensive soil degradation and desertification as a consequences of human mismanagement and natural disasters. Around 44 percent of the land is forested, but deforestation is occurring at a rate of 0.2 percent per year. The destruction of coral reefs is jeopardizing marine life. Marginal agriculture has been seriously threatened by prolonged droughts. Illegal hunting and trade, particularly the ivory trade, is posing major threats to Tanzanian wild life.

Because Mount Kilimanjaro is the highest freestanding mountain in the world, it has provided valuable information on climate change created by greenhouse gases and global warming. Scientists have observed a visible depletion of the snow in recent years. This factor is affecting the tourist industry and decreasing Tanzania's supply of fresh water. There is some indication that the situation on Kilimanjaro has also reduced fish supplies in Lake Tanganyika. A 2006 study by scientists at Yale University ranked Tanzania 83 of 132 countries on environmental performance, well above the relevant income and geographic groups. Only the low score in environmental health prevented Tanzania from a higher ranking.

Approximately 30 percent of the land has been claimed by the government to protect Tanzania's rich biodiversity. Protected lands include nature reserves, wilderness areas, national parks, species management areas, and wetlands. Wildlife has been seriously threatened, however, partially by rural Tanzanians who hunt wildlife for food because they cannot afford domestic meat. Bush meat provides around a fourth of all meat consumption for this segment of the population. Of 316 identified mammal species, 42 are endangered, as are 33 of 229 bird species.

In the 1960s and 1970s, Tanzania became involved in ecotourism as a means of preserving vulnerable ecosystems while helping villages meet their economic needs. Until that time, many villagers had seen wildlife only as hunting prey or pests that destroyed crops. In the 1980s, the Campfire programs were initiated in Africa, and villagers were given an economic stake in protecting the wildlife that attracted tourists to their areas by providing services and sharing in profits. Tanzania's Wildlife Division developed programs using ecotourism as an alternative to hunting, which wrecked the environment and destroyed wildlife populations. Some of the proceeds from the Campfire projects are used to supply water and sanitation systems to villages and to support the national park system. Critics claim, however, that resources are being directed toward the state treasury and away from conservation as originally planned.

In 1983, Tanzania passed the National Environment Council Act that created the National Environment Management Council, which advises the government on all environmental issues and formulates and recommends policy and standards. The Ministry for Tourism, Natural Resources, and Environment is the statutory body charged with implementing and enforcing environmental laws based on the framework provided by the National Conservation Strategy for Sustainable Development and the National Environmental Policy, which comprise national policy on land use, natural resources and conservation, pollution, and environmental management. Tanzania participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Wetlands.

SEE ALSO: Colonialism; Coral Reefs; Ecotourism; National Parks; Poaching; Safaris; Tanganyika, Lake.

BIBLIOGRAPHY. Central Intelligence Agency, "Tanzania," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); One World, "Tanzania: Environment," uk.oneworld.net (cited April 2006); United Nations Development Programme, "Human Development Report: Tanzania," hdr.undp.org (cited April 2006); World Bank, "Tanzania," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Taxidermy

TAXIDERMY IS THE practice of preserving the skins of animals and using them to create tableaux or dioramas of the animals in what are meant to be accurate representations of their shape, habits, and/or life environments. Taxidermical techniques have developed considerably in the modern age. The practice may be considered to be an offshoot of the mummification of corpses, human and otherwise, as found in ancient Egypt and Xinjiang. However, mummification was conducted primarily for religious purposes and the resultant mummies were not meant for public display. When taxidermy began on a significant scale in the 18th century, it served a partly scientific purpose to help to disseminate information about creatures that most people would have almost no chance of seeing live in the wild. It also became important for hunters to display the prey they had managed to kill.

Chemical processes were established to preserve skins and some other organic remains, although the methods were often somewhat crude and inconvenient. In the 19th century, processes improved to the extent that large tableaux could be created that were displayed in some of the better-regarded natural history museums of the world. As time progressed, taxidermists moved from the concept of stuffing animals with some kind of nonreactive filler to the concept of mounting them, which involves using a variety of structural materials and

Competitive Taxidermy

Taxidermy has become an activity of considerable scope, especially in the United States, where manufacture and retail of taxidermy supplies has grown into quite a significant industrial sector. Competitive taxidermy, in which contestants display their creations for the deliberation of judges, has become intense. The field has grown to include invertebrates and reptiles. Rogue taxidermists prefer to use their artistic talents to create scenes that have never been seen in the real world; they mount creatures that appear to be mermaids, unicorns, or some other fantastic hybrid. Such items can fetch high prices.

Modern techniques have led to more realistic taxidermy, but its scientific role is waning.

techniques to create the desired lifelike appearance. The American naturalist Carl Akeley is associated with the transformation of taxidermy into a systematic and well-ordered process. Recently, new processes have enabled the realistic recreation of a wider range of organic remains and a broader selection of the animal world.

While taxidermy is likely to continue as an artistic hobby, especially among common animals, its use in science and conservation is likely to decline as computer graphics improve and are better able to recreate the life conditions of animals.

SEE ALSO: Animal Rights; Animals; Hunting.

BIBLIOGRAPHY. Carl Ethan Akeley, *Taxidermy and Sculpture: The Work of Carl E. Akeley in Field Museum of Natural History* (Field Museum of Natural History, 1927); Mary L. Jobe Akeley, *The Wilderness Lives Again: Carl Akeley and the Great Adventure* (Dodd, Mead and Company, 1944); Gerald Grantz, *Home Book of Taxidermy and Tanning* (Stackpole Books, 1985).

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Taylor Grazing Act (U.S. 1934)

THE TAYLOR GRAZING Act of 1934 authorized the U.S. Secretary of the Interior to establish and regulate grazing districts on vacant, unappropriated, and unreserved public domain lands deemed “chiefly valuable for grazing,” to issue grazing permits for up to 10 years, and to collect grazing fees. Federal regulation of grazing first began on Forest Reserves in the early 1900s, but it took many years for legislation regulating grazing on the remaining public domain lands to pass. Although cattle ranchers were generally in favor of legislation that would bring order and stability to what was essentially an unregulated grazing commons, sheepherders, settlers, and farmers opposed it. In addition, the U.S. Department of Agriculture and the U.S. Department of the Interior battled over which one of them would administer the public rangelands. Legislation was also delayed because the future status of these lands was unclear. On the one hand, since the passage of the first Land Ordinances in the 1780s, Congress had adopted a policy of transferring the public domain lands to private ownership. On the other hand, President Herbert Hoover offered to give the public rangelands back to the states in 1929, but the states declined. Finally, in 1934, the Depression, coupled with an extended drought throughout the West, provided the necessary impetus for the passage of the Taylor Grazing Act.

The purpose of the Taylor Grazing Act was to “stop injury to the public grazing lands...to provide for their orderly use, improvement and development ... [and] to stabilize the livestock industry dependent on the public range." The Act directed the Secretary to cooperate with "local associations of stockmen" in the administration of grazing districts, a feature that its sponsor, Congressman Edward Thomas Taylor from Colorado, referred to as "democracy on the range" or "home rule on the range." It also gave "preference" in issuing permits to local residents. A crucial clause, "pending its final disposal," indicated that Congress was still trying to decide what to do with the remaining public domain and that these arrangements might be temporary.

Secretary of the Interior Harold Ickes established a Grazing Division (which became the Grazing Service in 1939, and the Bureau of Land Management [BLM] in 1946) to guide these procedures and appointed Farrington Carpenter, a Colorado cattleman and attorney, as its first director. The Secretary delegated authority to set up boundaries for grazing allotments, decide who would receive permits, and determine initial stocking rates to grazing advisory boards composed of local ranchers. State advisory boards and the National Advisory Board Council took on more general policy issues.

This structure kept bureaucracy to a minimum and reduced the potential conflict involved in implementing the new program by taking historic use patterns into account, providing relatively secure tenure, and giving local grazing interests real decision-making authority. It has been heavily criticized for effectively instituting private grazing rights on public lands, allowing the BLM to be "captured" by local interests, and allowing range degradation to continue. Although the management structure set up by the Taylor Grazing Act has been significantly altered by subsequent legislation, it should be noted that, in its initial form, it bore a remarkable resemblance to collaborative and community-based approaches to resource management now being promoted throughout the world and embraced by federal and state agencies in the United States.

SEE ALSO: Bureau of Land Management (BLM); Livestock; Overgrazing; Ranchers.

BIBLIOGRAPHY. J.N. Clarke and D.C. McCool, *Staking out the Terrain: Power and Performance among Natural Resource Agencies* (State University of New York Press, 1996); Debra Donohue, *The Western Range Revisited: Removing Livestock from Public Lands To Conserve Native Biodiversity* (University of Oklahoma Press, 1999); Christopher McGrory Klyza, *Who Controls the Public Lands? Mining, Forestry, and Grazing Policies, 1870–1990* (The University of North Carolina Press, 1996); Karen R. Merrill, *Public Lands and Political Meaning: Ranchers, the Government, and the Property Between Them* (University of California Press, 2002).

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Technology

ETYMOLOGICALLY, TECHNOLOGY (BASED on ancient Greek *technè* and *logos*) means the study of crafts. But the word is usually understood in a much broader sense to include objects (i.e., a hammer, car, or microscope), techniques (i.e., writing, agriculture, or advertising) as well as processes influencing aspects of human life (i.e., when technology is seen as creating its own culture or determining economic cycles). The relationships between technology and the environment are very close, as technology is sometimes defined as the way by which humans manipulate their environment to fulfill their needs. Indeed, through the invention of tools and techniques, humans have been able to take advantage of resources found in the environment. They have been able to increase resources, for instance through agriculture.

Today, as people are often surrounded by devices such as computers or cell phones, use transportation means ranging from cars up to planes for traveling, and eat food grown in greenhouses, there is a general feeling—at least in industrialized countries—that humanity lives in a more technological society than ever before. On the one hand, this sensation makes one think that humanity has freed itself of environmental constraints and is no longer dependent on what can be found in nature in order to survive. On the other hand, humans seem to have become dependent on these technologies, which contribute to the degradation and depletion of the environment and in some most extreme forms—such as nuclear weapons—can be a threat to the very existence of humanity. However, the relationship between technology and the environment is much more complex that either improvement or depletion.

Technology is most often referred to by the objects it includes. In this understanding, a spade, a plow, or a combine harvester are all technologies. From the simplest up to the most sophisticated, these devices allow humans to do things they could not do otherwise. In this sense, technological objects are considered as means to reach ends defined by their designers and users.

But technology also refers to techniques. For instance, agriculture can be considered as a technology to provide food, or writing as a technology to communicate through space and time. A technique does not refer directly to a specific object, but to a set of knowledge, skills, and routines that allows one to arrange and use objects in order to reach a specific goal. Most techniques can be put into practice only through the use of specific objects—agriculture in its simplest form implies the use of basic tools. Even observation activities may require the use of technological devices: The monitoring of a national park relies on data transferred by satellites or on rangers equipped with vehicles. Some authors consider that a technique can only be viewed as a technology when it is reflectively used to solve problems or satisfy needs. In this understanding, a technique for playing a musical instrument would not be considered as a technology. However, the distinction is not always easy to make.

A third understanding of the word *technology* considers it as a more abstract concept defining a process that influences the way humans deal with the world. This understanding relates to expressions like "technological society" or "technological culture" when they are used to qualify the state we live in. In these expressions, technology does not refer to specific devices or techniques, but is perceived as a force that brings changes to the way humans interact among themselves and with their environment compared to a situation with less or no technology. This understanding is driven by a feeling that the proliferation of technological objects is something ineluctable, almost independent from human will.

TECHNOLOGY AND SCIENCE

Current technological developments seem to rely strongly on scientific discoveries. The petrochemical industry would probably not have had the same development and impact without modern chemistry. The idea that scientific research is the main factor behind technological progress became common during the 19th century and culminated in the post–World War II period, influencing both scientific and technological policies. In the United States, such a view can be found in the Vannevar Bush model that drove federal scientific policy from the 1940's on and stated that technological innovations would trickle down from massive investments in fundamental research. It led to increased cooperation between scientific institutions such as universities and high technology firms and government branches. The word *technoscience* has been proposed by some authors in order to define this state in which science and technology are so strongly related that it is not possible to distinguish them.

Despite the strong links between science and technology, they are different activities and should not be confused. Science is defined as an activity that seeks to gain knowledge about the world, while technology enables human beings to complete specific tasks. A common misunderstanding stemming from this confusion is considering technology as applied science. When scientific results are applied, they usually lead to technological innovations, but not all results have applications. Moreover, not all technological innovations result from the application of scientific findings. They can also be the result of trial and error processes undertaken without an understanding of the mechanisms behind the innovation. For example, agricultural innovation relied for a long time on observations made by farmers before agronomists and botanists fostered rapid changes using scientific results. It is also important to note that most scientific activity would not be possible at all without the technological instruments used for observing or measuring.

ENVIRONMENTAL IMPACTS

One of the reasons why technology is sometimes perceived as an independent force is its continuous growth over long historical periods. Retracing a history of technology implies retracing a history of humanity. The periodization of early human ages is based on technological criteria such as Paleolithic (early stone age with chipped-stone tools), Neolithic (new stone age, which saw the development of polished stone tools and pottery) up to the Bronze Age. The distinction between prehistoric and historic ages is also based on the technological criteria of the appearance of writing. French philosopher of technology Gilbert Simondon goes as far as to say that humanity comes from the use of technology—by becoming technological beings humans have distinguished themselves from other species.

Technology is also a constituent of the human-environment relationship as it is the means by which humans are able to free themselves from environmental constraints, but it is also dependent on resources found in the environment. However, it seems that the human impact on the environment due to technologies is growing larger.

The first technologies used by humans consisted of very simple tools that could be found in their surroundings, such as sticks or rocks with useful shapes for reaching or breaking other objects. As humans learned to shape rock, wood, and other materials into more complex tools, direct dependence on environmental conditions began to decrease. The invention of cutting stones, for instance, allowed humans to use animal skins or furs, and therefore become less dependent on climatic conditions and survive in colder environments.

The development of agriculture and the subsequent sedentarization of communities it implied was probably the technological development that had the strongest impact on the environment for a long period. Historians of technology, although they use different types of periodization, usually consider the whole range of time from the point after which agriculture and sedentarization established themselves as dominant forms of human dwelling around 10,000 B.C.E. up to the Industrial Revolution in the 18th century as a single period. Agriculture contributed to powerfully transforming the environment by several means. First, with agriculture came the sedentarization of communities, with the first permanent settlements growing into towns, occupying space in a very different way than in former lifestyles. Second, the first areas where agriculture developed being floodplains of large rivers (the valleys of the Euphrates and Tigris Rivers in Mesopotamia, the Nile Valley in Egypt, or the Yangtze in China), there was a need to develop complex irrigation systems in order to take advantage of the regular floods of these rivers. These systems were developed as early as 3,000 B.C.E. and considerably shaped their environment. Chinese rice growing, for example, had a significant impact on the landscape. Even in Western Europe, where there was no need for such technological irrigation systems, early agriculture had an impact on the environment through deforestation.

Although there were great spatial variations over this long period of time, the main technological evolutions improved ways of living without radically changing them. The Agricultural Revolution that took place during the 17th century was essentially a rationalization and an intensification of the technologies available at that time. However, these were made possible through a new attitude toward technology of trying to understand how things worked, not just how to make them work.

The drive for scientists to foster technological innovation increased during the Enlightenment period and is one of the factors that favored the Industrial Revolution that began in Western Europe in the 18th century and eventually spread over most of the world. It triggered a period of fast technological transformations that also brought major changes to the ways humans occupied and exploited the earth's surface.

One of the main technological changes driving the Industrial Revolution was the invention and diffusion of steam-powered machinery, first in factories (i.e., spinning machines) then in transportation (i.e., trains or steamboats). The generalization of this form of power in industries throughout the 19th century had various environmental consequences. Steam engines were powered through the combustion of wood or coal; these resources had to be exploited more intensively in order to meet growing needs. The opening of new coal pits and deeper digging in existing ones had considerable roles in destroying ecosystems. The development of train transportation led to deforestation, as there was a great need for timber for crossties for the tracks. In the United States the situation became so dramatic by the end of the 19th century that a governmental Forest Service was created in order to manage timber resources and avoid depletion. Another consequence of the use of coal as the major fuel was much air pollution in industrial cities.

Just as the first Industrial Revolution centered around coal, it was sources of power that characterized the second Industrial Revolution and its environmental consequences. The exploitation of mineral oil resources that developed in the 1860s enabled their use as fuel, leading to considerable development of prototypes of gas engines. The invention of gasoline and diesel engines in the last two decades of 19th century led to the car becoming a significant means of transportation, with all its consequences in terms of urban organization and pollution later on in the 20th century. But petroleum has also had important impacts on the environment with the development of the petrochemical industry. Another important technological impact on the environment at the turn of the century was the use of electricity as a source of power for lighting and above all for urban transportation means such as subways and tramways. The development of this source of power during the 20th century had spectacular environmental consequences with the damming of rivers in order to produce hydroelectricity.

The two World Wars are often depicted as periods of important technological development; in order to have an advantage over their opponents belligerent governments invested in research for new technologies. But these periods also brought some important changes in the way people considered technologies. Technologies based on nuclear power are symptomatic for this, as their development for civil use was accompanied by constant opposition from more or less large parts of the population, depending on the country. If at first it was largely the destructive capacities of nuclear power used as a weapon that fed this opposition, accidents in the power plants of Three Mile Island in Pennsylvania in 1979 or at Chernobyl in the former Soviet Union in 1986 reinforced popular opposition

Public enthusiasm for technology in the postwar era was also altered by the growth of production in sectors that had emerged with the first two Industrial Revolutions. These had much more actual effects on the environment than the destructive potential of nuclear power. In the context of a competition economy, growth of consumption led to more technological innovation in order to differentiate everyday goods and renew the need for consumption. Therefore it induced more waste or pollution because of the constant growing production of goods.

During the last quarter of the 20th century, the development of biotechnologies has led to a new understanding of the consequences of human activity on the environment. Biotechnologies are technologies that use or modify living organisms in order to favor some of their features or even add new ones. One of the ways biotechnologies may have consequences on the environment is through the introduction of new breeds of cattle or crops for agricultural use through the modification of genetic information of existing species. These new breeds are called genetically modified organisms (GMO). By modifying the gene stock of living organisms it becomes possible to create new species such as pest-resistant corns.

Environmental impacts of biotechnologies were initially considered rather promising. It was said that biotechnological plants would make agriculture less dependent on environmental constraints such as weather or soil conditions. By creating crops that are pest-resistant or adapt to specific soil conditions, the need for fertilizers or pesticide could be drastically reduced. Despite the introduction of such crops in some countries, genetically modified organisms are very controversial as there is evidence that they are altering their environment by making some pests and weeds resistant to pesticides. There also may be a transfer from the modified genes to other plants, with all the unintended consequences this may have. Finally, as some agro-industrial firms are designing crops that are best suited for their respective environments, they may be a threat to biodiversity, especially in developing countries where there is an urgency to increasing agricultural production and where it can seem attractive to replace less productive local crops.

A consequence of the rising impact of technology on the environment during the second half of the 20th century has been to trigger even more innovation, but this time in order to minimize negative technological effects. These are sometimes called green technologies and are oriented toward efficiency in energy use, waste recycling, or reparation of damaged ecosystems. The main push for these efforts comes from governmental financial incentives and stricter regulation. In a way, technology is again clearly dependent on the state of the environment.

THEORIES OF TECHNOLOGY

Whereas for a long time impacts of technologies were mostly considered positive, the consequences of the introduction of new technologies since the Industrial Revolution have been viewed in more ambivalent ways. Relating to this ambivalence, there are different theories that can be used in order to study technologies. Philosopher of technology Andrew Feenberg offers a framework in order to characterize theories of technology by looking at whether they consider technologies to be value neutral (they are just means) or value laden (they include ends) and at whether they are considered autonomous or human-controlled.

Some theories of technology are deterministic in the sense that they consider that technologies have a functional logic that is autonomous from the rest of the social sphere and in return determines how society must function in order to make use of these technologies. However, the determination is considered to be value neutral in the sense that technologies develop only in order to meet human ends. In such a view, it would be said that water regulation techniques for rice culture in ancient China required centralization of decisions and therefore determined the form Chinese imperial societies took. Such a view can for instance be found in traditional Marxist theories.

However, regarding the proliferation of negative effects on the environment occurring from technologically mediated human activity, technology is often perceived as a threat to the environment or even to humanity as a whole and developed beyond the human needs it is supposed to fulfill. Such a view is largely present in public opinion, in some parts of the environmental movement, and also among some philosophers who have worried about the negative effects of technology on human freedom. In these views, technology is also conceived as autonomous but value laden. Such theories have been developed by philosophers such as Martin Heidegger or Jacques Ellul who claimed that technologies have their own ends that are guided by an instrumental rationality based on efficiency, which influences all other domains of activities not only by determining how the technology has to be used, but also by making efficiency the core value of all social activities.

Instrumentalism qualifies theories that consider technologies neutral. But unlike determinism, human agency is considered as the major force shaping them. In this view technology is pure instrumentality and its use is determined by other aspects of social life. Instrumentalism holds that technology is neither good nor bad, but depends on social, political, or cultural values and its outcome will depend on how humans make use of it. This view is very common among governmental institutions, engineers, and scientists. In instrumental theories there is an implicit idea that the negative consequences of a technology can be reversed, since those are consequences of human action. However, this view does not acknowledge the complexity of human agency, especially the variety of sometimes competing uses that can be made of a single technology.

A fourth kind of theory of technology holds that there is no clear distinction between means and ends when speaking of technology. This view can be found in critical theories of technology (i.e., Herbert Marcuse, Andrew Feenberg) or in some versions of Actor-Network Theory such as the one developed by Bruno Latour. The conflation of ends and means happens because technology implies human practice. On the one hand, a technology can be used in ways very different than it was intended, showing that it is not an end for itself. On the other hand, the very existence of a specific technology can lead humans to aim at ends they would not have thought about without this technology. So technology is also not just a means in order to reach predefined ends. In such views, there is no technological determinism but a path of dependency can occur once one technology is chosen. Humans retain a certain level of control, but because of the interrelatedness of ends and means, each technological change will bring changes in the way a society is organized. It is therefore impossible to reduce the question of how humans should deal with technology to a matter of wise or bad use. It is rather a political matter and always implies questions of social organization such as: Who takes advantage of a particular technology? What does it imply for everyday life? What environmental consequences may derive from it?

TECHNOLOGY AND POLICY

Technology is an important issue in environmental policy since it is both a cause of environmental problems but also very often a solution to them. One of the main ways in which environmental policy affects technology is the adoption of environmental regulations that put constraints on the use of specific technologies. Because industrial development has had a strong negative impact on the environment through depletion of natural resources or pollution, legal measures have been taken in order to limit its negative effects. As in the past, technology allows humans to transform the environment to take advantage of its resources, but the possibility of irreversible negative impacts on the environment because of technology have become higher. Most industrialized countries now have sets of environmental regulations that try to limit the negative impacts of technology. These regulations can take different forms such as increased taxation for companies that use dangerous technologies, strict norms of how to use technologies or even the banning of some technologies or products. But there can also be incentives to promote or develop new technologies, as in the case of renewable energies such as wind or solar power.

The adoption of a regulation is often subject to resistance from business circles using the targeted technologies. Constraining environmental laws are often considered a threat to the competitiveness of companies using the technologies in question in their production process. However, strict environmental rules can also have positive effects on the competitiveness of firms in that they force them to be innovative in order to be able to match legal norms as with the high level of governmental taxation on gas in Western European countries, which has led car manufacturers to develop more fuel-efficient vehicles.

One of the main issues at stake in the formulation of environmental policy is the ability to diagnose the actual problems. Therefore, technologies for the measurement of various factors intervening in environmental problems are very important for environmental policies. For instance, satellites can track changes in wide land cover patterns, such as the progression of deserts. Some environmental matters, such as global warming, require use of a set of technologies before they can be grasped. The liability of those technologies and the results they produce are often contested and give way to controversies led by experts in order to determine if one technology or the other is appropriate to make the diagnosis.

Technology has shaped the environment even through repairing damage caused by humanity. In the second half of the 20th century, important efforts have been made in order to restore altered ecosystems. Even when restoration projects are able to recreate functioning ecosystems and enhance the environmental value, it is not a return to the original nature free from human intervention. Very often these ecosystems are recreated through what are called *green technologies*. They require much human monitoring or intervention in order to retain a high environmental value. In fact, most of the areas called natural today have been shaped by human activity. Most of resources, whether exploited in a sustainable way, depleted, or put under strict protection are included in technological networks that determine how humanity can or should deal with them. This has led some authors to talk about "technonatures" to qualify this state where nature is no longer untouched by human hands, but where all natural resources are somehow marked by technological activity, whether for exploitation, distribution, protection, or just observation.

SEE ALSO: Agriculture (including Agricultural Revolution); Biotechnology; Genetically Modified Organisms (GMOs); Genetics and Genetic Engineering; Green Chemistry; Green Production and Industry; Green Revolution; Industrial Revolution; Industrialization.

BIBLIOGRAPHY. Jesse H. Ausubel and Hedy E. Sladovich, eds., *Technology and Environment* (National Academy Press, 1989); Ruth Schwartz Cowan, *A Social History of American Technology* (Oxford University Press, 1997); Andrew Feenberg, *Transforming Technology:*

A Critical Theory Revisited (Oxford University Press, 2002); Bruno Latour, "Morality and Technology: The End of the Means," *Theory Culture and Society* (v.19/5-6, 2002); Bruno Latour, *Politics of Nature* (Harvard University Press, 2004); Isabelle Stengers, *Power and Invention* (University of Minnesota Press, 1997); Jeffrey K. Stine and Joel A. Tarr, "At the Intersection of Histories: Technology and the Environment," *Technology and Culture* (v.39/4, 1998); Erik Swyngedouw, *Social Power and the Urbanization of Water* (Oxford University Press, 2004).

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Technology-Based Standards

TECHNOLOGY-BASED STANDARDS ARE the current legal basis for regulating pollution in American federal law. These new standards are more stringent and have replaced older demanding standards. They can be found in newer legislation affecting the removal of pollution from the environment. Until the 1970s, federal environmental policy focused on conservation as its approach to managing the environment. Pollution control was left to the states. In 1970 a dramatic shift occurred with the creation of the Environmental Protection Agency (EPA). Environmental policy shifted from management to regulatory control. Pollution became a national priority. By 2000, Congress had adopted at least 12 major environment acts and had amended them numerous times. This legislation created new standards for each kind of pollution or industry.

In the 1970s, the focus was on obvious forms of pollution such as raw sewage, industrial smoke stack pollution, water effluents, or automobile air pollution. The standards for handling pollution were those that were the best-known technologies of the day. At first, the emphasis was on health-based standards, but with a mandate to the EPA to engage in "technology forcing" standards-setting activities such as setting timetables for improvements. By 1972, the Federal Water Pollution and Control Act Amendments mandated federal permits for all future effluent discharges to use technology-based standards. Two standards in particular were mandated: "best practical technology" and the "best available technology." As knowledge increased about chemical pollution in potable water, and the dangers of carcinogens, public concerns increased. Environmental politics demanded the removal of numerous chemicals. During the 1980s and afterward, concerns about the cumulative effects of chemicals as carcinogens remained, but concern grew over the long-term effects on reproductive health and neurological toxicity.

Today, the Clean Water Act as amended employs technology-based standards. The act actually recognizes two other types of standards besides technology-based standards. These are the ambient or water-quality-based standards, and in a limited number of cases health-based effluent standards that deal with a small number of toxic compounds. The Clean Water Act uses four kinds of technology-based water pollution control standards. Industry-wide standards are set by the "best practical control technology currently available" (BPT) standard. This standard sets uniform effluent standards for operators in a particular industry, no matter where they are located. This standard sets the national ground floor for all existing sources of industrial water pollution for each industry.

The Clean Water Act also allows for the "best available technology economically achievable" (BAT). This standard applied to a limited number or toxic pollutants or to nonconventional pollutants such as thermal pollution. A third standard is the "best conventional pollutant control technology" (BCT). This standard is a modified form of the "best available technology" standard. The modified standard seeks benefits from pollution control where the costs are applied to "conventional pollutants" such as biochemical oxygen demand (BOD). The fourth standard is the "best available demonstrated control technology" (BACT) and is now the basis for judging the allowable pollution levels permitted in effluents. Technology-based standards have become more stringent.

In 1990, Congress amended the Clean Air Act. It gave the EPA the authority to go beyond health-based standards so that air quality regulations would be set by technology-based standards. The amendments allowed the EPA to relax standards in some cases, with the responsibility to regulate 189 specific substances. The law permits the EPA to add new chemical pollutants to the list and anyone may propose a possibly polluting chemical. The EPA will then evaluate the proposal. Politically, the change to technology-based standards work more in the favor of industry than did the older health-at-any-cost-based standards. The newer standards bring a different kind of science to the policy issues. They reduce the political and economic penalties of regulation because the costs are considered.

SEE ALSO: Best Available Technology (BAT); Clean Water Act; Environmental Protection Agency (EPA).

BIBLIOGRAPHY. David Harrison, *Who Pays for Clean Air: The Cost and Benefit Distribution of Federal Automobile Emission Controls* (Harvard University Press, 1975); Noga Morag-Levine, *Chasing the Wind: Regulating Air Pollution in the Common Law State* (Princeton University Press, 2003); David P. Novello, *The Clean Air Act Handbook* (American Bar Association, 2005); Mark A. Ryan. *The Clean Water Act Handbook* (American Bar Association, 2004).

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Tennessee Valley Authority (TVA)

DURING THE WORST days of the Great Depression in the 1930s, President Franklin D. Roosevelt initiated a series of new and innovative ideas to combat America's economic crisis. The programs, collectively known as the New Deal, offered relief and recovery to several groups and institutions that had been particularly hard-hit by the Depression, including farmers, youth, banks, industry, and workers. One of the most innovative accomplishments of the New Deal was the Tennessee Valley Authority (TVA), which became law on May 18, 1933, during the first 100 days of Roosevelt's initial term in office.

The TVA offered recovery and relief to an agriculturally devastated region in southern Appalachia, which incorporated seven southern states within the water tributaries of the Tennessee River system—an area encompassing approximately 40,000 square miles (103,600 square kilometers). This region, once identified by Roosevelt as the "nation's number one economic problem," included the states of Tennessee, Alabama, Georgia, Mississippi, North Carolina, Kentucky, and Virginia.

The Tennessee Valley had been prosperous in the past, but, according to Arthur E. Morgan, a Roosevelt intimate associated with the TVA, as quoted by Arthur M. Schlesinger Jr., by the 1930s, "only poverty remained—poverty, with thousands on thousands of families who never saw $100 cash income a year." Thus, the TVA sought to revitalize the South's economy but also to improve the lives of millions of families who lived in rural Appalachia. It was, Morgan suggested, "not primarily a dam-building program, a fertilizer job or power-transmission job," but, rather, a large idea for "a designed and planned social and economic order."

One of the primary goals of the TVA was to offer public power to a region devoid of electricity. The greatest champion of public power, Nebraska senator George W. Norris, had vigorously advocated the idea of public power during the 1920s. His defense of the government-owned dam at Muscle Shoals, Alabama, against private interests who hoped to purchase the complex led him to seek a broader federal program of dam construction along the Tennessee River. However, conservative Republican leaders in the House and Senate, as well as two Republican presidents, defeated six of his dam-building proposals before Roosevelt took office in 1933. Norris's efforts kept the dream of public power alive in the South and, in large measure, the TVA was actually his legacy.

Between 1933 and 1945, the TVA, in one of the largest construction efforts ever undertaken by the federal government, constructed 16 dams in the Tennessee River basin. According to Leuchtenburg, it was, in short, a "public corporation with the owners of government but the flexibility of a private corporation" that worked in conjunction with state and local agencies. TVA's benefits were immediately apparent. Millions of Americans found steady employment through the TVA. The dams also generated electricity to the rural South (only two out of every

David Lilienthal

David Eli Lilienthal (1899–1981) was a co-director of the Tennessee Valley Authority from 1933 until 1941, and then its chairman until 1946, and is one of the people most identified with the project.

Lilienthal was born at Morton, Illinois, and was educated at DePauw University at Greencastle, Illinois, and then at Harvard Law School. He then practiced as a lawyer, working on labor law and taking on public utilities. In one celebrated case he took on the telephone authorities in Chicago and managed to gain a refund of $20 million for the subscribers. This brought him to the attention of Philip La Follette, the governor of Wisconsin, who appointed him a member of the Wisconsin Public Service Commission in 1931. It was there that he reorganized the utilities statutes making them so much more efficient that six other states copied his scheme.

Lilienthal's genius had come to the attention of President Franklin Roosevelt and when Congress approved the TVA flood control project in 1933, the president appointed Lilienthal as one of the three directors of the power program; he became sole chairman in 1941. In 1944, he wrote *TVA: Tennessee Valley Authority—Democracy on the March* in which he defended the TVA from criticisms raised by detractors, many of whom were associated with private electric companies.

In 1946, Lilienthal had to resign from the TVA in order to become the first chairman of the Atomic Energy Commission. He assumed power over the U.S. nuclear-development program, which had, up until that point, been supervised by the U.S. Army. He was also involved in expanding nuclear power plants and building up stockpiles of nuclear weapons. He resigned in 1950, and for three years was chairman and chief executive officer of the Development and Research Corporation and was involved in major resource development projects. He died in 1981 in New York.

100 farms had electricity before the TVA) and manufactured fertilizer for the region's farmers. The lakes that it created offered recreational opportunities and a profusion of government-funded parks were built by the Civilian Conservation Corps (CCC) and other agencies along their shores. Conservationist goals, like soil conservation, the removal of depleted agricultural lands, flood control, and forestation, were also major components of the TVA program.

The TVA also pioneered in social experimentation. The altering of water levels at the system's dams, for example, helped to eliminate malaria as a serious health risk in the Tennessee Valley. Previously, about one-third of the region's inhabitants had been affected by malaria. Furthermore, the organization made major contributions to recreational lake management and architectural design.

TVA had its critics. The government's public power program, which infringed on rights of private utility companies, was highly controversial and led some opponents of the agency to label Roosevelt a Communist. Others leveled criticism at the TVA's bureaucracy, which they felt was riddled with fiscal mismanagement and poor planning.

Racial conflict also plagued the TVA. When the TVA compensated farmers for flooding their croplands, they paid landowners, but not sharecroppers and tenants who were forced out of work and off of the land. Hiring inequities and complaints of racial discrimination frequently surfaced within the TVA. Investigations during the mid-1930s by the National Association for the Advancement of Colored People (NAACP) substantiated evidence of racial discrimination and led to a congressional investigation. During the hearings, the TVA maintained that it had to uphold regional racial customs in order to maintain a good relationship with local authorities. Otherwise, the chances for a successful program that would benefit both blacks and whites would be jeopardized. The congressional committee only mildly chastised the TVA for its racial practices.

The conservation goals of the TVA were also compromised. The construction of dams disrupted the flow of freshwater in the Tennessee River valley and thus altered aquatic and riverine ecosystems. Several species of freshwater mollusks, for example, dependent on flowing water, became either endangered or extinct. In addition, thousands of acres of wetland areas were permanently lost under the waters of TVA lakes. The TVA also strip-mined coal fields in order to provide fuel to operate the power plants.

For the duration of the 20th century, the TVA continued to maintain its lakes and produce power. During the 1960s the TVA began producing nuclear power in several of its facilities. Although most of its nuclear plants have been phased out, the TVA has developed an energy plan for the Tennessee valley that will be phased in through 2020. In 1998, TVA announced a new plan for its facilities that would reduce pollutants that deplete ozone and cause smog. According to its own study, the agency will have spent $5.6 billion on clean air modifications to its coal-fired plants by 2010. As of 2005, the TVA operates 29 hydropower plants.

SEE ALSO: Coal; Dams; Electricity; Endangered Species; Floods and Flood Control; Habitat Protection; Hydropower; Justice; Malaria; Nuclear Power; Ozone and Ozone Depletion; Wetlands.

BIBLIOGRAPHY. Roger Biles, *The South and the New Deal* (University of Kentucky Press, 1994); William E. Leuchtenburg, *Franklin D. Roosevelt and the New Deal* (Harper Torchbooks, 1963); Arthur M. Schlesinger, Jr., *The Coming of the New Deal* (Houghton Mifflin Company, 1958); Tennessee Valley Authority, www.tva.gov (cited May 2006).

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Teratogenic Substances

TERATOLOGY IS THE study of the effects of teratogenic substances on the development of embryos, fetuses, or a pregnancy. Teratogenic substances can cause congenital malformations, or they can halt a pregnancy altogether. Clinical and experimental teratologists study how teratogenic agents that actively create birth defects can disrupt the normal development of a fetus or embryo. These include chemicals, drugs, maternal infections, and radiation. Exposure during pregnancy to teratogenic substances causes one or more structural abnormalities in the developing embryo or fetus. The discovery that a particular substance is a teratogen is usually the result of a significant increase in birth defects in an area or in a class of people.

The discovery of Minamata disease in Minamata Bay in postwar Japan is typical of the discovery of a teratogen. Minamata disease is a form of encephalopathy that closely resembles cerebral palsy. Eating fish contaminated with methyl mercury during pregnancy causes Minamata disease. The sudden appearance of over 3,000 cases of what appeared to be cerebral palsy puzzled health care officials. After an investigation it was discovered that Chisso Corporation, a chemical company, was dumping mercury into Minamata Bay where it had entered the food chain, including locally caught fish eaten by pregnant women. In the 1960s there was a surprising increase in the number of cases of phocomelia in Germany and Australia. An investigation identified thalidomide as a human teratogen. "Thalidomide babies" with severe birth defects were born to mothers who had been prescribed the drug thalidomide as a treatment for morning sickness. The exposure to the drug at the critical first trimester stage of development of the embryo produced severe birth defects.

The number of chemicals that are proven or suspected of being teratogens is growing as people are exposed to an increasing number of synthetic chemicals. In addition, attention to the problem has led to an increase in the number of defects identified. The identification of fetal warfarin syndrome, fetal hydantoin syndrome, fetal trimethadione syndrome, fetal alcohol syndrome, and low birth weight due to smoking during pregnancy, are fetal developmental problems that are given full recognition. Maternal infections during pregnancy from rubella or sexually transmitted diseases such as herpes simplex or syphilis can also cause teratogenicity. In addition, diabetes during pregnancy or other maternal health factors can interfere with fetal development.

Over-the-counter and prescription drugs are major sources of teratogenicity. Known teratogenic drugs are ACE inhibitors such as benazepril, captopril, and enalapril; antibiotics such as tetracycline and streptomycin; anti-depressants such as lithium; anticoagulants (blood-thinner) such as warfarin; or anticonvulsants. In addition, illegal drugs such as cocaine and marijuana are teratogenic substances. There are no absolute teratogens. The damaging effects of teratogenic substances are due to size of the dose, the length of exposure, and the stage of fetal development.

SEE ALSO: Drugs; Infant Mortality Rate; Mercury; Minamata; Radioactivity; Sexually Transmitted Diseases.

BIBLIOGRAPHY. J.M. Friedman and Janine E. Polifka, *Teratogenic Effects of Drugs: A Resource for Clinicians (Teris)* (Johns Hopkins University Press, 2000); James L. Schardein, *Chemically Induced Birth Defects* (Marcel Dekker, 2000); Thomas H. Shepard and Ronald J. Lemire, *Catalog of Teratogenic Agents* (Johns Hopkins University Press, 2004).

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Terraces and Raised Fields

TERRACES AND RAISED fields are earthworks created to improve cultivation conditions by manipulating slope, hydrology, soil fertility, erosion, and microclimate. While both require intense labor, they allow agriculture to flourish in potentially inhospitable topography and environments. Terraces carve out sections of hillsides to improve planting surfaces. Raised fields create dry platforms above wetlands.

Farmers around the world have used terraces since ancient times, from the Hanging Gardens of Babylon to Cajete agroecosystems of Mexico. Terraces are used for defense and aesthetics as well as agriculture. They are critical to growing crops in arid and semiarid climates. Dryland terraces in Yemen enhanced soil water retention, taking maximum advantage of local water sources. The Hopi of the American Southwest irrigated terraces to grow maize. Terraces are also used in moist climates. Wet rice production throughout southeast Asia uses terraces to regulate water flow and grow rice on mountainsides.

Check dams and cross-channel terraces are constructed in hillside hollows where water flows during rainy seasons. They control water runoff and prevent soil erosion. Sloping field or broad-base terraces are used on gently rolling hills or valley floor alluvial fans. Each terrace level is constructed around existing contours, and soil surface is not flattened. These terraces control surface water runoff, thus conserving soil moisture and nutrients and reducing soil erosion. In the United States, farmers use mechanized agriculture on broad-base terraces.

Bench terraces provide a horizontal planting surface and are common on steep hillsides. Examples include those found in Machu Picchu, Peru, and the Ifugao terraces in the Philippines. Bench terraces are constructed by cutting out soil and putting in retaining walls made of stone or other materials. Behind the wall, soil and rock are backfilled in to create a new planting surface. To aid drainage, bottom layers of the new soil profile consist of larger rocks, then smaller cobble, and finally soil. By controlling surface water runoff, terraces reduce erosion, nutrient loss, and flooding risk. Bench terraces modify microclimates and enhance sunlight capture. They often are integrated with irrigation channels. Cultivating on slopes avoids nighttime frosts that settle in valley bottoms. While cultivatable area may be smaller than an unterraced plot, agricultural yield increases significantly.

Raised fields are large platforms of soil constructed in areas with seasonal flooding or permanent wetlands. They are found in Mexican wetlands, coastal India, Indonesian tidal wetlands, New Guinea swamps, Venezuelan and Bolivian savannas, and surrounding Lake Titicaca. Raised fields take many forms, ranging from long ridges to mounds, with flat or ridged surfaces, scattered or in rows. Drainage canals often separate platforms.

Raised fields reduce crop failure risk by altering microclimate, soil nutrients, and hydrology. They allow cultivation in areas otherwise inundated with fresh or saline water, control flooding in rainy seasons, and conserve water during dry seasons. Water in drainage canals may be used for aquaculture. Cleaning muck from canals provides nutrients for raised beds. Around Lake Titicaca, where diurnal temperatures vary up to 30 degrees C, raised fields

By controlling surface water runoff, terraces reduce erosion, nutrient loss, and flooding risk.

reduce frost risk. Solar radiation heats canal water during the day. At night, this stored heat dissipates, heating raised bed soils and air.

Maintaining terraces and raised fields requires intensive labor, often in conjunction with social and religious rituals. Despite increases in agricultural productivity, thousands of acres of historic terraces and raised fields are abandoned today. The reasons why are complex, including indigenous population crashes after the Spanish conquest of Latin America, the high capital and labor investment required, low market prices for agricultural products, uncertain land tenure and water rights, shifts in land use and technology, and even climate change. Modern-day projects have reconstructed terraces and raised fields, demonstrating successful agricultural yields but uncertain longevity.

SEE ALSO: Agroecosystems; Farming Systems; Floods and Flood Control; Irrigation; Maize; Microclimates; Rice; Runoff; Soil Erosion; Titicaca, Lake.

BIBLIOGRAPHY. Lloyd E. Eastman, *Family, Fields, and Ancestors: Constancy and Change in China's Social and Economic History, 1550–1949* (Oxford University Press, 1988); S.K. Mickelson et al., "Effects of Soil Incorporation and Setbacks on Herbicide Runoff from a Tile-Outlet Terraced Field," *Journal of Soil and Water Conservation* (March 22, 1998); Arthur Stephen Morris, *Raised Field Technology: The Raised Fields Projects Around Lake Titicaca* (Ashgate Publishing, 2004).

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Thailand

NEVER FORMALLY COLONIZED, Thailand emerged as a modern nation-state in the mid- to late-19th century during the period of European colonial expansion in Southeast Asia. This country's elongated geography is a result of its own imperial expansion out from its central core in the valleys of the Chao Phraya River to the north, south, and northeast. Linguistically, the country is diverse, although Central Thai is the dominant, formally recognized language taught in schools and used in all public affairs.

This linguistic diversity parallels the ethnic and religious diversity in the country, which not only represents a number of Thai speakers (Northern Thai, Northeastern Thai, and Southern Thai), but also a number of minority ethnic groups, euphemistically called "hill tribes" or *chaaw khaaw* in Thai. While Buddhism is the dominant religion, represented in the image of the constitutional monarchy, animistic practices are common, as is Islam, which is dominant in the country's south.

Thailand is located in the tropics and is subject to a yearly monsoon, which brings significant amounts of precipitation through the rainy season from November to May. As a result, the country's main crop is rice. Thailand exports rice to other parts of the world and this crop remains one of its most significant economic sectors behind tourism. The extensive river system, which runs through much of the north and central regions of the country, fuels irrigated wet rice agricultural practices and a dynamic fisheries industry. Thailand is often portrayed as a rural country with extensive agricultural lands based around relatively small villages. Despite this popular image, the country's economy is diverse, including significant manufacturing and service sectors. This economic diversity parallels the growth of both urban and suburban areas, the latter of which includes the conversion of agricultural land into numerous housing subdivisions on the edge of the country's major cities, such as Khon Khaen in the northeast and Chiang Mai in the north.

This expanding economic diversity has had a number of environmental and social consequences. The expansion of the manufacturing and service sectors in cities, such as the capital of Bangkok, has drawn in massive numbers of people (it is estimated that one in six citizens of Thailand live in the capital for at least part of the year). This rapid expansion of the capital has fueled the growth of slums and other areas that are rife with environmental problems linked to the spread of illnesses, such as tuberculosis and cholera. Secondary cities are also witnessing similar patterns of urban growth, with a growing middle class occupying formal housing units in city centers and the poor living in the fringes often in illegal or temporary housing structures. The shifting nature of rural and urban life has also led to a number of social problems, including an expanding commercial sex work industry serving local and tourism communities as well as an increase in undocumented migrant populations from countries such as Burma, Cambodia, and Laos working in the rapidly expanding construction industry.

The Thai government, despite its commitment to its rapidly expanding economy and position as one of the new economic "Tigers" of Asia, has not made similar commitments to environmental regulation. There are numerous reports of environmentally related health problems linked to the pollution emanating from expanding rural and urban factories, as well as problems linked to the pesticides used in the agricultural sector. Thailand has also been a historical site for the export of wood products, and deforestation (and flooding) has been a growing concern that has been mitigated, to a certain degree, with the establishment of a national parks system. Despite this shifting environmentalism, which has been fueled by a growing nongovernmental sector and Buddhist environmental movement, Thais and their government often struggle over the ownership and use of common resource properties, including forest, river, and fishery resources, which have historically been critical to local economies.

SEE ALSO: Industrialization; Monsoon; Rice; Timber Industry; Tourism; Tropical Forests; Urbanization.

BIBLIOGRAPHY. Jim Glassman and Chris Sneddon, "Chiang Mai and Khon Khaen as Growth Poles: Regional Industrial Development in Thailand and its Implications for Urban Sustainability," *Annals of the Academy of Political and Social Science* (v.590/1, 2003); Clemens M. Grünbühel et al., "Socioeconomic Metabolism and Colonization of Natural Processes in SangSaeng Village: Material and Energy Flows, Land Use, and Cultural Change in Northeast Thailand," *Human Ecology* (v.31/1, 2003); Philip Hirsch, ed., *Seeing Forest for Trees: Environment and Environmentalism in Thailand* (Silkworm Books, 1997); Mary Beth Mills, *Thai Women in the Global Labor Force: Consuming Desires, Contested Selves* (Rutgers University Press, 1999).

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Thar Desert

LOCATED IN SOUTH Asia, the Thar Desert straddles the international border between western India and southeastern Pakistan covering an area of approximately 92,162 square miles (238,700 square kilometers). On the Indian side, most of this hot desert lies in the state of Rajasthan, but some parts extend into the states of Gujarat, Haryana, and

Punjab as well. In Pakistan, it is part of the Sindh and Punjab provinces. It is bounded by the Sutlej River in the northwest, the Aravalli mountains in the east, the Indus River in the west, and the Rann of Kutch (a salt marsh) in the south. Average annual rainfall in the Thar ranges between 6 to 31 cubic inches (100–500 millimeters) from the west eastward. It is an inhospitable desert with almost 10 percent consisting of shifting sand dunes and the other 90 percent of rocky outcrops, compacted salt-lake bottoms, and interdunal and fixed dune areas. Temperatures fluctuate from highs near 50 degrees C in May and June to as low as 5 degrees C in January.

With about 700 species of flora, of which 107 are grasses, the Thar is rich in biodiversity. However, there are few indigenous species of trees and strong winds facilitate desertification, which threatens the region's predominantly agricultural economy. According to the Central Arid Zone Research Institute in Jodhpur, India, wind erosion in the Thar can be checked through sand dune stabilization and shelterbelt plantation. Dune stabilization programs have involved plantation of naturally growing shrubs with extensive root networks such as Phog (*Calligonum polygonoides*), but have more commonly included a range of exotic species of eucalyptus, acacia, and cassia species, a few of which have proven to be pernicious invasives, causing unanticipated effects from well-meaning policy. Erecting shelterbelts around crop fields protects young seedlings from sand blasts and hot desiccating winds and reduces the loss of moisture from the fields.

The Thar's fauna includes threatened species like the blackbuck (*Antilope cervicapra*) and the great Indian bustard (*Ardeotis nigriceps*), as well as other species such as chinkara (*Gazelle bennettii*), caracal (*Felix caracal*), and the desert fox (*Vulpes bengalensis*). Recently, land use changes and agricultural intensification have brought problems to the region. As pasture has declined under the plow, livestock herds of the region have lost much of their traditional grazing land, leading to increased migration and some overgrazing. In India, almost 60 percent of the Thar is farmland and 30 percent is open pastureland. Intense grazing of livestock has altered the ecosystem by affecting soil fertility and destroying native vegetation.

The region relies on the Indira Gandhi Canal Project for irrigation and drinking water supply, but also increasingly upon direct tapping of groundwater through deep tubewells. As a result, groundwater levels are falling precipitously in some areas. Frequent droughts have also prompted the locals to devise ingenious water harvesting techniques such as *kunds* (covered underground tanks)—a traditional response to the scarcity of potable water exacerbated by the high salinity of groundwater, especially in western Rajasthan.

With a population density of about 263 persons per square kilometer for the entire Thar region, it is one of the most densely populated deserts. Multiple ethnic and religious groups make it culturally rich, with a variety of music, poetry, and architectural styles. It is home to Hindus, Muslims, Jains, and Sikhs on the Indian side while in Pakistan, Sindhis and Kohlis (both Hindus and Muslims) are the main ethnic groups.

Pokhran, in Rajasthan, has also served as the test site for India's nuclear programs. Underground testing of nuclear weapons was carried out in Pokhran in 1974 and 1998.

SEE ALSO: Biodiversity; Desert; Desertification; India; Overgrazing; Pakistan; Soil Erosion.

BIBLIOGRAPHY. Anil Agarwal and Sunita Narain, eds., *Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting Systems* (Center for Science and Environment, 2003); Robyn Davidson, *Desert Places* (Viking, 1996); H.S. Mathur, *Arid Lands, People, and Resources* (RBSA Publishers, 1994); R.C. Sharma, *Thar, the Great Indian Desert* (Lustre Press, 1998).

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Thatcher, Margaret (1925–)

MARGARET THATCHER WAS born in Grantham Lincolnshire, England, to a working-class family. She was elected as Member of Parliament for Finchley, London, in 1959 and held the posts of British Secretary of State for Education and Science, in the Ted

Heath government (1970–74); Leader of the United Kingdom (UK) Conservative Party (1975–90); Leader of the Government's Opposition (1975–79) and British Prime Minister (1979–90). She was the winner of three successive general elections in 1979, 1983, 1987 and is the longest-serving Prime Minister since Lord Liverpool. She is significant to British history because her policies represented a radical shift from the consensus politics that had characterized the previous postwar British political era.

Margaret Thatcher was a figurehead of a "new right" political philosophy and doctrine that became known as Thatcherism. Built on a belief in the free market and the private sector, this involved a range of actions including: Reductions in public/state spending, lower direct taxation, a tight monetarist policy, a program of privatization of government-owned industries, local and national deregulation of markets, and the curtailing of union powers and other perceived restrictions on the economy.

Thatcher's policies and style polarized public opinion of her, often along class lines. Her policies perpetuated the income gap between rich and poor, which were reflected geographically in a north/south divide. She resigned as Prime Minister in 1990 following an unconvincing victory in the first round ballot of a party leadership contest. In 1992, she was awarded the title Baroness Thatcher and became a member of The House of Lords. She was heavily engaged in public speaking, an activity that she was forced to curtail in 2002 due to ill health. Her legacy is that the new right has effectively become the current political center ground.

In terms of environmental policy, Thatcherism follows the broad outlines of free market environmentalism, which favors volunteerism, green consumption, and the trading of externalities over any form of regulation or imposition of systems or standards. As such, Thatcher was a reliable opponent of most forms of environmental regulation, which she viewed as extensions of socialist and left-leaning "big government" legacies.

Thatcher was throughout her career an opponent of multilateral and global governance systems, moreover, including in the realm of environmental issues. In her book *Statecraft*, she went so far as to say that global warming "provides a marvelous excuse for worldwide, supra-national socialism." While she was an early leader in raising and discussing the problem of global warming and the ultimate necessity of dealing with it, to the degree that such environmental issues might be addressed, Thatcher remained skeptical of international regulation and treaties or anything that might hinder economic development. The legacy of her approach to the environment in the UK remains somewhat unclear in the era of the Kyoto Protocol, to which the UK is a signatory, though there has yet to be a legislative framework to promote greenhouse gas reductions.

SEE ALSO: Kyoto Protocol; Markets; Trade, Free.

BIBLIOGRAPHY. M. Thatcher, *Statecraft* (Harper Collins, 2000); M. Thatcher, *The Downing Street Years* (Harper Collins, 2003).

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Thermodynamics

THE FIRST CRUDE thermometer was invented in the 1600s by Galileo. Accurate thermometers arrived some 200 years later. It wasn't until this time, in the mid-1800s, that the concept of energy was widely accepted. It is now clear that temperature is a measurable indicator of energy. In the last 150 years since the discovery of energy, fundamental laws governing the transport, conversion, and storage of energy have been developed. These laws are the basis for the science we call thermodynamics.

THE FIRST LAW OF THERMODYNAMICS

Simply stated, the first law of thermodynamics says that energy cannot be created nor destroyed. However, energy can be transformed and transferred. The main ways in which energy is manipulated are heat and work. It must be understood that heat and work are not properties of matter, but rather they are the routes by which energy is moved or converted.

When energy moves from areas of higher temperatures to areas of lower temperatures this is called heat transfer. If you touch a hot stove, large amounts of energy are transferred from the hot stove to your colder hand. Alternatively, if you make a snowball with your bare hands, energy moves from your warmer hands to the colder snow. The flow of energy in each of these situations is in the form of heat.

Work, as defined in physics, is force applied over a distance. In thermodynamics, work is a means of transferring and storing energy. If you pull a wagon up a hill, you are doing work, using your energy to move something over a distance. You have also stored some of your energy in the wagon. To see that energy, push the wagon off the top of the hill and it will race to the bottom, using the energy you gave it through work.

The first law says that no matter how energy is transferred, transformed, or stored through heat or work, the same total amount of energy is always present. For this reason, energy is said to be conserved. In other words, whenever energy decreases in one place, it must increase by an equal amount somewhere else.

THE SECOND LAW OF THERMODYNAMICS

The second law has been defined in many ways over the years. Heat cannot flow from areas of lower temperature to those of higher temperature. Creating order in one system must create equal or greater disorder in the surroundings. Perpetual motion machines are an impossibility. No process can convert heat completely to work. These are all valid statements of the second law.

The second law is concerned with the relationship between heat and work. Work can be completely converted into heat with no losses. For example, if you rub your hands together on a cold day, all the work you do is converted to heat. However, all of the energy in heat cannot be converted to work. Some of the heat will always be dissipated to the surroundings. In industry, hot steam is often used to drive work-producing turbines. This is a way of converting heat to work. However, some of the heat energy will be dissipated to the surroundings and not converted to work. The disparity between heat and work is filled by the concept of entropy.

Entropy is classically defined as disorder or randomness. It is also said that entropy tends to increase with time in natural environments. For example, pretend you have a large box with 100 rabbits in it. Fifty of the rabbits have black fur, and the other 50 have white fur. You put all of the rabbits with white fur on the far right hand side of the box, and all of the rabbits with black fur on the far left hand side.

At this point, the box of rabbits is very ordered and has very little randomness, hence low entropy. If you then leave and come back one minute later, it is likely that most of the white rabbits will still be on the right and most of the black on the left, with only a few of them mixing in the middle. So after one minute, there is a little more disorder in the box, therefore the entropy has increased slightly. If you then leave the box and come back several hours later, it is likely that the rabbits will be thoroughly mixed with black and white rabbits in all parts of the box. The box of rabbits now has a large degree of disorder and randomness, meaning very high entropy. To return to the original situation with all of the white rabbits on one side and all of the black rabbits on the other, you will have to do a significant amount of work to move and separate the rabbits.

Thermodynamic entropy works in a similar way. When heat is used to create work, some of the heat is "lost." This lost heat contributes to the entropy of the system. In other words, the extra heat makes the system more disordered and random. If you want to restore the original order to the system, you will have to add more work, similar to the rabbits in the box.

THE THIRD LAW OF THERMODYNAMICS

The third law also deals with entropy. It states that a system with a temperature of absolute zero (–273 degrees C or –459 degrees F or 0 degrees K) will have no entropy. Going back to our rabbit example, if the temperature in the box of rabbits is lowered, the rabbits will move around more slowly and the entropy of the box will increase much more slowly. However, if the temperature is made so low that the rabbits freeze in place, the entropy of the system will be at a minimum because the rabbits cannot mix, cannot increase their disorder.

It is the same with energy systems. As the temperature approaches absolute zero, the system becomes more and more sluggish, preventing any disorder from developing. The third law says that entropy will approach a limit of zero as the temperature approaches zero. These laws of thermodynamics are enough for a detailed energy analysis in most situations. Additional laws that deal with self-organizing and nonequilibrium systems may also exist.

USES OF THERMODYNAMICS

The practical uses of thermodynamics are limitless. Because energy is all around us, the laws of thermodynamics can be applied to almost anything. The practical application on which thermodynamics was founded is the engine. Studying and improving the engine were the real motivations for studying thermodynamics and developing the laws we have today. Throughout the last century, the engine has been the primary device for converting heat to work. Through thermodynamics, we have made engines more efficient and found ways that we can use engines to make our lives easier. Thermodynamics is also essential for understanding and designing air conditioning and heating systems. Understanding the flow of energy is pivotal to technology like refrigeration.

The transfer of energy in the body also follows the laws of thermodynamics. For this reason, thermodynamics is important for the medical field as well. Medical researchers use thermodynamics to develop medical equipment used for diagnosis and treatment of patients. Thermodynamics is also at the root of drug delivery systems, which govern how the medicine you take gets to the part of the body where it is needed.

SEE ALSO: Energy; Internal Combustion Engine.

BIBLIOGRAPHY. Roger Kinsky, *Heat Engineering: An Introduction to Thermodynamics* (McGraw-Hill Education, 1989); Anastasios Tsonis, *An Introduction to Atmospheric Thermodynamics* (Cambridge University Press, 2007).

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Think Tanks

THINK TANKS ARE nonprofit, research-oriented institutes whose primary objective is to influence public opinion and public policy. Think tanks have the objective of providing research and innovative policy solutions to legislators, the judiciary, and the public. Some scholars suggest that think tanks exist merely for the type of large-scale lobbying that aims to create a climate of opinion favorable to particular private interests. The term *think tank* was first used in the United States during World War II to refer to a secure room where defense scientists and army planners could meet to discuss war strategy, but the meaning has expanded to include any advice-giving institution, including public relations and marketing organizations.

Scholars who have studied the growth and development of American think tanks agree that the highly decentralized nature of the American political system, the lack of strict party discipline, and the large infusion of funds from philanthropic foundations have contributed to the expansion of think tanks in the United States. The first generation of think tanks includes the Carnegie Endowment for International Peace (1910), the Hoover Institution on War, Revolution and Peace (1919), and the Council on Foreign Relations (1921).

The second generation includes the Institute for Government Research (1916), renamed after a merger with other institutes into the Brookings Institution (1927), and the American Enterprise Institute for Public Policy Research (1943), a highly respected conservative think tank. This group was the first to focus on a foreign policy issues. After World War II, the RAND Corporation was created (1948) to promote and protect U.S. security interests during the nuclear age.

The third generation of think tanks were the "advocacy think tanks" such as the Center for Strategic and International Studies (1962), the Heritage Foundation (1973), and the CATO Institute (1977) that appeared in the 1970s. These think tanks combine policy research with marketing techniques.

Think tanks of the fourth and most recent generation, the Carter Center in Atlanta and the Washington, D.C.–based Nixon Center for Peace and Freedom, were created by former presidents with the objective of leaving a lasting legacy on foreign and domestic policy. Scholars note that the influence of think tanks has shifted to the right since the 1970s. Of the 10 think tanks most often cited in the media, six are conservative or right-leaning, three are centrist, and one is left-leaning. More than half of all media citations of think tanks referred to conservative or right-leaning institutions, such as the Heritage Foundation, which states that its objective is to "formulate and promote conservative public policies based on the principles of free enterprise, limited government, individual freedom, traditional American values, and a strong national defense." Only 13 percent of media citations referred to progressive or left-leaning institutions.

Strategies employed by think-tanks to transmit their views to policymakers and the public include organizing public conferences, seminars, and public lectures; testifying before legislative committees; writing opinion pieces in the print media and giving expert comment on electronic media; and creating content on the internet.

Today, there are over 3,500 think tanks worldwide, half of which are in the United States, where they are distinguished from their counterparts in other countries by their ability to participate directly and indirectly in policymaking. Think tanks in Canada, Australia, Europe, Asia, the Middle East, and Africa have developed around the idea of promoting independent and objective research on relevant policy issues.

In Europe, think tanks are perceived as independent nonprofit associations, open and accountable providers of analysis and information to assist policymakers in research and evaluation. The European Policy Institutes Network (EPIN) is a network of dynamic think tanks and policy institutes that focus on current European Union (EU) and European political and policy debates. With 25 member think tanks in 21 countries, EPIN includes almost all the EU member states and accession and candidate countries. Think tanks in Brussels use regular conferences and seminars as platforms to network and discuss policy opinions with other EU actors, thus allowing participants from the private sector, media, academia, and civil society to meet EU institutional representatives in a neutral environment.

Transnational think tanks founded by philanthropic foundations, corporations, and international organizations such as the World Bank have become a global phenomenon. A new trend is collaboration between think tanks across continents, such as the World Economic Forum's Council of 100 Leaders on West–Islam relations.

The first think tank devoted exclusively to natural resource and environmental issues was Resources for the Future (RFF), a nonprofit and nonpartisan organization founded in 1952 to conduct independent research—primarily in economics and other social sciences—on environmental, energy, and natural resource issues. RFF has pioneered the application of economics as a tool to develop more effective policy for the use and conservation of natural resources by analyzing critical issues concerning pollution control, energy policy, land and water use, hazardous waste, climate change, biodiversity and the environmental challenges of developing countries.

Scholars note that conservative, corporate-funded think tanks contribute to confusion about the scientific basis of environmental problems such as global warming, species depletion, acid rain, and ozone depletion. Conservative think tanks oppose environmental regulations and promote free-market remedies for those problems. On the other hand, liberal think tanks have promoted the work of environmental economists, and many of the leading scholars in this area are associated with think tanks, including Robert Hahn, a resident scholar of the American Enterprise Institute; Terry Anderson, who has written for several think tanks in Australia and the United States; Robert Stavins and Bradley Whitehead, authors of a Progressive Policy Institute study; Alan Moran from the Tasman Institute, an Australian think tank; and Walter Block from the Fraser Institute, a Canadian think tank.

SEE ALSO: Expertise; Lobbyists; Policy, Environmental.

BIBLIOGRAPHY. Donald E. Abelson, *Do Think Tanks Matter? Assessing the Impact of Public Policy Institutes* (McGill-Queen's University Press, 2002); Sharon Beder, "Examining the Role of Think Tanks," *Engineers Australia* (November, 1999); Elizabeth T. Boris and C. Eugene Steuerle, eds., *Non-profits and Government: Collaboration and Conflict* (Urban Institute Press, 1998);

Michael Dolny, "New Survey of Think Tanks," *Extra* (July/August 1997), www.fair.org (cited May 2006); Diane Stone and Andrew Denham, eds., *Think Tank Traditions: Policy Research and the Politics of Ideas* (Manchester University Press, 2004).

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Thoreau, Henry David (1817–62)

BORN DAVID HENRY Thoreau, the naturalist, essayist, poet, and philosopher familiarly known as Henry David spent most of his life and dedicated much of his writing (published and private) to his native Concord, Massachusetts. Whatever the order of his given name (which he reordered shortly after his 1837 Harvard graduation), posterity simply refers to the celebrated sage of Walden Pond as "Thoreau," a surname often connoting things mystical and mythical to subsequent generations of Americans.

Indeed, the life and writings of Henry David Thoreau are continual sources of inspiration, specifically for environmentalists—in the United States in particular, and throughout the world more generally. Why this is so is quite simple. Thoreau was a highly sensitive observer of nature; he was deeply interested and forever curious about his natural surroundings; and he was greatly concerned for the present and future condition of his environs—local, regional, and national.

Those qualities, the latter especially, most endear Thoreau to present-day environmentalists. By the last decade of his life he had achieved a heightened awareness of nature shared by few of his generation: During the late 1850s, Thoreau entered the (then) rarefied realm of preservationism, an obscure place left to his successors to clarify and make better known.

Thoreau's recognition of nature's rights, however, was evolutionary—that (biocentric) viewpoint emerged over time and transformed him in the process. Similar to his predecessors and contemporaries (European Romantics and Romantically-inspired American Transcendentalists), Thoreau originally engaged the natural world aesthetically.

Yet, while poeticizing nature, a veritable Transcendentalist odyssey of discovering the "self" and the "divine" in the natural environment, he developed a profound respect for it. To be sure, Thoreau revered nature from the outset of what would be a lifetime of environmental sojourning. That reverence, however, ceased to serve his spiritual and philosophical needs only. Although nature remained a sacred space suffused with revelatory power, just as Thoreau's former mentor Ralph Waldo Emerson counseled, by the 1850s, Thoreau surpassed—without abandoning—purely anthropocentric concerns. His intimate wilderness relationship, eagerly sought and passionately cultivated, bore unexpected fruit: The acknowledgment that nature, like humanity, possessed inherent rights as well. That insight received forceful expression in 1857 when Thoreau vented his disgust at the destruction of something as seemingly insignificant as a favorite patch of bushes: "[I]f some are prosecuted for abusing children, others deserve to be prosecuted for maltreating the face of nature committed to their care."

Such a statement reveals that Thoreau was exceptionally attuned to his immediate environment (and by implication the natural environment more generally). Yet, Thoreau's environmental ethic was not only ahead of its time, but against it as well. Confronting a rapidly modernizing New England in which textile factories and railroads encroached upon pristine nature, and facing increasingly materialistic New Englanders who viewed nature as commercially exploitable, Thoreau leveled his discontent by retreating into what he called "the Wild."

From the moment that Thoreau commenced his now-legendary (26-month) experiment on the outskirts of Concord at Walden Pond on July 4, 1845 (a one-person utopia immortalized in print in 1854 as *Walden, or Life in the Woods*), his literary career and private life received inspiration and meaning in the nonhuman, the world of nature from which Thoreau criticized contemporaries for their careless and abusive treatment of it. And although Thoreau sought solace in the natural environment, his was not a permanent escape from society. True, as his writings emphatically indicate—in addition to *Walden* consult, for example, the essay "Walking" (1850–62), the posthumously published *Maine Woods* (1864) and the voluminous private journals spanning his adult life—Thoreau expressed, directly and indirectly, his alienation from society. Among his primary artistic objectives, however, was his desire to reform American values concerning nature, not simply for humanity's own benefit (an initial concern), but for the welfare of the environment as well (a later concern).

SEE ALSO: Nature Writing; Preservation; Trancendentalism.

BIBLIOGRAPHY. Lawrence Buell, ed., *The American Transcendentalists: Essential Writings* (Modern Library, 2006); Robert L. Dorman, *A Word for Nature: Four Pioneering Environmental Advocates, 1845–1913* (The University of North Carolina Press, 1998); Richard J. Schneider, ed., *Thoreau's Sense of Place: Essays in American Environmental Writing* (University of Iowa Press, 2000).

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Three Gorges Dam

WHEN CONSTRUCTION IS completed in 2009, the Three Gorges Dam will be the largest hydroelectric dam in the world. Spanning Asia's longest river, the Yangtze, at Sandouping, Yichang, Hubei Province, the Three Gorges Dam will be 1.45 miles wide, 607 feet in height, and have 26 generating units with a combined capacity of 18.2 million kilowatts, producing 84.7 billion kilowatt-hours of electricity per year. When the reservoir created by the dam is filled, its waters will rise to be 574 feet deep and stretch for some 360 miles, flooding thousands of villages over 243 square miles of land, and displacing roughly 1.2 million peasants. A system of ship locks are intended to bring ocean liners from Shanghai 1,500 miles inland to the city of Chongqing, which was promoted to a provincial-level municipality under direct central control in 1997 in part to coordinate the resettlement of refugees from the dam. Official cost estimates for the project are roughly U.S. $25 billion.

Construction of the Three Gorges Dam was first proposed in 1919 by the father of modern China, Sun Yatsen. Serious planning began in the 1930s, and toward the end of World War II, the U.S. Bureau of Reclamation's chief design engineer conducted a major study. It was hoped that the dam would provide both electricity and relief from the long history of devastating summer floods along the Yangtze. After the founding of the People's Republic of China, Mao Zedong pushed for the building of the monumental dam as a symbol of national pride and human mastery over nature. A sharp debate emerged in the mid-1950s, however, between leaders who opposed the project on technical grounds and favored a series of smaller dams instead, and those who favored the project. Soon after, the economic depression of the Great Leap Forward and political upheavals of the Cultural Revolution put the plans on hold. Debates were revived after the death of Mao and the beginning of economic reform. Momentum picked up as Deng Xiaoping became an enthusiastic supporter of the dam, though there continued to be bitter disagreement on whether, when, and at what height the dam should be built, as well as how the surrounding area should be administered.

In 1986 a study commissioned by the government and funded by the Canadian International Development Agency concluded that the dam was feasible. This moved the project closer to implementation but also sparked a vocal debate within China, coinciding with China's democracy movement and growing international opposition to large dams. The State Council agreed in 1989 to suspend construction plans for five years, but this changed after the crackdown on Tiananmen Square, which led to the arrest of journalist Dai Qing and other critics, and silenced opposition to the dam. With a strong push from Premier Li Peng, the State Council and Politburo approved the project in 1992. Three months later, the National People's Congress (NPC) approved the project with a vote of 1,767 yes, 177 no, and 664 abstentions. This was an unprecedented level of dissent for the NPC, which generally rubber stamps leaders' proposals. Construction has proceeded in three stages over 17 years. From

1993–97, the river was diverted; at the end of the second phase, 1998–2003, the first group of generators began to produce power, and a permanent ship lock opened for navigation; and in 2004–09, the entire project is to be completed. Corruption scandals and poor construction have plagued the project. In 1999 a bridge collapsed and a crack developed in the dam; in 2000, officials were arrested for extortion, kickbacks, and embezzling resettlement program money.

The major rationales for the dam are flood control, navigation improvement, and clean power generation to substitute for coal burning. By 2009, it should provide 10 percent of China's total power supply, but most of the electricity will be sent to the prosperous coastal region rather than used in the area around the dam. Power was in short supply when the dam first generated electricity in 2003, but in 2006, the Three Gorges Power Company was concerned about a power glut and how it should offload its supply. Nevertheless, the company was also already planning to build four more dams upstream in the Yangtze's longest tributary. The power generated by the Three Gorges Dam is eventually to pay for about 7.5 percent of its total cost. The rest has been financed by the China Development Bank, export credits, corporate bonds, and some taxes; the World Bank declined funding because of environmental concerns.

The gargantuan reservoir created by the dam threatens the habitat of many rare and endangered species including 36 endemic plants, the now-endangered Chinese sturgeon, and the Yangtze River dolphin. Though fish ladders were built, they have not been very successful. The dam also holds back sediment, which formerly carried nutrients downstream, and lowers water temperature; this further affects habitat for fisheries. Decomposing organic material in the reservoir will produce significant methane emissions. More importantly, the reservoir may alter the local climate, and worsen problems with schistosomiasis, a parasitic, snail-borne disease. Current patterns of dumping untreated garbage, sewage, industrial chemicals, and heavy metals into the river could lead to a public health disaster and affect normal dam operations if unchecked, because the reservoir will concentrate the pollution rather than flushing it out to sea. The government has laid plans to build numerous pollution control and treatment facilities, but critics remain skeptical of effective implementation.

The role of sedimentation is also disputed. While the reservoir is supposed to lessen the frequency of large downstream floods, and sluice gates are in place to flush out silt, critics warn that the technology is unproven. If ineffective, the build-up of sediment behind the dam could shorten the life-span of the dam, cause the reservoir to lose flood storage capacity, accelerate coastal erosion, and cause dam failure. Officials, however, claim that the technical issues have been resolved, that upstream erosion is being reduced through massive afforestation, and that after 100 years, the dam should still have 92 percent of its effective storage capacity.

Critics also warn that the dam is built on a fault and that water held by the dam could trigger landslides or an earthquake, but the government emphasizes the geological suitability of the chosen site, and claims that the dam could withstand even a class seven earthquake and a nuclear attack. Also of concern is the fact that the reservoir will flood thousands of graves and more than 1,000 recognized cultural and archeological relics.

Finally, the reservoir will inundate very fertile farmland and has necessitated the involuntary resettlement of some 1.2 million people, who have been moved either to higher land, to live with relatives in nearby urban areas, or to more distant provinces. Although government officials state that the involuntary migrants are "satisfied with their new lives, enjoying better living conditions," independent surveys have found a majority saying they are worse off. Among other problems they face in their new homes are inadequate or missing compensation, discrimination, and reduced standards of living because of the poorer quality of the land they received, and difficulty finding jobs.

SEE ALSO: China; Dams; Fish Ladders; Floods and Flood Control; Hydropower; Narmada Dam.

BIBLIOGRAPHY. Deirdre Chetham, *Before the Deluge: the Vanishing World of the Upper Yangtze River* (Palgrave, 2002); Li Heming, Paul Waley, and Phil Rees, "Reservoir Resettlement in China: Past Experience and the Three Gorges Dam," *The Geographical*

Journal (v.167, 2001); Kenneth Lieberthal and Michael Oksenberg, *Policy Making in China: Leaders Structures and Processes* (Princeton University Press, 1988); Dai Qing, *Yangtze! Yangtze!: Debate over the Three Gorges Project* (Earthscan Publications, 1994); Dai Qing, *The River Dragon Has Come: The Three Gorges Dam and the Fate of China's Yangtze River and Its People* (Armonk, 1998).

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Three Mile Island Accident

THE THREE MILE Island (TMI) plant, located on the Susquehanna River, about 10 miles from Harrisburg, Pennsylvania, was the site of what the Nuclear Regulatory Commission (NRC) calls the most serious nuclear accident in American history. Metropolitan Edison then owned the TMI facility, consisting of two reactors. The accident began at about 4:00 A.M. on March 28, 1979, in the non-nuclear section of the power plant, when the pumps that feed water to the system to create steam (which propelled the power turbines) failed. Because these pipes carry away part of the heat from the reactor, the cooling system would be required to carry the extra load. The water and steam pressure increased in the cooling system, which caused a relief valve to open. The valve was supposed to close when pressure reached a safe level, but it did not, and, unknown to controllers, pressure and water in the cooling system was lost, thereby leading to a partial meltdown of the reactor core. The NRC summarizes the situation:

> As coolant flowed from the core through the [cooling water] pressurizer, the instruments available to reactor operators provided confusing information. There was no instrument that showed the level of coolant in the core. Instead, the operators judged the level of water in the core by the level in the pressurizer, and since it was high, they assumed that the core was properly covered with coolant. In addition, there was no clear signal that the pilot-operated relief valve was open. As a result, as alarms rang and warning lights flashed, the operators did not realize that the plant was experiencing a loss-of-coolant accident. They took a series of actions that made conditions worse by simply reducing the flow of coolant through the core.

This sequence of events describes what Charles Perrow calls a "normal accident" that results when redundant safety systems interact with human actors to result in unpredictable system accidents. By mid-day, the NRC, Environmental Protection Agency, and Department of Energy inspectors and scientists were at the scene. The utility's and the agencies' efforts appeared to be successful, but, on March 30, there was a small release of radiation due to attempts to release pressure on the coolant system. The radiation had come from an auxiliary building, not the containment, but the radiation was sufficiently worrisome to induce the governor of Pennsylvania to urge an evacuation of school-aged children and pregnant women within five miles of the reactor.

Another concern soon arose when it became evident that a bubble of hydrogen gas had appeared at the top of the containment structure; the highly flammable gas could explode and cause a small breach of the containment, thereby releasing dangerous radiation. By April 1, engineers and scientists had determined that the lack of oxygen in the containment would minimize the chance of an explosion, and, in any case, the size of the bubble had diminished.

What remained for the utility and the regulators was to secure the reactor, assess the damage, and figure out what went wrong. The accident was sufficiently serious that President Jimmy Carter created a commission, popularly known as the Kemeny Commission after its chair, to investigate what happened. The basic conclusion they reached is that the accident was partially caused by mechanical failure, but that failure was greatly compounded by human error. The commission noted that the control room technicians were poorly trained, that they failed to properly interpret the information their instruments provided, and that they did not suspect a loss of coolant accident (LOCA) until quite late in the day. It was not until late in the chain of events that the operators realized that the core was not covered by cooling water, and that a partial meltdown had taken place. The LOCA was ultimately discovered, and by 3:30, the immediate crisis had passed.

In October 1979, the NRC fined the utility $155,000 (about $440,000 in 2005 dollars), a rather small amount considering the seriousness of the accident. In 1982 during a remotely controlled television inspection of the TMI-2 reactor, engineers found that the damage to the core was much greater than anyone had expected. Since the late 1980s, the TMI-2 has been in "monitored storage." Between 1979 and 1985, TMI unit 1 was shut down, but in 1985, the NRC granted permission to restart that unit. Many people believe that the TMI accident was the event that stopped nuclear power from becoming a more important source of energy in the United States. Under this logic, nuclear power had a bright future until TMI proved that nuclear power was too dangerous to be relied upon as an energy source.

There are other reasons for the decline in nuclear power plant construction in the United States. The first of these reasons is the reordering of the politics of nuclear power. By the early 1970s, the system of promoting and regulating nuclear power policy was beginning to break down. Congress's Joint Committee on Atomic Energy (JCAE) was seen as too closed and too powerful. Members of Congress pressed to break up the JCAE's responsibilities and ultimately distributed its responsibilities among several committees. The Atomic Energy Commission (AEC) was broken up, and its regulatory role was transferred to the new Nuclear Regulatory Commission in 1976, and its research and promotion function was transferred to the Department of Energy in 1979. Second, there was the increasing cost involved in building and getting nuclear power plants approved. This was a function of more aggressive regulation by the NRC even before the TMI accident, and of the lack of one or two industry-standard designs. Unique power plants often underwent costly design changes as knowledge of nuclear technology changed.

The third reason was the increasing strength and visibility of the antinuclear power movement in the United States and in Europe. The existence of an active and well-informed antinuclear movement was made clear in the aftermath of a 1975 accident at the Tennessee Valley Authority's (TVA) Browns Ferry, Alabama, nuclear plant, in which an accidental fire cut off communications between the reactor and the control room. This incident motivated the Union of Concerned Scientists (UCS) to argue that government estimates of the safety of nuclear power plants had been inaccurate. As a result, by 1979, the NRC had fully repudiated an earlier AEC report on the very low likelihood of an accident.

In a seemingly prescient coincidence, a Hollywood movie, *The China Syndrome*, about a potential LOCA, was released a mere 12 days before the TMI accident. The combination of the TMI accident, interest group opposition to nuclear power, and the dramatic power of the movie helped turn public opinion against nuclear power. After TMI, the rate of reactor licensing slowed considerably, peaking at 112 units in 1990 and declining to 104 units in 2006, although actual power output has been level since 1990 at abut 99,000 million kilowatts. No new nuclear plants have been ordered in the United States since the late 1970s, and while TMI did not trigger this downturn, it most likely accelerated it. Even today, with calls for alternative, less-polluting power generation, no new nuclear plants are on the horizon, in large part because of TMI.

SEE ALSO: Electrical Utilities; Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); Nuclear Weapons; Tennessee Valley Authority (TVA).

BIBLIOGRAPHY. F. Baumgartner and B.D. Jones, *Agendas and Instability in American Politics* (University of Chicago Press, 1993); T.A. Birkland, *After Disaster* (Georgetown University Press, 1987); D.J. Chasan, *The Fall of the House of WPPSS* (Sasquatch Publishing, 1985); D. Nelkin, "Some Social and Political Dimensions of Nuclear Power: Examples from Three Mile Island," *American Political Science Review* (v.75/1, 1981); C. Perrow, *Normal Accidents: Living with High-Risk Technologies* (Princeton University Press, 1999); *Report of the President's Commission on the Accident at Three Mile Island* (Kemeny Commission, 1989); L. Stephenson and G.R. Zachar, eds., *Accidents Will Happen: The Case Against Nuclear Power* (Perennial Library/Harper and Row, 1979).

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Throughput

THROUGHPUT IS A term used in a number of fields. In industry, it denotes the amount of raw material that a processing plant handles in a set amount of time. In the computer world, it is the amount of work a computer system or a component does in a specified amount of time. In the pharmaceutical industry, it signifies chemical screening technology used to manufacture drugs.

Throughput, when denoting a processing plant, can refer to any kind of processing plant such as an oil refinery that can handle a given number of barrels of oil per day. It may be a gas pipeline or an oil pipeline. Or throughput may refer to the loading facilities in a port and depot or some other point of debarkation or embarkation.

In the case of a gas pipeline the volume of natural gas that can be pumped through it in a given period of time such as a 24-hour day is very important information to planners. As long as demand for natural gas is steady the throughput will be a supply that is sufficient to meet demand. However, if a severe and prolonged period of freezing weather occurs it may well be that the carrying capacity of the pipeline is inadequate. It means that the volume of gas that can be delivered will not meet demand. If this should occur then the natural gas available for heating, for industrial use, or for other purposes may not be sufficient. As a result, people may freeze to death, or contract serious illnesses, or suffer injuries due to frostbite or other effects from the loss of heat. Planners are dependent upon accurate statements of the throughput of many resources.

Computer technology uses the term *throughput* to measure the effectiveness of large computers that run a number of different programs at the same time. Early in the history of computers their power was assessed by the number of jobs they could handle when bundled into batches of different jobs for a single day. Later computer operations used the term to measure the productivity of a computer in terms of its performance. The performance was the time it took from input to output. The time was reported as the computer's response time. The term has since come to mean the speed at which data is transferred between receptors. Since there are a number of factors that can interfere with data transfers it is a measure of its final communication time.

The notion of throughput is now being using in the pharmaceutical industry. Advances in several sciences have led to the development of many new drugs. The human genome project has greatly increased knowledge of human genes. Because there are thousands of proteins in human DNA, the knowledge is now available for seeking new receptors for drug testing as possible medicines. Since all drugs are chemicals that have an effect on some target such as an organ, a bacterium, a nerve cell, or even a plant cell, the development of new drugs is now using high throughput technology.

The development of robot chemistry toward the end of the 20th century has made it possible to assembly in combinations and permutations vast numbers of chemicals that can then be tested on the thousands of receptor sites in proteins that represent human organs or body parts, or that represent those of animals in veterinary medicine. The chemistry techniques that have been developed allow a single chemist to develop thousands of new compounds each week. Previously, a skilled chemist would have done well to develop one or two chemicals in a week.

Many new companies have arisen that synthesize chemical libraries. These libraries contain thousands or millions of chemicals. The data for these is stored in computers allowing them to be tested at different receptors in a test tube or cell culture. Pharmaceutical companies can buy high throughput technology systems in order to test for some target receptor that is of interest to it. Using the computer's database of chemical formulas it is possible for a pharmaceutical company to screen as many as a million chemicals against a chosen receptor site in only a month.

It is possible to design throughput libraries so that the natural characteristic of a receptor is presented with a library of chemicals. The chemicals can be reduced to those that are viewed as most likely to be matched and lock into the site. The goal is to use the throughput screening in a search for responses at receptor sites to chemicals being tested. With the vast number of new synthesized chemicals that can now be made throughput technology allows testing on a large scale at high speeds. This reduces the cost and time for developing new drugs significantly.

From the process of mass screening those compounds that show some effects are those that warrant further investigation. Those chemicals that do not show results are not abandoned because they may prove useful in future trials. Rather, they are returned to the library for another day's testing against another receptor site. The number of receptor sites is growing rapidly as knowledge about cells, genes, and the use of gene splicing is increasing.

SEE ALSO: Analytical Chemistry; Human Genome Project; Industry; Measurement and Assessment; Natural Gas.

BIBLIOGRAPHY. C. K. Atterwill, W. Purcell, and P. Goldfarb, eds., *Approaches to High Throughput Toxicity Screening* (CRC Press, 1999); Thomas Corbett, *Throughput Accounting* (North River Press Publishing Corporation, 1999); John P. Devlin, *High Throughput Screening: The Discovery of Bioactive Substances* (Marcel Dekker, 1997); James Kyranos, ed., *High Throughput Analysis for Early Drug Discovery* (Elsevier Science & Technology Books, 2004); David A. Wells, *High Throughput Bioanalytical Sample Preparation: Methods and Automation Strategies* (Elsevier Science & Technology Books, 2003).

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Thunderstorms

THUNDERSTORMS ARE DRAMATIC weather phenomena that may deliver much-needed rain or cooling relief from oppressive heat and humidity, but they are also the makers of dangerous, violent winds, flash floods, damaging hail, and deadly air-to-ground lightning. Hundreds of people are killed every year by thunderstorm winds, floods, and lightning. Thunderstorms also destroy property, crops, and significant numbers of livestock every year.

Thunderstorms are formed by rising air that is warm and moist. The warm air currents become strong updrafts that can reach 7–11 miles high. Some storms have updrafts so powerful that the warm moist air reaches the troposphere where the updraft circulation produces hail. The hail may be the size of a marble, an orange, or even a grapefruit. These hail storms may kill people caught in the open and do significant property damage.

Thunderstorms may occur as a single storm; these are usually products of local conditions and may be called air mass or convective thunderstorms. In contrast, frontal thunderstorms are associated with rapidly moving moist air masses that are colliding with cold air masses. When these conditions occur the thunderstorms may occur in clusters or along frontal lines between advancing cold and slow-moving warm air masses.

Most thunderstorms occur in the late afternoon and early evening hours when the heating of the earth's surface produces the most updrafts. They have three stages to their development. The first is the rising of unstable warm moist air. As the mass of warm air reaches heights of 50,000–80,000 feet the cumulonimbus stage is reached with its anvil-shaped head. This is the mature stage, however, as cooling moisture moves out of the updraft and creates downward currents that strike the ground as precipitation. In the final stage the warm upward air drafts are shut off by the descending cold air and the storm ends.

Most single thunderstorms last from a few minutes to over an hour. If a single thunderstorm explodes over a small area and lasts a significant amount of time it may dump great quantities of rain in amounts greater than six inches (18 centimeters or more) in an hour. Thunderstorms producing large amounts of rain in a short period of time can cause flash floods. The western United States is very prone to flash floods caused by thunderstorms. Many people have been killed by flash floods that caught them in a canyon or arroyo that was normally dry. In the Middle East thunderstorms can easily flood the *wadis* of an area, sweeping away anything in the path of the storm water.

Thunder is caused by electrical discharges between clouds or between clouds and the ground. The electrical charge is visible as lightning. The sound is caused by the lightning breaking the sound barrier as the discharging current superheats the air between the positive and negative contact points for the electrical discharge. Within milliseconds, the air is heated to temperatures of about

18,000 degrees F (10,000 degrees C). Expanding violently, the superheated air forms pressure waves that are audible for up to 15 miles (24 kilometers). The rumbling sound is due to the variations in the sound waves caused by the various parts of the lightning channel.

Some regions of the world, like the western United States, experience dry thunderstorms that do not produce rain because the rain evaporates before it hits the ground. This type of thunderstorm produces lightning that often starts forest fires.

There are about 50,000 thunderstorms occurring on the earth every day. The tropics, where heating of the land and sea occur steadily all year long, are prone to the most thunderstorms. In the Northern and Southern Hemispheres the spring and summer months are the seasons with the greatest numbers of thunderstorms.

SEE ALSO: Fire; Floods and Flood Control; Livestock; Tropics; Weather.

BIBLIOGRAPHY. John A. Day and Vincent J. Schaefer, *Peterson First Guide to Clouds and Weather* (Houghton Mifflin Company, 1998); Ron Holle et al., *National Audubon Society Pocket Guide to Clouds and Storms* (Knopf Publishing Group, 1995); Thomas D. Potter and Bradley R. Colman, eds., *Handbook of Weather, Climate and Water: Dynamics, Climate, Physical Meteorology, Weather Systems, and Measurements* (John Wiley & Sons, 2003).

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Tides

TIDES ARE THE twice-daily rising and falling of the ocean at the shores of continents and islands. Over an approximately 12-hour cycle the tide in a locality flows out to low tide (ebb tide) and flows in to high tide (flood tide). The cycle is repeated again over the next 12 hours so that each day and each night there is a high and a low tide.

Tides also occur in all bodies of water on the earth. In some freshwater lakes, such as the Great Lakes, the tide may be only an inch or two, as most tides are too small to be noticed without instruments. In some places, tides are relatively shallow; in other places, the turning of the tide creates tidal rushes that are many feet in depth. Tidal highs and lows vary between localities because of local topological conditions, the strength of winds blowing on or off shore, and the position of the earth relative to the sun and the moon.

Tides provide natural cleansing of estuaries and bays and renew nutrient levels in marshes.

Tides in all places display the enormous amounts of energy that it takes to create them. The forces creating tides are the gravitational pull of the moon and the sun, the rotation of the earth, and the drag of the earth's uneven surface upon the movement of the oceans' waters.

The envelope of water on the surface of the earth is attracted by the moon's gravitational pull toward the moon. As the moon rises and sets relative to an observer on the earth, the earth rotates on its axis as well. High tide will be on the side of the earth facing the moon and on the side of the earth opposite to the moon. Low tide will be on the two sides of the earth at 90-degree angles to the moon. The moon's gravity pulls the water closest to it toward itself causing high tide. In addition, it causes high tide on the side of the earth opposite to the moon by also pulling the solid earth toward itself.

The earth rotates on its axis once every 24 hours. However, the moon always faces the earth with the same side as it rotates around the earth in every 29 and a half days. When the moon and the sun are aligned with the earth, the sun's gravity combines with the moon's to create the highest tides (spring tides) of the month. The tides occur at the full of the moon and at new moons when the pull of the moon and sun combined are at their greatest. The gravitational pull of the sun is 46 percent less than the moon's gravitational pull. The weaker gravitational pull of the sun is due to its distance from the earth, though its mass is many times greater.

Twice each month, the moon's orbit takes it to a position that is at a 90-degree angle to the earth and the sun. This is the time of neap tides, which are the lowest tides of the month. These occur at the times of the first and third quarter of the moon when the moon's gravitational pull is most out of line with the gravitational pull of the sun.

Tides are constantly changing as the sun, moon, and earth change. Tides are also affected by the winds of the seasons and by the local topography of the land next to the seaside. In estuaries and bays that are broad and open, the tide will be less than in those places where the entrance to the land is narrow and confined. In some places, such as the Bay of Fundy, the tidal range may be as much as 50 feet (15 meters) between tides.

The tides in the Atlantic and Pacific are different because of the size of the oceans. Pacific tides can be so-called "mixed" tides. Some islands have mixed tides where the tidal flows are such that one ebb tide is slight and then after the next high tide the following ebb tide is great. In a few localities in the Pacific, there is only a daily tide of a high and a low tide.

Tides provide natural cleansing of the estuaries and bays and renew the nutrient levels in the marshes. People who live beside the sea will usually regulate their activities according to the tides. Ships come and go with the tide using high tide in harbors to avoid shallows or underwater obstacles. Digging clams, crabbing, or some kinds of fishing (flounder) are done at low tide. There are also tides in rock and tides in the atmosphere, but these are too slight to detect without instruments.

SEE ALSO: Beaches; Estuaries; Fisheries; Oceans.

BIBLIOGRAPHY. John D. Boon, *Secrets of the Tide: Tide and Tidal Current Analysis and Predictions, Storm Surges, and Sea Level Trends* (Horwood Publishing Limited, 2004); James Greig McCully, *Beyond the Moon: A Conversational, Common Sense Guide to Understanding the Tides* (World Scientific Publishing Company, Inc., 2006); David T. Pugh, *Changing Sea Levels: Effects of Tides, Weather, and Climate* (Cambridge University Press, 2004); John Wright, ed., *Waves, Tides, and Shallow-Water Processes* (Elsevier Science & Technology Books, 2000).

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Tigers

THE LARGEST OF the big cats, the tiger *Panthera tigris* has become the global face of wildlife conservation. Tigers are carnivorous mammals classified in the biological family Felidae, characterized by territorial behavior and specialized hunting skills. The tiger is listed in the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species as a critically endangered species. One of the commonly voiced benefits of protecting tigers is that tiger conservation requires the protection of entire terrestrial ecosystems, essentially large areas of land, which in turn helps protect myriad other plants and animals that live in those ecosystems. Thus, tiger conservation efforts should ideally lead to larger gains in terms of the conservation of biodiversity and genetic diversity in the wild.

The recent history of tigers, however, continues to concern conservationists, biologists, wildlife managers, and others. Despite a complete ban under the Convention on International Trade in Endangered Species (CITES) since 1976 of the sale and use of tiger skin, bones, or any other body parts, tiger-derived products continue to be used in traditional Chinese medicines, for which the United States is the main market outside Asia. The plight of the tiger and the dramatic decline in the populations of its subspecies has gained worldwide attention since the 1960s. By then, the tiger was already on a dangerous path toward becoming an endangered species. It was systematically hunted either as a pest or as a trophy by Indian royalty and the colonial British elite in the 19th and early 20th century in undivided India, the epicenter of its historic range. These days, despite the protection that tigers receive within parks, sanctuaries, reserves, world heritage sites, protected forests, and occasionally as a result of community action to protect their habitat, they are coming in contact with humans as never before. Agricultural expansion; loss of forest cover to mining, dams, and other developmental projects; conversion of natural forest to plantations; poaching of prey species; and destructive activities due to human migration and population growth in areas bordering protected tiger habitat are some of the reasons contributing to the decline in tiger populations.

Historically distributed from the Caspian Sea in the west through south and southeast Asia and up to Siberia and northern China, the tiger is often depicted in Asian mythology representing both good and evil. Durga, a female Hindu deity, is depicted in temples throughout India riding a tiger. Buddha is believed to have offered his body to a starving tigress. Regenerative powers have been attributed to tigers and people believe they are protectors, guardians, and the harbingers of peace. Tigers have inspired ecologists, such as George Schaller of the Wildlife Conservation Society, and continue to inspire artists specializing in tiger paintings at the Ranthambhore School of Art.

India is home to the world's largest population of tigers, estimated at between 3,000 and 4,700 individuals, while an optimistic estimate for the entire world pegs the number at about 7,500. Traditionally, in countries like Nepal and India, tiger numbers have been estimated by counting their pug marks; plaster casts or paper tracings of pug impressions are taken from the ground. This method is in some cases supplemented by the use of radio telemetry and DNA-based scat (tiger droppings) and hair

Tasmanian Tigers

The thylacine on the Australian island of Tasmania is more commonly known as the Tasmanian tiger, though it is not actually related to the tigers of Asia. It was well-known by the Aboriginal peoples, and engravings of the thylacine going back to 1000 B.C.E. have been found. It was not known to Europeans until it was encountered by French explorers in 1792. George P.R. Harris, a surveyor, wrote the first description of the animal in 1808, and it seems likely that it was extremely rare, even then—five years after the British settlement of Tasmania (then called Van Diemen's Land).

The thylacine was similar in size to a large short-haired dog, being about 100–130 centimeters long. It had a stiff tail, and because it was striped, it gained its name of "tiger." The thylacine was actually a marsupial, with the females holding their young in a pouch. It was nocturnal and is believed to have had a highly developed sense of smell allowing it to track prey easily. Living in the woodlands and heath of the midlands and coastal regions of Tasmania, areas that were turned into agricultural land by early British settlers, the thylacine was hunted by them. The thylacine lived on kangaroos, wallabies, small animals and birds, and possibly on the Tasmanian emu, a large flightless bird. The Tasmanian emu was hunted to extinction in 1850; this might also have contributed to the fall in the number of thylacines.

By the early 1920s, the number of thylacines in the wild had become extremely low; plans were advanced to reintroduce them into the Australian mainland. The last known wild thylacine was shot dead by a farmer in 1930 in northeast Tasmania; the last captive thylacine died in the Hobart Zoo in 1936. Known as Benjamin, in spite of its probably being a female, it may have died of neglect and exposure, as it did not have a sheltered place to sleep. Thought to be the last of its species, it was much photographed. A naturalist shot a short film of it—and was bitten in the process. Since its death, there have been many reported sightings of the thylacine, and rewards offered for evidence that any have survived. However, in spite of the discovery of some droppings and paw prints similar to that of a thylacine, none has ever been photographed or found.

analysis. In recent years, field trials of camera traps to photograph and record individual tigers have been conducted. Human error and technical issues mean that all methods have their limitations and tiger numbers are best viewed as estimates.

Only about five percent of the tigers alive at the beginning of the 20th century now roam the forests, grasslands, and swamps such as those of the Sundarbans Tiger Reserve and World Heritage Site, a mangrove forest straddling the India-Bangladesh border and one of the largest protected areas for the Bengal tiger as well as 260 bird species. Tigers can easily weigh up to 225 kilograms and consume one-sixth of their body weight in food at a time. A good prey-base is essential to maintain tigers in the wild and some studies indeed suggest that tiger densities can be predicted if the approximate number of prey is known. Cameras triggered when an infrared beam is broken by prowling tigers have been used by ecologists to determine that these largely solitary animals that thrive in dense undisturbed vegetation can reach densities as high as 16 tigers in a 100-kilometers-square area at Kaziranga National Park in India.

But such high tiger densities are uncommon, and three subspecies of the tiger have gone extinct in just the past 70 years. These were the Bali, Caspian, and Javan tigers. The five subspecies that remain are all threatened by poaching and loss of habitat. Of these five, the Amur Tiger (*Panthera tigris altaica*, found largely in the easternmost provinces of Russia, China, and the Korean peninsula), the Sumatran Tiger (*Panthera tigris sumatrae*, found only on the Indonesian island of Sumatra), and the South China Tiger (*Panthera tigris amoyensis,* found in four Chinese provinces) have very low or declining populations, and are classified as critically endangered by the IUCN. The Indochinese Tiger (*Panthera tigris corbetti*, found primarily in southeast Asia from Bangladesh to Vietnam) was recognized as a distinct subspecies as recently as 1968, and the Bengal Tiger (*Panthera tigris tigris*, found largely in India with some in Nepal, Bhutan, and Myanmar), are both endangered. All tiger subspecies are listed in Appendix I of CITES and are protected in most of their range under CITES and national laws. The level and extent of enforcement of these laws, however, varies widely from country to country.

SEE ALSO: Convention on International Trade in Species of Wild Flora and Fauna (CITES); Poaching; World Conservation Union (IUCN); World Wildlife Fund (WWF).

BIBLIOGRAPHY. David Alderton, *Wild Cats of the World* (Facts on File, Inc., 1993); Simon Barnes, *Tiger!* (St. Martin Press, 1994); Government of India, “Project Tiger,” projecttiger.nic.in (cited April 2006); George B. Schaller, *The Deer and the Tiger* (The University of Chicago Press, 1967); John Seidensticker, ed., *Riding the Tiger: Tiger Conservation in Human-Dominated Landscapes* (Cambridge University Press, 1999); John Seidensticker and Susan Lumpkin, *Cats: Smithsonian Answer Book* (Smithsonian Books, 2004); Valmik Thapar, *Land of the Tiger: A Natural History of the Indian Subcontinent* (University of California Press, 1997); Valmik Thapar, ed., *Saving Wild Tigers, 1900–2000: The Essential Writings* (Permanent Black, 2001); Alan Turner, *The Big Cats and their Fossil Relatives* (Columbia University Press, 1997); World Wildlife Fund, “Tigers,” www.worldwildlife.org/tigers (cited April 2006).

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Tigris and Euphrates Rivers

WATERS FROM THE Tigris (in Arabic *Dijla*, in Turkish *Dicle*) and Euphrates (in Arabic *Furat*, in Turkish *Firat*) Rivers gave rise to some of the first known agricultural civilizations. These early societies of the Mesopotamian plain arose with irrigation techniques and water infrastructure dating back to 4000 B.C.E. and earlier. The Tigris and Euphrates Rivers are also well known for their high inter-annual and seasonal variability, leading to intense flooding with maximum flows as much as 10 times minimum flows. Sediment loading on the rivers is also high, resulting in raised river beds that historically have facilitated irrigation.

The “twin rivers” begin approximately 30 kilometers from each other in the highlands of eastern Turkey, travel through Syria and Iraq, and join together as the Shatt al Arab for 150 kilometers before draining into the Persian (or Arab) Gulf. The

Euphrates extends a total of 2,700 kilometers (40 percent in Turkey, 35 percent in Iraq, and 25 percent in Syria); the Tigris travels 1,900 kilometers (20 percent in Turkey, 78 percent in Iraq, and 2 percent in Syria). The mean flow of the Euphrates is approximately 30 billion cubic meters per year (BCM/Y); and the Tigris conveys considerably more after contributions from tributaries in Iraq, with approximately 50 BCM/Y.

Water diversion and damming of the twin rivers for irrigation and other uses continues today with major engineering works pursued by all three riparians (Turkey, Syria, and Iraq) for agriculture, hydroelectricity generation, and to overcome flooding and the intense seasonality of the rivers. In Turkey, there are approximately 20 dams completed or planned that comprise the GAP project (Southeastern Anatolia Project, with the Atatürk dam the largest among them, filled in 1991). In Syria, several large dams are in operation, including the Tabqa dam, completed in 1975 with the aid of Soviet engineering and financing during the Cold War. In Iraq, large reservoirs include Lake Abu-Dibbis, Lake Habbaniyah, and Lake Tharthar (serving flood control and facilitating water transfers from one river to another).

Planned future use of the rivers by all three countries is estimated to outstrip available freshwater supply by 148 percent on the Euphrates and 111 percent on the Tigris. Given this, the Tigris-Euphrates basin is often cited as a potential site of future water-related conflict, with troops already having been deployed to the Syria-Iraq border in the 1970s over water use conflicts; diplomatic hostilities that have led to decades-long stalemates and the absence of a tripartite water sharing agreement (there is, however, a 1987 agreement between Turkey and Syria guaranteeing 500 cubic meters per second of Euphrates water to flow over the border, and a 1990 agreement between Syria and Iraq, but none involving all three countries); as well as regional and international concern over Turkey's use of the river waters with continued implementation of the Southeastern Anatolia Project.

As Turkey's GAP project involves damming and water diversions on both rivers, it threatens to reduce the quantity and quality of freshwater for downstream Syria and Iraq—figures cited are as high as a reduction of 80 percent of Euphrates flow for Iraq, and 60 percent for Syria. Within Turkey, water diverted for irrigation has led to considerable agro-ecological and societal changes in the Southeastern Anatolia region and poses long-term sustainability concerns, such as issues related to pollution and salinization. There are also important implications of the project for the long-standing Kurdish conflict, as Kurdish populations occupy areas around the rivers in all three countries, and as former Turkish President Özal is said to have threatened Syria with cutting off flow of the Euphrates if it did not stop support for Kurdish insurgents.

However, there are also efforts underway to promote regional cooperation in the basin, for instance with recent efforts to establish ETIC, the Euphrates Tigris Initiative for Cooperation, involving technical experts from all three countries and led by the former president of Turkey's GAP project, Dr. Olcay Ünver.

Each of the three riparians invokes different rights claims to use of the rivers, for instance, with Turkey taking advantage of its upstream position, and also arguments related to territorial "contributions" to the rivers. Iraq similarly highlights "contributions" to make claims over Tigris waters, but also invokes historical use claims to the river waters. When examining much available data on the Tigris-Euphrates system, politics related to these different claims are often readily apparent. For instance, sources might insist on treating the rivers as a combined system, as doing so also gives Turkey a majority share in terms of contributions to the joined river system, while isolating the rivers might enhance Iraq's claim to the Tigris (Turkey contributes 60 percent to the joint river system, while separately, Iraq contributes a majority share to the Tigris system). Others similarly argue for concepts such as "economically irrigable lands" to argue that irrigation uses are more reasonable in one country over another, or analysts invoke the suitability of transferring water from the Tigris to the Euphrates to meet demand.

In terms of other notable political issues related to use of the rivers, historically, floodwaters would dissipate into the extensive marshes of the lower Mesopotamian plain. More recently, these marshes are the site of degradation and contentious engineering transformations. Under the regime of Saddam Hussein in Iraq, marshlands were drained to allow for agriculture and a canal was built to improve

Wilfred Thesiger and the Marsh Arabs

The travel writer Wilfred Thesiger has often been called the last of the Victorian travelers, born half a century after his time. He is still heavily identified with the Marsh Arabs of the Tigris River Delta with whom he lived, and about whom he wrote so evocatively.

Wilfred Thesiger was born in 1910 in Addis Ababa, Abyssinia (now Ethiopia), where his father was the British Minister. He was educated at Eton College and Oxford University, returning to Abyssinia at the age of 20. In 1935, he joined the Sudan Public Service and at the outbreak of World War II was seconded to the Sudan Defense Force. During the war, he served in Abyssinia and Syria, and then with the S.A.S. in the Western Desert.

After the war, he traveled to Arabia, and then went to Southern Iraq in 1951, planning to stay for a fortnight. He ended up staying for eight years, living with the Madan tribe, which became well-known through Gavin Maxwell's *A Reed Shaken by the Wind* (1957). The Marsh Arabs treated him well and in June 1958 Thesiger left Iraq and moved to Copenhagen, Denmark, where he wrote *Arabian Sands,* which was published in late 1959 and received excellent reviews. He then started work on his next book *The Marsh Arabs,* which was published in 1964.

Thesiger appeared to have enjoyed the eight years he spent with the Marsh Arabs and during that time with them he shared many experiences including pig hunts and fishing, and was even an eyewitness to many blood feuds. He prophesized in the introduction to *The Marsh Arabs* that he expected the marshes would soon be drained and the way of life of the Marsh Arabs, little changed over thousands of years, would disappear. In the 1970s, this came to pass, and many historians are thankful that Thesiger took the time to describe a culture and way of life that no longer exists. Wilfred Thesiger died in 2003.

transport from the Persian Gulf to Baghdad. While the project enjoyed international support in the decades before its completion, more recently it has been contested, with some suspecting the draining of 57 percent of the marshland was a move against Shiite dissidents opposed to the Ba'athist regime. The draining of the marshes is also widely cited for having posed significant threats to the livelihoods of Marsh Arabs, as well as to migrating birds and other wildlife dependent on the marsh ecosystem. While engineering works in Iraq clearly resulted in degradation and losses of the wetland ecosystems, the changes must also be understood in the context of withdrawals occurring throughout the river system, including withdrawals in neighboring Iran.

The Iran-Iraq war, and the more recent wars in Iraq in the past two decades have also had important implications for the rivers. For instance, the burning of oilfields and loss of infrastructure for production has resulted in considerable water pollution, with ongoing disposal of "black oil" in locations that threaten to degrade Tigris River waters. This is just one example of emergent insecurities and vulnerabilities with implications for water and conflict possibilities throughout the region.

SEE ALSO: Iraq; Persian Gulf; Persian Gulf Wars; Riparian Areas; Rivers; Syria; Turkey.

BIBLIOGRAPHY. D. Altinbilek, "Development and Management of the Euphrates-Tigris Basin," *Water Resources Development* (v.20/1, 2005); Center for Strategic and International Studies, "The Tigris and Euphrates River Basins: A New Look at Development," *Future Watch* (Global Strategy Institute, June 2, 2005); J. Glanz, "Waste Oil Dumps Threaten Towns in Northern Iraq: Seepage into Tigris River is Seen as Potential Disaster for Region," *New York Times* (A1, June 19, 2006); P. Gleick, *The World's Water: The Biennial Report on Freshwater Resources* (Island Press, 2005); L. Harris, "Water and Conflict Geographies of the Southeastern Anatolia Project," *Society and Natural Resources* (15, 2002); D. Hillel, *Rivers of Eden: The Struggle for Water and Quest for Peace in the Middle East* (Oxford University Press, 1994); J.F. Kolars and W.A. Mitchell, *The Euphrates River and the Southeast Anatolia Development Project* (Southern Illinois University Press, 1991); S. Postel, *Pillar of Sand: Can the Irrigation Miracle Last?*

(W.W. Norton, 1999); S.L. Postel, and A.T. Wolf, "Dehydrating Conflict," *Foreign Policy* (September/October 2001); V. Shiva, *Water Wars: Privatization, Pollution and Profit* (South End Press, 2002); A.T. Wolf, "A Hydropolitical History of the Nile, Jordan and Euphrates River Basins," in A. Biswas, ed., *International Waters of the Middle East: From Euphrates-Tigris to Nile* (Oxford University Press, 1994).

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Timber Industry

WOOD AND WOOD fiber are found in thousands of different products that meet a variety of human needs. Accessible forests have been increasingly harvested around the globe, although relatively untouched areas still exist in isolated regions such as Siberia. Nevertheless, due to rising awareness of the problems associated with deforestation and biodiversity loss, there is increasing protection for primary forests, especially rare or endangered ecosystems. As much as 10 percent of the earth's forested areas are designated for conservation, yet the degree of protection varies by country and region.

Transition to plantation forestry is rapidly expanding, although less than 5 percent of global forests are currently within plantations. Large-scale, industrial production is used to produce low-cost lumber and paper products. Plantations cannot be considered a replacement for native forests as there is a considerable reduction in biodiversity. Forests managed for commercial production face other ecological risks, such as the use of herbicides as a treatment during reforestation in order to give timber species an advantage over vegetation that is not commercially valuable. There is also controversy over international research in genetic engineering to promote desirable traits for rapid lumber production, which is sometimes advocated as a means to take pressure off of natural forests, but there is concern that altered genes may drift into wild areas.

Productive timber lands are deemed a good economic investment, but a variety of natural disturbances can impact harvests: Fires, insect damage, floods, ice, wind, and hurricanes. Hurricane Katrina is believed to have damaged billions of board feet in the southern United States, and only a small percentage was recovered before the wood began to deteriorate.

Despite the large number of tree species existing around the globe, the timber industry has focused on just a few. On average, 5 percent of the tree species native to a country are either vulnerable, endangered, or critically endangered. In most regions as few as 10 tree species dominate commercial markets. Illegal logging contributes to the overextraction of favorite tree species, such as big-leaf mahogany. Timber companies increasingly support international campaigns against illegal logging because they realize that illegal practices keep global timber prices low. Illegal timber extraction also means a loss of revenue for state programs, including some targeting forest conservation.

Timber companies frequently harvest in areas of indigenous peoples, as their homelands are where the largest expanses of natural forest remain. In many countries the government maintains control over natural resources and can often grant concessions without local approval. While more than 80 percent of the world's forests are publicly owned, private ownership is increasing.

In spite of corporate mergers and acquisitions, as a result of a harsh operating environment for the industry post-2000, timber is often sold through a series of small- and medium-size intermediaries located in countries all over the world. When unable to compete to produce cheap roundwood, companies in industrial countries look to encourage additional processing with paneling or engineered products. While wood remains a popular construction material, there has been some transition away from traditional lumber boards to a variety of engineered wood products, such as particle board, oriented strand board, and composite board. These products make use of smaller trees or waste from milling, but there is concern over the environmental safety of some chemicals used as binding agents.

Timber extraction and lumber processing involves environmental regulation related to air emissions, wastewater discharge, solid and hazardous waste management, site remediation, and forestry operations. While there have been undisputed improvements to many logging operations around the world in recent years, there are still widespread challenges to sustainability. Slickly marketed "green" forest products are sometimes only slightly improved from their conventional counterparts.

Since 1995 there has been a transition in the timber industry created by independent certification of sustainable ecological lumber harvested within socially just production systems. The original intent was to focus on tropical areas, but international certification grew most quickly in temperate and boreal forests. The world's largest certified forest product marketing companies include giant chains like Home Depot, IKEA, and B&Q. Such stores were previously criticized for contributing to tropical deforestation and thus have been able to improve their public image with this "eco-friendly" product line. However, there are many competing certification standards around the globe, and they are not equally stringent. Industry standards are often not as rigorous as independent regimes, such as the Forest Stewardship Council.

SEE ALSO: Biodiversity; Boreal Forests; Chipko Andolan Movement; Deforestation; Endangered Species; Forest Management; Forest Service (U.S); Habitat Protection; Indigenous Peoples; Plantation Forestry.

BIBLIOGRAPHY. American Forest and Paper Association, "'Illegal' Logging and Global Wood Markets" (November 2004); "Down in the Woods," *The Economist* (March 2006), www.economist.com (cited May 2006); Food and Agriculture Organization, *Global Forest Resources Assessment* (2005); PricewaterhouseCooper, *Global Forest and Paper Industry Survey* (2005); J.P. Siry, F.W. Cubbage, and M.R. Ahmed, "Sustainable Forest Management: Global Trends and Opportunities," *Forest Policy and Economics* (v.7, 2005).

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Time

THE RELATIONS BETWEEN time and nature are so complex and so close that the two are often implicitly collapsed into one category. Whether or not "time" describes some movement in the world beyond the social (philosophers continue to debate the question), the experience of time is always socially determined. Still, time almost always seems to be the most "natural" phenomenon. Time appears to be the fabric of everything dynamic, from night and day, to the seasons, to something so fundamental to current thinking about "nature" as evolution. Without ideas of time, our current notions of change and causation are unthinkable. In much of the contemporary world, in which we understand the "passage" of time as "linear", and the future as a result of what has "come before"—i.e., the past cannot return, and the future is passive—the idea that time could be constituted otherwise seems not only culturally alien, but empirically false.

Conceptions of time as reversible, cyclical, or fate, are associated with "primitive" mythology. But there is nothing necessarily more false about these ways or understanding the order of experience. We cannot prove the existence of the pace or form of a "natural" time, by which others could be standardized. We are time's only fixed measure; Einstein's relativity shows that even the rate at which time ticks away depends on how fast we are moving through space. Indeed, the concept of space-time that falls out of physics is based on the idea that the two dimensions are in fact one: All space exists in time, all time ticks away in space, and, perhaps most importantly, all movement and change takes place in both time and space simultaneously.

Consequently, while assuming a constant linear rate of temporal change (years, seasons, days, milliseconds) is necessary for strictly biophysical analyses of the environment, in the investigation of the relation between nature and society, it is much more problematic to rely on a single time; for the problem of time is already posed by the idea of nature-society relations. Its most obvious manifestation is perhaps the diversity of "timescales" we use to understand change: We speak of different timescales depending upon the phenomena of interest. For example, think of the idea that human life has only existed for a brief instant on the "evolutionary" or "geological" clock, or of the charge that those who are not obviously concerned with a sustainable future are "myopic"—i.e., their personal timescale is too short or too private. Even the vagueness of phrases like *short-term*, or *long-run* show how geographically, culturally, and historically specific any notion of time is.

The problem of time is also common in historical studies of more recent nature-society dynamics, and in theoretical attempts to deal with the direction and form of those dynamics. First, the patchiness of data often makes it difficult to establish past conditions, and even harder to guarantee the continuity across the times and places for which we do have data. Archeologists trying to piece together the fate of ancient societies usually find only a few points of reference across thousands of years, with no information directly pertaining to the centuries in between. Evidence that diets changed radically at a certain point, for instance, often offers no clue as to the how and why of the transition.

To fill in those blanks, we rely on assumptions about relations between humans and human relations to the non-human world to provide a priori narratives about the form and direction of change. These assumptions can be grossly inaccurate, as Fairhead and Leach show in a famous study of west African forests. They explain how the expectation that indigenous people's environmental practices are inevitably destructive led scientists to completely misread the forest history of some parts of the region, seeing deforestation where there has actually been active afforestation. Temporal assumptions like these also trouble dominant narratives of progress and development, which lead to nature-society analyses that frame environmental degradation as natural, or presume an inevitable if as yet unnamed technological fix. A good example of this is the so-called environmental Kuznets curve, which suggests that ecological damage is inevitable in the process of national economic growth, but will decrease after a certain development plateau has been reached.

Time is also central to the study of the difference nature's difference makes in human productive systems. Mann and Dickinson's seminal work framed this problem as the mismatch between periods of circulation or reproduction in biology and those in political economy. In other words, crops and money have different timescales over which they can grow or be reproduced. Corn will only grow at some times and in some places, and it takes a more or less specific duration to do so. Money can grow anywhere at any time, at least in theory. To the extent that nature does not instantly reward investment in nature-based sectors like agriculture or forestry, then, capital's circulation and accumulation is slowed while it must wait for the weather to get warmer, crops to ripen, or trees to reach merchantable dimensions. From this perspective, agricultural biotechnology can be seen as the efforts of business and the state to overcome this mismatch by, for example, accelerating crop growth rates to speed up production, or increasing cold or heat tolerance to extend growing season or geographic range. In addition, from this view it is the degree of the mismatch in circulation times that defines a natural resource as renewable or nonrenewable; coal, for example, despite the fact that it is produced over time, cannot attract capital willing to wait out the time of production.

Another way in which the problem of time affects the study of society-environment relations is crystallized in what might be called the ecology of the future. Many environmental narratives take what is called a *declensionist* form—it is presumed that humanity always harms the nonhuman world, and that, barring radical change, we are on a downward slide to an apocalypse that will significantly alter the biology of the planet, and possibly remove us from the picture altogether.

Other, more progressive narratives are founded upon the idea that we can weather this storm, or technology will allow us to avoid it. Either way, the future has become one of the principle frames through which environmental change is understood today, and our ecological expectations matter as much as, if not more than, present conditions in the planning and management of socio-environmental systems. All so-called "environmental policy" is thus a political statement about time. Whether it is the local and informal arrangements for the sustainability of a common property fishery, or the formal and state-enforced management of nuclear waste storage, it is always about how fast change is happening and in what direction, what temporal horizon should be meaningful to society, what form the future will take, and how we should care about it.

SEE ALSO: Anthropology; History, Environmental; Industrialization; Intergenerational Equity; Nature, Social Construction of.

BIBLIOGRAPHY. Robert Ayres, "Limits to the Growth Paradigm," *Ecological Economics* (v.19, 1996); Frederick Buell, *From Apocalypse to Way of Life* (Routledge, 2004); Gregg Easterbrook, *A Moment on Earth: The Coming Age of Environmental Optimism* (Viking, 1995); James Fairhead and Melissa Leach, "False Forest History, Complicit Social Analysis: Rethinking Some West African Environmental Narratives," *World Development* (v.23, 1998); David Harvey, *Justice, Nature and the Geography of Difference* (Blackwell, 1996); Claude Lévi-Strauss, *Structural Anthropology* (Basic Books, 1963); Susan Mann and James Dickinson, "Obstacles to the Development of a Capitalist Agriculture," *Journal of Peasant Studies* (v.5, 1978); Joseph Masco, "Mutant Ecologies: Radioactive Life in Post-Cold War New Mexico," *Cultural Anthropology* (v.19, 2004); Bill McKibben, *The End of Nature* (Random House, 1989); W. Scott Prudham, *Knock on Wood* (Routledge, 2004).

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Titicaca, Lake

LAKE TITICACA IS the highest commercially navigable lake on Earth located at 2.4 miles (3.8 kilometers) above sea level. The lake is located in the high Andean Altiplano on the border of Bolivia, with a port at Guaqui, and Peru, with ports at Puno and Huancane. It is the largest lake in South America and has a surface area of 3,205 square miles (8,300 square kilometers) with a length of about 121 miles (195 kilometers) and an average width of about 31 miles (50 kilometers). Lake Titicaca is a deep lake with a maximum depth of 922 feet (281 meters) and an average of 351 feet (107 meters). The mean water temperature of the lake remains about 51.8 degrees F (11 degrees C).

Lake Titicaca is fed by rainfall and water from numerous streams and rivers that originate in the snow-capped contiguous mountain ranges. Lake Titicaca is drained by the Desaguadero River, which flows south throughout Bolivia. The lake has more than 40 islands, including human made floating Uros islands, some of which are very densely populated. The extenuating effect of Lake Titicaca to the surrounding climate coupled with its water allows for irrigation of such crops as potatoes, barley, and maize. Trout farming and herding of alpacas and llamas are also common agriculture practices.

The basin of Lake Titicaca is one of the few intact and undisturbed areas in the Americas where indigenous societies and cultures developed. The Urus people, an indigenous ethnic group that appeared on earth about 8000 B.C.E. and today is extinct, originally settled the territories of Lake Titicaca basin. Later, Lake Titicaca was conquered by Aymara warlords, Quechuas of the Inca Empire who considered the lake a sacred place, and finally by the Spanish conquerors. The banks of the lake territories were dominated by the culture of Tiahuanaco (Tiwanaku) people whose descendants went north and founded the Inca kingdom after their kingdom was destroyed. As evidence of a flourishing ancient civilization, the Tiahuanaco culture left behind ruins of megalithic constructions, statues, and a temple to the sun. The territory of the Lake Titicaca basin is one of the very few places in the world where the craft of balsas (reed boats) building, which was practiced by the Urus people, still exists.

Poverty remains one the core causes of many social problems experienced by the population of the Lake Titicaca basin. The poor condition of education and health care systems in the Lake Titicaca region are the major socio-economic characteristics of living conditions. Major health problems are linked to the problems of malnutrition, lack of sanitation, and ecosystem fragility with regard to flooding. The major economic activities of the population inhabiting the lake basin are focused on food production activities, agriculture, and cattle herding. Only small-scale subsistence agriculture is possible due to rural property fragmentation land reforms, limited machinery and fertilizer supplies, natural drought, floods, and frosts. Providing very low crop yields, subsistence agriculture encourages over-harvesting and overexploitation of the fertile lands of the lake basin causing soil degradation and further environmental problems. Irrational use and mismanagement of natural resources has caused serious organic and bacteriological contamination, particularly poor waste disposal, and mining of the important urban cores in the basin.

SEE ALSO: Basin; Bolivia; Indigenous Peoples; Lakes; Peru; Poverty.

BIBLIOGRAPHY: Clark L. Erickson, "*The Lake Titicaca Basin: A Pre-Columbian Built Landscape*," ccat .sas. upenn.edu (cited December 2006); Charles Stanish and Brian Bauer, *Archaeological Research on the Islands of the Sun and Moon, Lake Titicaca, Bolivia: Final Results of the Proyecto Tiksi Kjarka* (Cotsen Institute of Archaeology at UCLA, 2004); Charles Stanish, Amanda Cohen, and Mark Aldenderfer, *Advances in Titicaca Basin Archaeology* (Cotsen Institute of Archaeology at UCLA, 2005); United Nations Environmental, Scientific, and Cultural Organization (UNESCO), "Water: A Shared Responsibility, Lake Titicaca Basin," www.unesco.org (cited December 2006); UNESCO World Water Assessment Program, "Lake Titicaca Basin, Bolivia," www. unesco.org (cited December 2006).

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Tobacco

TOBACCO IS INDIGENOUS to the Americas and was unknown to Europeans until the late 16th century. Its use among Native American peoples was widespread by this time; it was consumed largely for medicinal and religious purposes. Successfully grown by early settlers and exported to Europe, the plant (*Nicotiana spp., L.*) became a crucial crop for the pre-revolutionary American colonies, which relied heavily on slave labor in cultivation and processing.

Today, tobacco is grown in more than 100 countries and most tobacco is used for smoking. Tobacco is an essential ingredient for cigarettes, pipes, cigars, hand-rolling tobacco, bidis, and *kretek* cigarettes. Cigarettes account for the largest share of manufactured tobacco products in the world—96 percent of total sales. Except for chewing tobacco in India, and possibly *kreteks* in Indonesia, cigarettes are the most common method of consuming tobacco.

China is the world's leading producer. According to data provided by the World Health Organization (WHO), worldwide over 15 billion cigarettes are smoked every day. The global tobacco industry is dominated by three large multinationals: Altria Group (formerly Philip Morris) based in the United States, Japan Tobacco, which is government-owned and controls 75 percent of the Japanese market, and British American Tobacco (BAT) based in the United Kingdom. Tobacco is one of the United States's oldest and most profitable industries, but the tobacco market has been hit by price increases, higher state taxes, increased consumer awareness of health risks, and hefty litigation costs. Smoking has been linked to many types of cancer by medical research institutions. For years, the tobacco industry presented studies of its own in attempts to counter growing scientific knowledge about the additives and adverse health effects of cigarettes. Efforts to curtail tobacco use have increased throughout the world as many countries continue to tax tobacco heavily and restrict its use in public facilities.

Employment in the tobacco industry has been declining in developed countries as a result of the introduction of new technologies and national and international tobacco control policies. In developing countries, on the other hand, tobacco consumption and employment in the tobacco industry have been on the rise.

In some developed countries, consumers spend more on tobacco than they do on alcoholic beverages; however, the popularity of smoking is in decline. The main factors driving the long-term decline include: Concerns relating to the impact of smoking on health, the increasing view that smoking is an anti-social habit, growing restrictions governing where individuals can smoke and how companies can market their products, and the rising cost of legally bought tobacco. Consumers are increasingly turning to economy brands and smuggled tobacco—contraband products and those legally bought abroad account for 31 percent of sales—in response to taxation increases. Cigarettes are a legal, but controversial product.

Several Western European countries have increased taxes on cigarettes far more aggressively than the United States to discourage smoking, and they have imposed greater restrictions on cigarette advertising, but have been less aggressive in prohibiting smoking from workplaces and restaurants.

Only in the United States has litigation against tobacco companies become an important feature of national tobacco control efforts. The U.S. Department of Justice is pursuing a case against the industry, citing 50 years of evidence it claims points to a cover-up of the health risks associated with smoking. Smokers stricken with cancer and other smoking-related health problems have also tried to pool their complaints together in large class-action lawsuits. Often, the courts frown upon such tactics; however, individuals have fared much better, but face lengthy appeals from the tobacco giants.

A $3 billion California award against Philip Morris in 2001 was among the top 10 jury verdicts in the country. However, the U.S. Department of Justice's case against the industry has weakened permanently, and awaits appeals (elimination of a $280 billion disgorgement claim). Other significant triumphs for big tobacco occurred in late 2005, when the Illinois Supreme Court dismissed the appeal of the Price "lights" class-action case. The third major problem, the review of the $145 billion Engle verdict, resulted in a dismissal by the Florida Supreme Court in July 2006.

Since late 1998, when cigarette manufacturers raised prices sharply as a consequence of the Master Settlement Agreement (MSA), deep-discount cigarette producers saw their market share increase from about two percent in 1998, to over 13 percent in 2003, with about a 45 percent price discount to premium brands. Increasing cigarette prices also encouraged purchase of cigarettes over the internet, sacrificing convenience for cost savings. Federal lawmakers contended that these internet stores were clear tax evasions: The Jenkins Act requires that both the retailer and consumer report online purchases to aid in tax collection. State governments aware of the loss in tax revenue, and retailers feeling the competition, have pushed for stricter regulation and greater enforcement.

The U.S. market is dominated by four main manufacturers known as Big Tobacco: Altria Group, which sells approximately half of the nearly 500 billion cigarettes sold in the United States, Reynolds American Inc., Loews subsidiary Lorillard Tobacco Company (a subsidiary of the Carolina Group), and Vector Group's Liggett unit. In the United States, people are quitting smoking in great numbers, while restrictions on advertising impede manufacturers' ability to attract new smokers.

China, with some 25 percent of the world's 1.2 billion smokers, is the big prize. Government-

Philip Morris

Philip Morris was a tobacconist who ran a business in Bond Street, London, selling Havana cigars (known in those days as "seegars") and pipe tobacco from Virginia. Many British gentlemen took snuff, and Philip Morris ran a discrete business until the Crimean War of 1854–56. During the war, many British soldiers had been based in Turkey and came across cigarettes there; they began asking Morris for them. Philip Morris started producing his own cigarettes, which he called Oxford and Cambridge Blues, and later called another brand the Oxford Ovals. However, the production of cigarettes was slow with no more than 1,500 or 2,000 produced by a single roller each day. Philip Morris stressed in his advertisements that he only used the best paper, the cleanest factory conditions, and the "purest aromatic tobacco," with a fine cork tip to prevent the cigarette from sticking to the mouth.

Philip Morris died in 1873 at the age of 37, and his widow Margaret continued running the business along with Philip's younger brother Leopold. The business grew with the patronage of Prince Albert, and Leopold bought out his sister-in-law in 1880, running it with Joseph Grunebaum. When the company was floated on the stock market soon afterwards for £60,000, the public offering was oversubscribed six times. In 1894, however, owing to Leopold Morris running up large debts, the company was in the hands of creditors and was then sold to another company that, in 1901, helped form Imperial Tobacco. Philip Morris, which in 2003 changed its name to Altria Group, Inc., is now one of the largest tobacco companies in the world.

owned China National Tobacco, the world's largest tobacco producer, primarily operates in the domestic market. The major tobacco companies have signed licensing agreements with Chinese partners to distribute their brands in the Chinese market. A country with a largely restricted market and laws against tobacco advertising, China still has 300 million smokers and four times the consumption rate of the number two world market, the United States, and is just about the only major international market that is growing. Tobacco contributes a tenth of all tax revenues in China.

Despite the health problems, lawsuits, and rising prices associated with cigarettes, tobacco companies still make profits. Altria Group, the U.S. and global tobacco leader, grew revenues by 17 percent in 2003 as economies in the United States and abroad grew. BAT, number two in the world, also held its own with about 15 percent growth in sales. Tobacco manufacturers are increasingly focusing activities on developing countries, which tend to have less stringent health and advertising regulations, and where the potential for brand development remains significant.

SEE ALSO: Cash Crop; China; Disease; Drugs; Smoking.

BIBLIOGRAPHY. *Economics of Tobacco Control, Curbing the Epidemic: Governments and the Economics of Tobacco Control* (World Bank, 1999); Judith Mackay and Michael Eriksen, *The Tobacco Atlas* (World Health Organization, 2002); G. Van Liemt, *The World Tobacco Industry: Trends and Prospects* (International Labor Office, 2002).

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Togo

FORMERLY FRENCH TOGOLAND, the Togolese Republic won its independence from France in 1960. Togo was governed by military rule for the next several decades. The government has repeatedly been accused of human rights violations, and the political situation remains unstable. Because of the accusations, most bilateral and multilateral aid to Togo is frozen, although the European Union has resumed some aid in exchange for promises of political reform. More than 46 percent of Togo's land area is arable, and the 65 percent of the labor force that is engaged in the agricultural sector is employed in both commercial and subsistence agriculture. Nevertheless, some basic foods are imported. Cocoa, coffee, and cotton are the chief export crops, generating around 40 percent of the Gross Domestic Product. Togo ranks fourth in the world in phosphate production. Other natural resources include limestone and marble. With a per capita income of $1,700, Togo ranks 191st in world incomes. Almost a third of the population lives below the national poverty line, and over a fourth of Togolese are seriously undernourished. The United Nations Development Programme's Human Development Reports rank Togo 143 of 232 countries on overall quality-of-life issues.

Bordering on the Bight of Benin in the Atlantic Ocean, Togo has a 56-kilometer coastline and 2,400 square kilometers of inland water resources. Togo shares land borders with Benin, Burkina Faso, and Ghana. Northern lands are comprised of gently rolling savanna that gives way to hills in central Togo and to plateau in the south. The coastal plain contains extensive marshes and lagoons. Elevations range from sea level to 986 meters at Mont Agou. The length of Togo extends for 317 miles, allowing it to stretch through six distinct geographic zones. The tropical climate is hot and humid in the south and semiarid in the north. Togo is prone to periodic droughts, and the north experiences the harmattan, a hot, dry, dust-laden wind that accelerates the pace of environmental damage and reduces visibility in the winter months.

Togo's population of 5,548,702 is at great risk for the environmental health hazards that go hand-in-hand with poverty and an unstable political system. One of the major threats comes from the 4.1 percent adult prevalence rate for HIV/AIDS. Some 110,000 Togolese have this disease, and another 10,000 have died with it since 2003. Only 35 percent of rural residents and 51 percent of all Togolese have sustained access to safe drinking water. In rural areas, only 17 percent have access to improved sanitation, as compared to 34 percent of all Togolese. Consequently, the population has a very high risk of contracting food and waterborne disease that include bacterial and protozoal diarrhea, hepatitis A, and typhoid fever, the respiratory disease meningococcal meningitis, and the water contact disease schistosomiasis. In some areas, there is a high risk of contracting vectorborne diseases such as malaria and yellow fever.

Because of environmental health factors, the Togolese have a lower-than-expected life span (57.42 years) and growth rate (2.72 percent), and higher-than-expected infant mortality (60.63 deaths per 1,000 live births) and death (9.83 deaths/1,000 population) rates. The low literacy rate (60.9 percent), particularly among women (46.9), contributes to the high fertility rate (5.4 children per female) and adds to the difficulty of disseminating information on birth control and disease prevention.

At one time, much of Togo was covered with dense rain forests. The Togolese have engaged in slash-and-burn agricultural tactics, however, in addition to cutting down trees for fuel and selling woods such as acajo, sipo, and aybe for export, with the result that deforestation of the rain forest is occurring at a rate of 3.4 percent per year. Extensive water pollution is endangering health and threatening the fishing industry. Urban areas are experiencing elevated levels of air pollution, in large part because of the extensive use of so-called taxi-motos that ferry people around cities such as Lome, the capital of Togo. Solid waste management is a major issue in both rural and urban areas.

In 2006, scientists at Yale University ranked Togo 103 of 132 countries on environmental performance, in line with the relevant income and geographic groups. The overall ranking was reduced by the low score on environmental health. Existing rain forests have been reduced to river valleys and small sections of the Atakora Mountains, even though the government has protected nearly eight percent of land area. Of 196 identified mammal species, nine are endangered; however, none of the 117 bird species are threatened with extinction.

Although Togo established an environmental framework with the Environmental Code of 1988, environmentalism has not always been a priority with the Togolese government. The Minister of Environment and Tourism and the Minister of Rural Development bear the major responsibility for implementing and enforcing Togo's environmental laws and regulations, which are focused on: Sustainable development through reinforcement of legal and environmental institutions; enhancing environmental education, communication, training, and research; eradicating poverty; and checking pollution. Two of the major policy goals of the Togolese government are designed to provide 100 percent access to safe drinking water and improve sustained access to sanitation in the near future.

Togo participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Law of the Sea, Ozone Layer Protection, Ship Pollution, Tropical Timber 83, Tropical Timber 94, and Wetlands.

SEE ALSO: Deforestation; Poverty; Rain Forests; Waste, Solid.

BIBLIOGRAPHY. Central Intelligence Agency, "Togo," *World Factbook*, www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Togo," hdr.undp.org (cited April 2006); World Bank, "Togo," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Tomato

TOMATO (*LYCOPERSICON ESCULENTUM*) is a member of the genus *Lycopersicon* and was categorized thus by the Swedish botanist Linnaeus. Its

The tomato made history as the first crop plant to be modified with modern genetic engineering techniques.

botanical name is literally translated from ancient Greek as "wolf peach," which reflects the once widely held belief that the tomato was poisonous. In contrast, *esculentum* means "edible." The genus *Lycopersicon* is in the Solanaceae family of plants, which contains several species of plants of food or ornamental value, including the potato, tobacco, eggplant (aubergine), tamarillo, hot and sweet peppers (capsicum), Cape gooseberry, ground cherry, and various nightshades. The tomato is a vine that bears round or oval fleshy fruits with a high juice content. It is an annual plant whose stem grows between three to 10 feet (one to three meters). The stem is not self-supporting, so it climbs up or trails along neighboring plants in the wild or along supports when cultivated.

Precisely where the tomato was first selected as a crop plant is unknown, but it may have been the coastal Andes of Peru-Ecuador-Bolivia, a region characterized by a high diversity of tomato's wild relatives, as is also the case for tobacco and potato. It was sufficiently useful to be introduced into Mesoamerica, where domesticated tomato was a component of the food resource. Indeed, the word *tomato* derives from the Aztec word *xitomatl*. It was being cultivated in Mexico when first encountered by European colonists in the early 1500s and there is written reference from the 1530s to recipes that include tomatoes mixed with chiles. Spanish colonists probably introduced it to Florida in the mid-1500s, from where tomatoes spread along the eastern seaboard. Portuguese explorers introduced tomato to west Africa, and Spanish explorers brought seeds to Europe, where the plants flourished in Mediterranean environments, producing irregularly shaped and rough-skinned fruits.

The first known appearance in written records in Europe dates to 1554. Tomatoes became known as *pome dei Moro* (Moor's apple) and later as *poma Peruviana, pomme d'amour,* or in Italy as *pom d'oro*. They were not widely embraced outside southern Europe as suspicions about possible poison persisted, mainly due to recognized botanical links with the nightshades. The first tomato plants were grown in England in the 1590s, mainly for ornamental purposes, until the mid-1700s when tomato first began to appear in British cookbooks. Colonists from England reintroduced it to the United States, and although grown in the 1780s by estate owners such as Thomas Jefferson, it was not until the early 1800s that tomatoes were first consumed in the United States, beginning in the southern states and spreading to northern states by the 1850s. These fruits probably looked like the cherry tomatoes available today.

Today, the tomato is grown worldwide; almost 11.1 million acres (4.5 million hectares) are planted worldwide, generating an annual yield of more than 265 billion pounds (120 million metric tons). Numerous tomato types are now produced from a wide range of cultivars that have been bred for specific properties such as flavor and shape; red varieties dominate but yellow and orange varieties are also available. Nutritionally, tomatoes are about 94 percent water and are a low-calorie food; they are rich in vitamins A and C, calcium, and fiber and are a source of the antioxidant lycopene. Apart from being marketed and consumed as fresh salad or salsa ingredients, tomatoes are canned, processed to produce paste used in many prepared foods such as soups and pasta and meat sauces, and are also used to produce juice, jams, and chutneys.

The tomato made history by being the first crop plant to be modified using modern genetic engineering techniques involving the manipulation of plant deoxyribonucleic acid (DNA). It was modified to enhance flavor, which gave rise to the name Flavr Savr. It was produced in 1994 and sold to the general public in the United States and United Kingdom as tomato paste. No adverse effects of its consumption have been recorded, but lack of interest prompted its withdrawal.

SEE ALSO: Biotechnology; Crop Plants; Gardens; Genetically Modified Organisms (GMOs); Parasites.

BIBLIOGRAPHY. Mark Harvey, Stephen Quilley, and Huw Beynon, *Exploring the Tomato: Transformations of Nature, Society and Economy* (Edward Elgar, 2004); Belinda Martineaux, *First Fruit: The Creation of the Flavr Savr Tomato and the Birth of Biotech Food* (McGraw-Hill, 2002); Judith Sumner, *American Household Botany. A History of Useful Plants 1620–1900* (Timber Press, 2004).

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Topographic Maps

A TOPOGRAPHIC MAP is a depiction of the earth's landscape, displaying elevation and selected natural and human features. The map portrays elevation as contour lines, lines that connect points of equal elevation, the natural features of hydrology and vegetation, and a variety of cultural characteristics such as roads, buildings, or cemeteries. Topographic maps are generally produced at different scales, with corresponding variations in the configuration of contours, natural and human features and labels to make the map legible.

Landscape portraits depicting relief have been used for over 2,000 years. Beginning in the Middle Ages and continuing into the 1800s, hachuring was used to illustrate slope, using lines drawn downhill to illustrate steep or low relief. In the early to mid-1800s, the French were the first to use contour lines for elevation. To begin, elevations at known locations are collected using surveying techniques. Contours lines are formed by connecting points of equal elevation, interpolating the elevation values between known point heights creates the equal elevation sites.

The topographic map depicts a specific portion of the earth's surface based on the map scale. For instance, the 1:24,000 scale map covers an area of 7.5 minutes of latitude by 7.5 minutes of longitude, an area of approximately 57 square miles (147 square kilometers), while the 1:100,000 scale map covers 30 minutes of latitude by 1 degree of longitude and an area of approximately 1,805 square miles (4,675 square kilometers). The 1:250,000 scale map represents an area of 1 degree of latitude by 2 degrees of longitude, an area of almost 7,845 square miles (20,320 square kilometers). The areal coverage will increase with latitudes closer to the equator or decrease with latitudes closer to the polar regions because of the convergence of longitude lines.

The topographic map presents the terrain as a series of lines depicting levels of constant elevation. Each line represents a set height above mean sea level (MSL). Most maps will have a standard contour interval—such as 10, 20, or 40 feet—by which the elevation will increase (upslope) or decrease (downslope) from one contour to another. Index contour lines are labeled with the elevation in either feet or meters, depending on the scale. In addition to the contour lines, the topographic map will display spot elevations, hydrologic features (streams, lakes, ponds), vegetation (green areas), select cultural features and several different coordinate systems (latitude/longitude, UTM, SPC, and PLSS). The amount of additional information illustrated on the map will depend on the map scale, with the primary purpose not to display everything but to present a visually-readable map of the terrain with additional information for locational reference.

To begin an interpretation and analysis of a topographic map, the map scale, location of the mapped area, and the contour interval has to be known. There are five basic rules in topographic map interpretation. First, any location on the same contour line will have the same elevation. Second, contour lines will never cross each other. Third, generally speaking, a move to an adjacent contour line is a change in elevation either an increase or a decrease. Fourth, the closer the contour lines are together the more rapid the change in elevation and the steeper the slope, conversely, the farther apart the contour lines the less slope or the flatter the terrain. Fifth, contour lines crossing a stream or drainage channel will form a V-shape, with the apex pointing uphill or upstream.

Today in the United States, the U.S. Geological Survey produces over 54,000 topographic maps at a scale of 1:24,000 for the conterminous United States and Hawaii, and a scale of 1:63,360 for Alaska. In addition, the entire United States is covered at scales of 1:100,000 and 1:250,000. Currently, it requires the integration of field surveying for horizontal and vertical accuracy and control, the use of aerial photography and analysis for contour mapping, printing techniques to produce the topographic map, and computer analysis and databasing for storage and reproduction. Topographic maps are now produced as a paper copy or a computer-compatible file, to be downloaded into mapping software or into global positioning system units for visualization and location. The use of computers for computation and illustration also allows the cartographer to combine contour lines with different types of color-shading and light enhancement to create a 3-dimensional perspective, emphasizing the landscape relief.

SEE ALSO: Global Positioning Systems (GPS); Latitude; Longitude; Maps.

BIBLIOGRAPHY. A.J. Kimerling, P.C. Muehrcke, and J.O. Muehrcke, *Map Use: Reading, Analysis, and Interpretation* (JP Publications, 2005); V.C. Miller and M.E. Westerback, *Interpretation of Topographic* Maps (Merrill Publishing, 1989); M.M. Thompson, *Maps for America: Cartographic Products of the U.S. Geological Survey and Others* (U.S. Government Printing Office, 1979).

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Tornadoes

A TORNADO—also popularly known as a twister—is an atmospheric phenomenon associated with a supercell thunderstorm or hurricane. It consists of a small rapidly and violently rotating column of air—or vortex—extending continuously from a convective cumuliform cloud to the ground. When the vortex is spinning but not touching the ground, it is called a funnel cloud, which eventually may extend to the ground evolving into a tornado. It becomes clearly visible in daylight as a funnel or tube cloud when it carries water vapor and debris lifted from the ground. It may be thin and rope-shaped in the case of weak tornadoes with speeds below 175 kilometers per hour (110 miles per hour). Sometimes the funnel is not visible except by signs such as whirling debris on the ground. A prolonged roar and hail or heavy rain happen during the event.

Most tornadoes are associated with rotating and long-lasting supercell thunderstorms. Tornado formation starts with a vortex in the base of the storm cloud, out of the wall cloud. Next, an organizing phase follows when wind intensity increases and the vortex extends to the ground. In its mature stage, the tornado reaches its maximum width and speed. After that it weakens, dimensions are reduced, and it adopts a rope-like form.

Tornadoes can last seconds or hours. Most tornadoes last from one to 20 minutes; however, some have been observed to last hours. The vortex may touch ground several times in different locations. The vortex has a diameter of 20–100 meters (20–100 yards) and travels at a translational average speed of 50–65 kilometers per hour (30–40 miles per hour), reaching maxima of 115 kilometers per hour (70 miles per hour), with a rotational speed of 480 kilometers per hour (300 miles per hour). Forward speed is not the only factor in damage; lifetime also contributes, as slow-moving tornadoes may be more dangerous than fast-moving ones. Maximum rotational speed is developed at the edge, decreasing to the center, so that major destruction takes place where rotational and translational speeds sum up. Indirect measurements indicate there is a pressure drop at the center of the tornado. Vortex rotation is commonly counterclockwise in the Northern Hemisphere. The average path length is 8 kilometers (5 miles) although some tornadoes have traveled for 100 miles, and the average path width is 300–400 meters (300–400 yards), and some have covered up to a mile.

Seventy-four percent of tornadoes are in the F0–F1 range of strength level, the weak class, while less frequent, violent tornadoes cause 68 percent of fatalities. They are most likely to occur in the afternoon and move from southwest to northeast.

A single tornado can develop various smaller vortices, known as subvortices or suction vortices with higher speeds. A sequence of continuous tornados along a line of storms is called a tornado outbreak. When the tornado happens over water it is called a waterspout.

Tornadoes represent a major local hazard causing notable destruction, loss of lives, and injuries. Houses collapse, structures are uprooted, and pieces of debris become projectiles. About 1,000 tornadoes are reported every year across the United States, versus 30–50 in the United Kingdom. The number of tornadoes registered in the United States has increased with the implementation of the Doppler Radar Network by the National Weather Service, particularly F0 tornadoes, many of which were not formerly detected.

Tornadoes are frequent in central North America, including: The Canadian central provinces of Alberta, Saskatchewan, and Manitoba; northern Argentina; western and central Europe, South Africa; and eastern and southwestern Australia. About one-fourth of all significant tornadoes occur in Tornado Alley in the Central Plains region of the United States, which includes parts of Texas, Oklahoma, Kansas, Colorado, Nebraska, Iowa, South Dakota, and Minnesota. In the southern states peak tornado season is spring, while in the northern states it is summer, with maximum frequency in May–June.

The most deadly tornadoes happen, however, in areas where they are less frequent, particularly the southeast. In the period of 1950–99, the national year average was 89 deaths. The three deadliest tornadoes were the Tri-State (MO/IL/IN) tornado outbreak on March 18, 1925, which killed 689 people; Natchez, Minnesota, on May 6, 1840, with 317 victims; and St. Louis, Missouri, on May 27, 1896, causing 255 deaths. The three costliest tornadoes happened in Omaha, Nebraska, on May 6, 1975, with an estimated damage of $1.132 billion; Wichita Falls, Texas, on April 10, 1979, which reached $840 million; and Lubbock, Texas, on May 11, 1970, which caused damage of $530 million.

The F-scale (or Fujita scale) was proposed by Tetsuya "Theodor" Fujita in 1971 to categorize the intensity of tornadoes based on the structural damage caused to man-made structures, estimated once the tornado has passed. It comprises six categories, from F0 to F5, although a theoretical maximum F12 tornado is possible. From F0 to F1 a tornado is considered to be weak, strong if in the range F2–F3, and violent from categories F4 to F5. Although subjective in damage assessment, which causes overestimation of wind speeds, the F-scale has widespread use in the United States after being accepted as the official classification system.

Despite the limitations, it was decided to maintain and improve the scale in order to provide continuity to historical tornado records. An enhanced Fujita scale (EF-Scale) was developed for use in the United States after February 2007. Twenty-eight indicators are used and the degree of damage estimated up to eight levels, associating them to upper and lower wind speeds.

As damage is not necessarily associated to wind speed, however, Terence Meaden proposed the Tornado Intensity Scale in 1972, relating the levels to the well-established Beaufort wind intensity scale. As the speed can be measured directly—or, better, remotely estimated—this allows the determination of intensity even if the tornado causes no damage. The scale ranges from T0 to a maximum T10, each level representing a range of windspeeds. From T0 to T3 tornadoes are considered to be weak, from T4 to T7 are strong tornadoes and from T8 to T10 are violent tornadoes; a degree higher than T10 is possible.

U.S. emergency administration issues two differentiated levels of risk to alert population. A tornado watch indicates there is a high probability of a tornado in the area and recommends remaining alert to future evolution. A tornado warning indicates a tornado has been sighted or detected by radar in the area and recommends taking shelter in pre-designated places of safety.

SEE ALSO: Hazards; Disasters; Thunderstorms; United States, Central South; Weather.

BIBLIOGRAPHY. Howard B. Bluestein, *Tornado Alley* (Oxford University Press, 1999); Thomas P. Grazulis, *The Tornado: Nature's Ultimate Windstorm* (University of Oklahoma Press, 2003); Long T. Phan and Emil Simiu, *The Fujita Tornado Intensity Scale: A Critique Based on Observations of the Jarrell Tornado of May 27, 1997* (National Institute of Standards and Technology, 1998);

Philip W. Suckling and Walker S. Ashley, "Spatial and Temporal Characteristics of Tornado Path Direction," *The Professional Geographer* (v.58, 2006).

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Totalitarianism

IN ALMOST ALL modern totalitarian governments, environmental policy is used as an instrument to control society and economic development for the benefit of those in power. Social theorists like Max Weber believe that the roots of totalitarian power can be found in specific environmental conditions of society. These conditions will have a direct impact on rule, necessitating a totalitarian state. Thus, according to this theory, nature itself determined the nature of government.

Alluvial societies (societies based on river irrigation like Egypt) were based on highly-centralized, and most often totalitarian systems of government since the dawn of civilization. The pharaohs ruled Egypt and the great Sumerian and Assyrian kings ruled Mesopotamia for millennia because only a strong ruler could guarantee the effective and efficient maintenance of canals and river irrigation. Recent genetic and archaeological research indicates that throughout most of human evolution, people lived in small bands and roving tribes; it was the growth of river agriculture that transformed this pattern of human existence into vast, centralized civilizations. The totalitarian ruler represented the maintenance of a predictable environmental order. Totalitarian rule is almost always supported by the ruler's actual or even mythical ability to manipulate nature and the environment.

The powers of even the most influential or charismatic rulers of the ancient past were pale in comparison to the potential power of rulers to harness the environment in modern totalitarian states. Yet, even as the methods are different and potentially far more devastating, the objectives of modern totalitarian environmental policy are almost identical to those of ancient regimes: To prove that the totalitarian ruler not only has power over people but power over nature itself, making resistance to the totalitarian system as futile as resistance to nature itself. By taming the Nile River with the Aswan Dam, Gamal Nasser of Egypt not only tamed a mighty river, but he tamed and controlled a society historically dependent on the Nile for its existence. By draining the marshes of Southern Iraq and fundamentally altering an entire ecosystem, Saddam Hussein eliminated much of the resistance from Marsh Arabs who were resisting his rule.

Often, however, modern totalitarian environmental policies have resulted in disastrous consequences. During the Cultural Revolution, Chairman Mao of China commanded peasants to kill all of the country's small birds as they were eating grain and crops. This mass culling of birds, however, only led to an even more massive infestation of insects. Gamal Nasser's Aswan dam has upset the natural balance of flooding, silted up portions of the Nile and has made much of the river undrinkable and dangerous even to touch. The construction of the enormous Three Gorges Dam in China shows that centralized and environmentally risky projects can still be pursued in China's hybrid command capitalist system. The taming of rivers was also one of the major objectives of Stalin's rule. Dams and other massive centralized projects not only allowed the efficient, domestic production of electricity and the centralized control of resources, but they also provided the totalitarian ruler with a great deal of prestige. Unlike the pharaohs and kings of the past who called on the gods to bring down the rains, the modern totalitarian need only flip a switch.

Unlike democratic societies, in which environmental policy is often shaped by popular movements to preserve human welfare, totalitarian systems have little regard for long-term environmental consequences. The primary concern of the totalitarian ruler is how environmental policy can enhance the regime's grip on power.

SEE ALSO: Aswan High Dam; China; Dams; Egypt; Movements, Environmental; Three Gorges Dam.

BIBLIOGRAPHY. Hannah Arendt, *The Origins of Totalitarianism* (London, 1986); Juan Linz, *Totalitarian and Authoritarian Regimes* (London, 2000); Max

Weber, *The Agrarian Sociology of Ancient Civilizations* (London, 1976).

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Total Maximum Daily Load (TMDL)

THE PASSAGE OF the federal Clean Water Act in 1972 established the water standard qualities and the total maximum daily load (TMDL) ceiling. The TMDL is intended to maintain the quality standards of water. To do so, TMDL is set to control the amount of pollutants that are allowed to flow into a given water source. The TMDL is calculated by adding the allowed pollutant loads for point sources, nonpoint sources, projected growth, and a margin of safety, resulting in a sum that is the TMDL.

Every state is responsible for its own water quality levels by establishing its own TMDL. However, if the state fails to do so, the U.S. Environmental Protection Agency (EPA) is then responsible to prevent pollution to the water. Because TMDL implications were not clearly defined in the federal regulations, its details continue to evolve and the EPA must adapt in many ways.

The TMDL process starts with identifying the water sources that do not meet the water quality standards. When water that does not meet the standard is identified, the cause of the pollutant for that particular area is investigated. Water sources containing more important or potentially dangerous pollutants are prioritized to be addressed earliest, so that the ones with more minor pollution issues, which often occur naturally, are at the bottom of the priority list. In order for certain areas to pass the state water standards, the TMDL staff must work hard to control the amount of the pollutants allowed into the water.

More than 40 percent of the water from the total U.S. watersheds did not meet the federal quality standards, leading the EPA to take actions to improve the TMDL programs. In the 1992 TMDL regulations established by the EPA demanded that the states and authorized groups publicly list waters that were polluted. Those water sources had to meet the standards in order to be removed from the list. There is a two-year listing cycle, and the authorities in charge of a particular water source are required to submit the list of polluted waters on the first of April of every even year. To avoid excluding certain polluted waters, the EPA required that the authorities provide a good reason to not include certain waters or remove waters from the list of polluted waters. The authorities in charge have 30 days to provide the list of polluted waters to the EPA. If some of them are disapproved by the EPA, the EPA has to come up with the list within 30 days and have the approval of the public or the list they disapproved from the authorities will be approved.

After an approval for a TMDL, all the authorities and responsible organizations must regularly update the progress of the process. The evaluation of a TMDL is performed by monitoring the loading of pollutants, keeping track of the controls of the pollutants, assessing water qualities, and then reevaluating the TMDL for water standards.

The priority of cleaning a certain watershed is determined not by the percentage of pollution, but by the priorities set on how the water is being used. When the water directly affects people's health, the source is ranked higher. Some of these risks include water used for fishing, swimming, and drinking water.

In 1997 the EPA established updated guidelines for the TMDL program to address issues raised as the program itself developed. In the new program, there are some recommendations that were also included to help address these issues. After the authorities establish the list of polluted waters, they normally have to come up with a resolution within eight to 13 years. When the schedules are made for the water sources, there are factors that need to be considered, including the number of segments of the polluted water, the distance of the water that needs cleanup, the number of similarities and differences among these waters, and significance of the threat of the pollutant in the water.

SEE ALSO: Clean Water Act; Drinking Water; Nonpoint Source Pollution; Point Source Pollution; Pollution, Water; Water Quality.

BIBLIOGRAPHY. Center for TMDL and Watershed Studies, tmdl.net (cited May 2006); North Carolina Division of Water Quality, "Modeling and TMDL Unit: The N.C. TMDL Program," h2o.enr.state.nc.us (cited May 2006); State of Maryland Department of Environment, "Total Maximum Daily Loads," www.mde.state.md.us (cited May 2006); U.S. Environmental Protection Agency, "Overview of Current Total Maximum Daily Load-TMDL-Program and Regulations," www.epa.gov (cited May 2006).

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Tourism

TRAVELING TO DISTANT places and lands has been a human activity since people first began to spread over the earth. However, there has always been a difference between visiting, inspections, migrations, business trips, scientific expeditions, pilgrimages, and tourism.

The great improvements in transportation in the 19th century opened the way for enormous numbers of people to go on tours around Europe and beyond for recreation such as visiting spas, or other leisure purposes. At first, touring was affordable mainly to the gentry, but with rising levels of prosperity members of the emerging middle class went touring.

Before World War II, most touring was of the United States, Canada, or in Europe west of the Danube. In the United States and Canada a great deal of tourism was by private automobile. After the war, increasing numbers of people traveled from frigid winters in the north to winter in Florida with an inevitable ecological impact.

Much of the postwar tourism was to Europe by cruise ships, until the advent of trans-Atlantic and then global passenger air travel made almost any place in the world accessible in just a matter of hours. The boom in the mass tourism industry since 1945 has had a significant impact on tourist sites, both historic and natural. Today, from San Francisco to Sydney, Australia or from Alaska to Antarctica, masses of tourists travel over the globe in search of leisure, recreation, or educational experiences. Companies compete for tourist dollars by advertising travel to almost any place in the world at an affordable price for most people. Cruise ships ply the Mediterranean, Baltic, and Caribbean Seas, as well as other waters.

ECOTOURISM

So voluminous has the tourist trade become that "ecotourism" has developed as a form of tourism. Ecotourism or ecological tourism seeks to give travelers on nature tours experiences of nature that do not harm the environment. The goal is to create a benign, sustainable tourism.

Ecotourism may seek volunteers to be part of scientific research on natural areas. It usually takes tourists to places where the cultural heritage or fauna and flora are the main attraction. This may mean being paddled by expert boatmen in *bancas* (traditional dugout canoes) up the Bumbungan River to the Pagsanjan (Magdapio) Falls on southern Luzon island, the Philippines. Or it may mean touring Palawan Island in the Philippines for the rich diversity of species that can be found there.

Ecotourism to Costa Rica features tours that present the extremely rich environment of Costa Rica, which can include tours of active volcanoes. Tourism of the volcanoes in Hawaii and well as of some of the numerous ecological areas in the islands is oriented toward preserving the unique ecosystem.

In the case of wilderness adventures, ecotourism may mean hiking with backpacks or riding horseback into remote areas of the Rocky Mountains or other wild areas of the world. The number of people visiting such areas has grown tremendously and shows no signs of leveling off.

Many of these wilderness adventures may stress personal growth; others may teach new ways to live in harmony with nature. Or they may focus on local cultures or volunteering to preserve areas of cultural or natural interest. Always these programs seek to minimize the impact of traditional tourism. They also seek to protect or encourage the preservation of local cultural heritage areas. To minimize adverse effects on the environment or the traditional culture, the touring program is designed to minimize the impact of the visitors.

To design an ecologically friendly touring program requires an evaluation of the natural environment and the cultural heritage area of the local people. The goal is to ensure hospitality providers have means for recycling and efficient use of water and energy, while creating economic opportunities for local people. Conservation practices that preserve both biological and cultural diversity must be implemented. Sustainability must be sought to prevent heritage or habitat destruction. The jobs created must include jobs for indigenous people; their input is also absolutely necessary and their participation in the management of tourism is essential.

To achieve these goals, the focus is put upon sustainable activities. For example, ecotourism is an issue in the Carpathian Mountains in Romania which are little changed since the Middle Ages. The region is still filled with bears, bison, lynx, wolves, and a variety of other wildlife. A program backed by the United Nations is seeking to promote sustainable tourism there. Balea Lac, Romania, is the site of a wintertime "ice hotel." High in the mountains, it can be reached only by cable car. The cost of building it is low and it melts away in the spring; yet it attracts those willing to pay for a sustainable adventure.

Globally, there are efforts underway to define and describe ways to create environmental tourism for the sake of the planet and for future generations. The use of environmental certificates is probably not sufficient because some tours are to extremely sensitive areas. Some tour companies treat ecotourism as a marketing tool, or as some critics call it, "green-washing." Other critics have pointed out that putting a magnificent hotel in a beautiful landscape does not qualify as environmental tourism; in fact it is just the opposite.

Some suggest the aim should be to make all *tourism more environmentally, economically, and culturally sustainable.*

ENVIRONMENTAL IMPACTS OF TOURISM

Humans can have an enormous environmental impact even outside of extremely sensitive areas. In some places the ecological impact of great numbers of people can be very serious. The influx of tourists to Zion Canyon in Utah's Zion National Park frightened away its population of mountain lions. This allowed the deer population to explode; deer browsing on a great number of plants led to the destruction of cottonwood seedlings. This affected a great many species, including toads and butterflies, in a "trophic cascade" in which most species disappeared. Comparison with nearby areas where humans normally do not go and where mountain lions still prowl showed a balanced ecology.

Tourism has been economically profitable to many areas of the world. The income earned from tourist visits has in many areas provided incentives for developing, managing, and preserving tourist sites. Tourism to environmentally sensitive areas such as the coral reefs in the Florida Keys grows, but so does local concern for protecting such vital resources.

Many nations are now seeing environmental tourism as essential for the preservation of tourist income. In many places tourism is first, second, or third in income generation for a nation's gross domestic product.

SEE ALSO: Beaches; Coral Reefs; Costa Rica; Development; Ecotourism; Galapagos Islands; Globalization; Indigenous Peoples; National Parks; Poverty; Recreation and Recreationalists; Safaris; Sustainability; Transportation; Underdeveloped ("Third") World.

BIBLIOGRAPHY. Brian Garrod and Julie C. Wilson, *Marine Ecotourism: Issues and Experiences* (Multilingual Matters Ltd., 2003); Andrew Holden, *Environment and Tourism* (Taylor & Francis, 2000); Stephen Page and Ross K. Dowling, *Ecotourism* (Longman Group, 2001); Joseph L. Scarpaci, *Plazas and Barrios: Heritage Tour-*

ism and Globalization in the Latin American Centro (University of Arizona Press, 2004); Hellen Vriassoulis and Jan van der Straaten, eds., *Tourism and the Environment: Regional, Economic, Cultural, and Policy Issues* (Kluwer Academic Publishers, 1999).

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Toxaphene

TOXAPHENE IS A now-banned insecticide that was previously used extensively across the United States to control insect pests in cotton-growing areas in particular. It is generally encountered as a gas or as a waxy, yellowish solid with an aroma of turpentine. Toxaphene is made up of some 670 separate chemical substances and has an average chemical structure of $C_{10}H_{10}Cl_8$ (it is also known as chlorinated camphene and other names). Although effective in its role as an insecticide, it has also been found to have serious negative impacts on human health including damage to the kidney, lungs, and nervous system; severe exposure to the substance might lead to death. The substance is persistent in the environment and not susceptible to biodegrading. Consequently, although it has been banned completely since 1990 (and in most of the country since 1982), its presence is still regularly found in many parts of the country. It accumulates within the bodies of mammals or fish and so its effects can start to occur years after initial exposure.

Because toxaphene will evaporate from its solid state and only imperfectly dissolves in water, it can remain active in the atmosphere for extended periods. Research indicates its pervasive presence in the Great Lakes area as well as other locations. While in use, its presence in the air was measured at one part per billion and this level has presumably declined in subsequent years. Its presence in drinking water is very rare, although it is most prevalent in those bodies of water in which it was used to eliminate what were considered excess species or numbers of fish. Its presence is greater at the lower levels of such bodies of water, where it tends to collect. However, there is comparatively little information about the impact of mild exposures to the substance or the point at which mild exposure becomes dangerous. Nevertheless, it is classified as a probable carcinogen for humans. Exposure is possible through atmospheric interaction, drinking contaminated water, or eating fish or shellfish that are contaminated. Research suggests that while the substance is detectable over wide areas, few such areas are heavily contaminated to the extent of representing a serious menace to human life.

Toxaphene is an example of the almost indiscriminate use of a substance that subsequently turns out to be dangerous to people and animals and damaging to the environment. It demonstrates the need for a properly rigorous testing regimen prior to the licensing of new chemical substances and the need to monitor their effects in the light of new learning.

SEE ALSO: Carcinogens; Marine Pollution; Pesticides; Pollution, Air; Pollution, Water.

BIBLIOGRAPHY. Agency for Toxic Substances and Disease Registry (ATSDR), "ToxFAQs for Toxaphene" (ATSDR, 2006), www.atsdr.cdc.gov (cited December 2006); Environmental Protection Agency (EPA), "Toxaphene" (EPA, 2000), www.epa.gov (cited December 2006); Jianmin Ma et al., "Tracking Toxaphene in the North American Great Lakes Basin: 2. A Strong Episodic Long-Range Transport Event," *Environmental Science and Technology* (v.39/21, 2005); M.A. Saleh, "Toxaphene: Chemistry, Biochemistry, Toxicity and Environmental Fate," *Review of Environmental Contaminants and Toxicology* (v.118, 1991).

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Toxics Release Inventory (TRI)

THE TOXICS RELEASE Inventory (TRI), established under the U.S. Emergency Planning and Community Right-to-know Act (EPCRA), is a database produced by the U.S. Environmental Protection Agency (EPA) that tracks chemical releases and waste reported by major industrial facilities.

The EPCRA established the TRI and it requires the industrial facilities to annually report releases of waste into the environment to the EPA.

Not all toxic releases are covered by the EPCRA Act; the categories that qualify to be on the list are determined by whether or not they may damage public health, such the possibility of causing cancer, reproductive defects, or anything harmful to the neurological functions. In addition, the possible effects of toxic releases on the environment and animal life are also addressed.

The EPA has never officially inventoried the number of chemicals produced in the United States that are actually able to meet the TRI's requirements. The number of substances that are currently covered by the TRI is 650, which is equivalent to only 1 percent out of over 75,000 substances that are manufactured in United States.

TRI is based on company self-reporting and companies are held responsible for the accuracies of the reports. There is currently no penalty mechanism for those who provide inaccurate reports. Unfortunately, because TRI has been lenient about the accuracy and exact measurement of waste releases, many companies estimate them rather than actually measure them. The Environmental Integrity Project (EIP) estimated after a study that the companies are inaccurate about their waste release by as much as 15 percent.

The EIP tries to pinpoint the sources of inaccurate data in company reports, and one of the most frequent causes is improper emission monitoring, which has been replaced by the method of estimation. Even though most of the companies use the method of estimation to monitor the waste emissions, there are as few as 4 percent of all the companies who do in fact use the proper accurate emission monitors.

Companies frequently underreport emissions, causing the public to remain unaware of exposure to waste emissions and toxic substances, especially those released into the air. Companies have also made unintentional, though no less egregious, reporting errors, such as putting down the incorrect geographic locations of their company. In demanding more accurate reports, environmental defense associations have worked to correct these errors.

The TRI has expanded significantly since 1987 dramatically increasing the number of substances it covers. Seven additional sectors have been added to broaden industry coverage. Being a crucial tool for community information and advocacy, the TRI has gained a great deal of support nationwide with the hope of holding companies more accountable for chemical waste emissions.

SEE ALSO: Environmental Protection Agency (EPA); Pollution, Air; Pollution, Water; Waste, Solid.

BIBLIOGRAPHY. Louisiana Department of Environmental Quality, www.deq.state.la.us (cited May 2006); U.S. Environmental Protection Agency Toxics Release Inventory Program, www.epa.gov/tri (cited May 2006); U.S. National Library of Medicine, National Institutes of Health, www.nlm.nih.gov (cited May 2006).

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Trade, Fair

IN THE RAPIDLY-EXPANDING alternative trade movement known as fair trade, consumers in more developed regions of the globe subsidize the livelihoods of small-scale, marginalized farmers in poor countries by paying a premium for their goods. This new and more direct ethical relationships between rich consumers and poor producers contributes to the social, economic, and community development of fair trade growers. Fair trade has been characterized as "working in the market but not of it." The multi-million dollar fair trade market has become serious business; it is now defined by its moves into mainstream retailers as much as by its alternative economic model, new markets, and novel development opportunities for third world farmers.

Begun in the 1970s with the importation of handicrafts, fair trade was developed by European and American aid organizations with social justice underpinnings. Early activist groups include Max Havelaar (Netherlands), Oxfam and Traidcraft (United Kingdom [UK]), Ten Thousand Villages (United States), and GEPA (Germany). The idea has long been to develop trading relationships that give poor farmers opportunities to enter markets under favorable conditions and move out of poverty. Current arguments put forth fair trade as an antidote to the excesses of "free trade" globalization with its control of markets by multinational corporations and wildly fluctuating or plummeting prices for coffee, cocoa, sugar, bananas, and other tropical crops. For example, the world price for coffee is at its lowest in decades, and, of the average price paid at a café, less than 1 percent of the value of a cup of coffee is captured by growers.

As the market has grown, a formalized regulatory system has developed. Currently, the Fairtrade Labelling Organizations International (FLO), created as an umbrella organization of 17 Euro-American labeling groups, maintains the standards for the Fairtrade logo. International production standards work to stimulate demand through consumer trust in the fair trade market.

Generalizing across products, fair trade standards involve: (1) A guaranteed price floor for all commodities—the minimum price for a pound of coffee is $1.21, which covers the cost of production and producers' livelihood support; (2) a "social premium" of 10 percent or more ($.05 for coffee) is tacked on to pay for community development such as new schools; (3) transparent and long-term trading contracts so communities might invest in new production techniques; (4) access to credit to smooth income streams; and (5) shorter supply chains to reduce intermediaries and permit farmers to capture more of the value of commodities.

To participate in fair trade, producers—like the long-standing Mexican coffee cooperative UCIRI—must: (1) Be a democratically-run cooperative and use the fair trade premium to the benefit of members; (2) be committed to improving the environmental conditions of production; and (3) prohibit child and slave labor. New standards have been created for workers on fair trade estate-farms and plantations.

The FLO then certifies that these and other standards are being adhered to by performing audits at each stage in the commodity chain. After this certification, the Fairtrade logo can be used on the packaging of all commodities deemed fairly traded. This logo is important as it demonstrates to consumers the "fairer" conditions under which a particular commodity was produced and differentiates these products on supermarket shelves.

Fair trade contributes to environmental conservation in several ways. First, production standards dictate that all cooperatives must work to resource management plans to encourage environmental conservation. Second, fair trade supports small farmers actively involved in resource conservation through the use of traditional farming methods, such as growing coffee under a canopy of trees. Eighty percent of U.S. fair trade coffee is grown this way (i.e., shade-grown) as it maintains a greater biodiversity of trees, insects, and birds. Third, greater economic resources have permitted many cooperatives to become organically certified (80 percent of U.S. fair trade coffee is organic) and institute sustainable post-harvest techniques. Recent work by the anthropologist Mark Moberg, however, describes how fair trade's specified environmental standards can be difficult to comply with given the poverty and marginality of third world farmers.

Fair trade markets have boomed in the last few years. In 2004, the UK market total for all fair trade products was £140 million ($252 million), with a massive 70 percent increase from the year before. Also, in 2004, the U.S. market for fair trade coffee was $369 million, a 75 percent increase from 2003. Over one million producers in 48 countries worldwide are now growing for fair trade markets. Through the fair trade "difference"—minimum prices combined with the price premium—the U.S. fair trade coffee market alone provided $26 million in additional money to producers in 2004. Many attest to these real economic and allied social benefits as evidence of fair trade's impact beyond its tiny international market share.

While there is little doubt that fair trade markets will continue to expand, some new developments include: The movement of fair trade products into large supermarkets in the United States and the UK; the growing ability of fair trade markets to build-up small-producer capacities to enter into larger commodity markets and leave the niche of fair trade behind; the growth of certified "fair trade towns" and "fair trade universities" in the UK where fair trade products are supplied to citizens and students; and the expansion of fair trade into manufactured products like soccer balls and clothes.

SEE ALSO: Coffee; Ethics; Globalization; Green Consumerism; Markets; Moral Economy; Organic Agriculture; Poverty; Trade, Free; Underdeveloped ("Third") World.

BIBLIOGRAPHY. Fairtrade Labelling Organizations International, www.fairtrade.net (cited November 2006); Mark Moberg, "Fair Trade and Eastern Caribbean Banana Farmers: Rhetoric and Reality in the Anti-Globalization Movement," *Human Ecology* (v.64, 2005); Douglass Murray, Laura Raynolds, and Peter Taylor, *One Cup at a Time: Poverty Alleviation and Fair Trade Coffee in Latin America*, (Fair Trade Research Group, 2003), www.colostate.edu (cited November 2006); Alex Nicholls and Charlotte Opal, *Fair Trade: Market-Driven Ethical Consumption* (SAGE, 2005); Oxfam International, *Mugged: Poverty in Your Coffee Cup*, www.maketradefair.com (cited November 2006).

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Trade, Free

MUCH OF CONTEMPORARY economic policy is based on the notion that free trade raises the standard of living of all countries. This is the position espoused by advocates of neoliberal economic policies such as those of the World Trade Organization (WTO), its precursor, the General Agreement on Treaties and Tariffs (GATT), and the North American Free Trade Agreement (NAFTA). Yet, many environmentalists and antiglobalization activists remain critical of that assertion that free trade benefits the environment, suggesting that free trade actually leads to a race to the bottom in which polluting industries migrate to countries with the lowest standards.

The argument about free trade begins with the assumption that tariffs, taxes, subsidies, and regulations across international boundaries distort the terms of trade. The purported consequences of this leads to economic inefficiencies and imposes artificial costs on the movement of goods. One of the central tenets of free trade is the principle of comparative advantage, a theoretical explanation for why two countries can both benefit from international exchange. The first mention of comparative advantage is in economist Robert Torrens's *Essay on the External Corn Trade*. But the idea is often attributed to the English economic philosopher David Ricardo who sought to explain why both Portugal and England benefitted from their exchange of wine and cloth. Ricardo argued that Portugal could produce wine more cheaply than England. Even though England and Portugal could both produce cloth at similar costs, it was still beneficial for Portugal to produce more wine for trade with England because of benefits from economies of scale.

Since the time of Ricardo, the theory of comparative advantage has come under fire for some of its primary assumptions. For example, Ricardo assumes that transportation costs are negligible. This assumption may hold true in today's economy of subsidized oil, but it certainly does not account for externalities. Ricardo also assumed negligible labor costs because he assumes that there would also be a free market in labor, something that does not hold up in today's economic and political circumstances.

Perhaps the biggest pitfall to following the comparative advantage policy prescription is the narrow, even risky, set of economic enterprises that a country relies on. A good example of this can be found in the Yucatan, Mexico, as told by historian Sterling Evans. In the early 1900s, the Yucatan exported extensive quantities of sisal fiber, derived from an agave plant (*spp. Agave sisalana*) similar to that used to produce tequila, to the United States where it was used to bind wheat. Successive years of bumper wheat crops and a free trade zone in New Orleans made sisal production so profitable that by the 1920s and 30s the Yucatan was the wealthiest Mexican state and the first with electricity. But soon after extensive sisal monoculture plantations were established throughout the region, the combine harvester, which could bind the wheat at harvest, was invented, rendering the fiber useless to the U.S. wheat industry. The sisal plantations were subsequently abandoned and soon the Yucatan was one of the poorest states in Mexico. The low diversity of economic engagements and the dependency on a single industry were to blame.

Before free trade became the dominant economic ideology, it was opposed by mercantilism. The mercantilists argued that the state should protect national interests through policies that promote protectionism. The protectionism was in the form of tariffs and import restrictions. Since mercantilism rested on an economic base of gold and silver bullion, it provided much of the impetus for early European imperial ambitions. Mercantilism was the dominant economic ideology of the 16th–18th centuries until it was supplanted by the laissez-faire economic policies of free trade proponents such as the physiocrats and later by the teachings of Adam Smith and Ricardo.

Often, nations will enact trade restrictions in order to improve the health of its citizenry, yet they will still be accused of protectionism, creating a conflict between the autonomy to protect human health and the global goal of free and unrestricted trade. The most disconcerting of these conflicts culminated with the two 19th-century Opium Wars. The Chinese emperor had completely restricted the import of opium as the nation was suffering from an addiction epidemic. Subsequently, British gunboats surrounded Chinese ports demanding that they open their markets to British imports of opium because the British had a considerable trade imbalance with China.

Often environmental regulations are considered barriers to free trade. Some rulings at the WTO have made this explicit. For example, the United States banned the import of Mexican tuna caught with purse seine nets because it inadvertently killed significant numbers of dolphins; the ban was justified by the U.S. Marine Mammal Protection Act. However, a GATT tribunal ruled that all like products should receive like treatment and that how a product was harvested could not be considered in the determination of likeness. Another case involved an amendment to the Endangered Species Act to include a ban on shrimp imported from countries that do not require turtle excluder devices. After suit was brought by Malaysia, Thailand, Pakistan, and India, the WTO dispute settlement tribunal reasoned that the requirement was excessive and an illegal barrier to trade.

More disconcerting to environmentalists are the investor rights provisions of free trade agreements that offer an opportunity for private companies to sue nations for regulatory takings. Part of the neoliberal free trade policy paradigm is the belief that regulations that affect investment are also seen as barriers to trade. NAFTA's Chapter 11 provides protections to the rights of investors and has been considerably controversial. In one case the Ethyl Corporation of North Carolina sued the Canadian government for banning the fuel additive MMT, a manganese-based fuel additive already banned in the United States. Fearing a NAFTA dispute tribunal would rule that the Canadian government ban was made without enough scientific evidence to support its environmental and health consequences, the Canadian government paid $13 million to the Ethyl Corporation and reversed their ban on MMT. This was the first of several cases under NAFTA's Chapter 11 that had direct implications for environmental policies. A similar, but global, investor rights provision called the Multilateral Agreement on Investment was targeted by activists in 1997 and defeated.

Free trade in cross border capital transactions has trended toward short-term speculation, putting some countries at the mercy of international investment trends. This can greatly affect the relative strength and stability of some national currencies. Opposed to the idea of free trade is the proposed Tobin tax, a tax that aims to discourage short-term currency speculation by taxing individual cross border financial investments in currency. Because the proposed tax is small and done on a per volume basis, long term investments, necessary for maintaining the strength of some currencies, would not be affected. It has been proposed that the United Nations manage the tax fund, which is estimated to generate hundreds of billions of dollars per year and apply it to humanitarian and emergency situations. The Tobin tax is championed by many environmental nongovernmental organizations (NGOs), green movements, and the antiglobalization movement.

One of the significant questions debated is whether or not free trade is a race to the top or a race to the bottom regarding environmental regulations. Critics of free trade's impact on the environment argue that polluting industries will move to poor nations that have weak environmental regulations, creating pollution havens. Proponents of free trade argue that it will result in a ratcheting up of environmental policy, citing the famous Kuznets curve, which argues that environmental conditions improve with increased national income. Cases have shown both to be true. For example, the regulation of genetically modified organisms in the European Union has led the United States to improve its environmental regulations. On the other hand, in the United States, some polluting industries have moved across the Mexican border out of the Los Angeles Basin in the years subsequent to NAFTA. It might be argued that if the nations involved are on equal footing, it is possible that free trade will lead to a situation where regulations improve. But if the countries are in disparity regarding wealth or environmental protections to begin with, it could lead to a situation where regulations improve.

The negotiation of global free trade agreements has proceeded in a series of rounds since the founding of the GATT after World War II. It was during the Uruguay Round that the WTO was founded as an organization to implement the principles previously held by the GATT. Perhaps the most widely covered trade negotiation session in the popular press was in Seattle where the WTO Millennial Ministerial was shut down by tens of thousands of activists and labor union organizers in 1999. Since then the WTO, while still sticking to the neoliberal orthodox of free and unhindered trade, has become enmeshed in the discourse of sustainable development.

Since the Uruguay Round, when many developed nations promised to decrease subsidies to their producers of agricultural goods, and many developing countries actually removed their own, agriculture has been a sticking point in free trade negotiations. The high level of protectionism and the entrenched subsidies provided to developed world agricultural producers has led to a disparity in the impact of free trade on agricultural producers where many farmers in developing countries are exposed to the whims of international competition, unlike their counterparts in the developed world. These debates and negotiations are played out through the WTO Agreement on Agriculture.

There are still debates about whether or not multilateral environmental agreements like the Convention on Biodiversity, the Montréal Protocol, and the Basel Convention have jurisdictional precedence over WTO rules, a question of considerable importance to international environmental law. For example, the WTO Agreement on Trade-Related Aspects of Intellectual Property Rights comes into conflict with the Convention on Biodiversity on the issue of benefit sharing with indigenous farmers regarding plant genetic resources. The Cartagena Biosafety Protocol of the Convention on Biodiversity also comes into conflict with the Agreement on Technical Barriers to Trade because it is often asserted that regulations and bans are surrogates for protectionism.

Whether by slip of tongue, or honest confusion, people often confuse *free trade* with *fair trade*. But the terms have very different meanings. Proponents of free trade often suggest that free trade is fair trade. But advocates of fair trade use the term to signify an attempt to link consumers more directly to producers, redistribute inequality in terms of trade, and provide a minimum price to low-income producers, notably in cocoa, bananas, and coffee.

SEE ALSO: Capitalism; Globalization; Markets; Movements, Environmental; North American Free Trade Agreement (NAFTA); Race-to-the-Bottom Hypothesis; Subsidies; Sustainable Development; Trade, Fair; World Trade Organization (WTO).

BIBLIOGRAPHY. Sterling Evans, *Bound in Twine: Transnational History and Environmental Change in the Henequen-Wheat Complex for Yucatan and the American and Canadian Plains: 1880–1950* (Texas A&M University Press, forthcoming 2007); Kevin P. Gallagher, *Free Trade and the Environment: Mexico, NAFTA, and Beyond* (Stanford University Press, 2004); Howard Mann, *Private Rights, Public Problems; A Guide the NAFTA's Controversial Chapter on Investor Rights* (International Institute for Sustainable Development, 2001); Gary Sampson, *The WTO and Sustainable Development* (United Nations University, 2005).

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Trade Winds

THE TRADE WINDS are a persistent band of easterly winds that blow toward the equator in both hemispheres, covering most of the earth between 25 degrees N and 25 degrees S latitude. These winds originate on the equatorial sides of subtropical high-pressure systems that exist over the tropical and subtropical oceans and represent a major component of the general circulation of the atmosphere. The high-pressure areas force air to move toward a belt of low-pressure near the equator called the doldrums. The air converging at the doldrums rises high over the earth, recirculates toward the poles, and sinks back toward the earth's surface to about 30 degrees latitude, thus completing a cycle. The surface air that flows from the subtropical highs toward the equator is deflected toward the west in both hemispheres because of the earth's west-to-east rotation. This results in the northeast trade winds in the Northern Hemisphere and southeast trade winds in the Southern Hemisphere.

The most reliable winds on earth are unquestionably the trade winds. They are extremely consistent in both direction and speed throughout the year, averaging about 11 to 13 miles per hour (18 to 21 kilometers per hour). These steady winds are called trade winds due to their ability to quickly propel trading ships across the ocean. The trade winds were named by the crews of sailing ships that depended on these winds during ocean navigation. The name *trade winds* derives from the Old English "trade," meaning "path" or "track," because of the regular course of the winds. These winds helped carry Christopher Columbus on his voyage to the New World in 1492. Mariners of the 16th century recognized early that the quickest and most reliable route for their sailing vessels from Europe to America lay in the belt of the northeasterly winds in the tropical North Atlantic Ocean.

The trade winds are best developed on the eastern and equatorial sides of the subtropical high-pressure systems, especially across the Atlantic Ocean. The trade winds are stronger and more consistent over the oceans than over land due to increased friction on the continental surfaces. When the trade winds reach the western edge of an ocean basin, they turn toward the poles and then loop back east to become part of the prevailing westerlies. The trade winds are primarily a surface wind and move north and south about 5 degrees with the seasons.

The trade winds originate as warm, dry winds capable of holding a tremendous amount of moisture. As they blow across the tropical oceans, they evaporate huge quantities of moisture. The trade winds are overlain by warmer and drier air, creating a temperature inversion in which temperatures increase with height. The temperature inversion often limits the vertical development of clouds, producing clear skies that make trade wind islands a popular tourist attraction. As the trade winds blow against mountain ranges, they are forced to rise and cool. This allows the moisture to condense and fall as rain. These conditions create large differences in rainfall due to topographic variations. Low-lying islands usually experience desert-like conditions, while the windward slopes of some islands are among the wettest places in the world.

SEE ALSO: Atmosphere; Climatology; Orographic Effect; Precipitation; Weather.

BIBLIOGRAPHY. Edward Aguado and James E. Burt, *Understanding Weather and Climate* (Prentice Hall 2004); Frederick K. Lutgens and Edward J. Tarbuck, *The Atmosphere* (Prentice Hall, 2004); Tom L. McKnight and Darrel Hess, *Physical Geography: A Landscape Appreciation* (Prentice Hall, 2005); Brian J. Skinner and Stephen C. Porter, *The Blue Planet: An Introduction to Earth System Science* (John Wiley and Sons, 1994).

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Tragedy of the Commons

THE "TRAGEDY OF THE COMMONS," probably the most common framework through which environmental issues are understood today, was made famous by biologist Garrett Hardin in a 1968 essay in *Science*. Hardin was specifically concerned with population growth and invoked the notion made popular by Thomas Malthus in 1798 that because population grows exponentially while food supply grows only linearly, population growth will lead inevitably to starvation, war, and disease, and eventually to a collapse in population levels. Hardin argued that population growth is a tragedy of the commons, which he explained with this image: "Picture a pasture open to all. It is expected that each herdsman will try to keep as many cattle as possible on the commons." Every animal that is added contributes to pasture degradation, but this negative effect is shared by all of the herders. Each herder enjoys full benefits, however, from adding an additional animal to his own herd. Because each herder acts to maximize his or her own gain, more and more animals will be added. In the end, this leads to overgrazing and a tragedy of pasture degradation: "Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited...Freedom in the commons brings ruin for all." Hardin argued that there are only two solutions to this problem. The first option is coercion, or control of each individual's behavior by an outside agent, particularly the state. The second is to privatize the commons; only if the common pasture is divided up into privately owned parcels will individuals take care of the resource, and thus preserve it from overuse and destruction.

Though Hardin's essay was focused on overpopulation, its broader legacy has been the idea that environmental resources held in common are naturally and inevitably subject to overuse and degradation. The metaphor of the "tragedy of the commons" has become conventional wisdom for understanding all kinds of environmental problems today, including: the depletion of ocean fisheries, hunting that led to the extinction of the American passenger pigeon, rangeland degradation, the overuse of national parks, and a variety of pollution problems.

Despite its popularity, Hardin's tragedy of the commons is flawed in many respects. First, Hardin's idea was modeled after an inaccurate understanding of the medieval English commons. Far from being completely unregulated and free for the taking, common pastures were available for the use only of specific villagers or individuals; even for them, there were often regulations including limits on the numbers of animals each tenant could put on the pasture. In other words, the model assumes that "commons" are in fact what is more accurately termed an "open access" situation, in which there are no rules and limitations whatsoever on the use of a resource.

The model also assumes that users do not have or develop social or cultural norms that might cause them to regulate their resource use, and that users are inherently selfish, have perfect information, and always seek to maximize their short-term gains. In other words, the model of the tragedy of the commons fails to take into account the specific historical, social, and cultural contexts of resource users.

To further understand this model, it is helpful to distinguish between the characteristics of a resource itself, and the characteristics of the system that governs resource management. Two key characteristics of resources in general are first, whether it is easy or hard to control access to the resource (excludability); and whether one person's use of the resource takes away from another's (subtractability; sunlight is an example of a nonsubtractable resource). Common property resources (sometimes called common pool resources) are those that are subtractable but not easily excludable; these include forests, pastures, fisheries, and sinks for various types of environmental pollution. Resources can be classified into those that are private (subtractable and easily excludable); common; public or state (nonsubstractable and difficult to exclude); and club or toll resources (easily excludable and nonsubtractable).

There is no necessary or automatic correspondence, however, between the type of resource and the management regime under which it is governed. One type of management regime is open-access, where there are no regulations and anyone can easily gain access to the resource. Another type is private property, where the right to use and exclude others is vested in an individual or legal individual (such as a corporation). Third, common property regimes are those in which there is an identifiable set of users who can exclude outsiders and who have legal or informal rules governing use. Finally, in public or state property, the government makes decisions about access to and use of the resource.

The resource overexploitation and degradation predicted by Hardin in the "tragedy of the commons" is indeed often seen in cases where resources are managed through an open access regime. Examples include the depletion of unregulated ocean fisheries, and the current unregulated emissions of carbon dioxide leading to anthropogenic global climate change. Where Hardin went wrong, however, were the assumptions that common property resources are always governed by open access regimes and that common property regimes never work.

In fact, case studies from around the world have shown that common property regimes often work quite well. Well-known cases include Native American hunting and fishing lands in James Bay, cooperative-based coastal fisheries in Japan, communal meadows and forests in the Swiss Alps, medieval irrigation systems in Spain, and contemporary lobster fishing territories in Maine.

Research on successful cases around the world has suggested a number of institutional factors which contribute to the success of common property management. Favorable factors include having clearly defined boundaries around both the users and the resource; ability to monitor resource use; mechanisms for conflict resolution, congruence between local conditions and rules; graduated sanctions; and the legal right to devise institutions and sustain ownership of the common property resource. When these conditions exist, the tragedy of the commons is likely to be averted.

Another flaw often arising from use of the tragedy of the commons model is the assumption that if commons are the problem, then conversely other forms of ownership will not lead to resource degradation. In fact, no type of resource or type of management regime is completely guaranteed in advance to be either sustainable or subject to degradation through overuse. The particular context is important in determining the outcome. As a model of resource degradation, the tragedy of the commons works in some cases, but is too over-simplified to accurately predict or explain the sustainability of resource use in general.

SEE ALSO: Common Property Theory; Hardin, Garrett; Lifeboat Ethics; Malthusianism; Overfishing; Overgrazing; Overpopulation; Pastoralism; Prisoner's Dilemma (PD); Rational Choice Theory; Resources; Scarcity.

BIBLIOGRAPHY. Susan J. Buck Cox, "No Tragedy of the Commons," *Environmental Ethics* (v.7, 1985); Thomas Dietz, Elinor Ostrom, and Paul C. Stern, "The Struggle to Govern the Commons," *Science* (v.302, 1912); David Feeny, Fikret Berkes, Bonnie J. McCay, and James Acheson, "The Tragedy of the Commons: Twenty-Two Years Later," *Human Ecology* (v.18, 1990); Clark C. Gibson, Margaret A. McKean, and Elinor Ostrom, eds., *People and Forests: Communities, Institutions, and Governance* (MIT Press, 2000); Garrett Hardin, "The Tragedy of the Commons," *Science* (v.163, 1968); Thomas Malthus, *An Essay on the Principle of Population* (London, 1798); Bonnie McCay and James Acheson, eds., *The Question of the Commons: The Culture and Ecology of Communal Resources* (University of Arizona Press, 1987); Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action* (Cambridge University Press, 1990).

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Transamazon Highway

THE TRANSAMAZON HIGHWAY was constructed as an east-west road corridor across the Brazilian Amazon during the 1970s. This was one of several interregional road projects promoted by Brazil's then military government as a means of impelling frontier expansion. The military not only sought to relieve agrarian tensions in other parts of Brazil by opening land to landless populations, but also to secure remote portions of the national territory against perceived geopolitical threats by other countries.

Highway construction comprised one component of an integrated model of colonization, which the government implemented by selecting colonists, surveying and demarcating agricultural lots, and otherwise supporting frontier land settlement. The state land agency, INCRA, oversaw design and construction of the road network, which formed a "fishbone" pattern with feeder roads running perpendicular to the Transamazon itself. Colonist families settled along the highway corridor, first in the east, and increasingly toward the west, during the early 1970s. Integral to land settlement was the clearing of upland primary (old-growth) forest, which was not only necessary for colonists to establish land claims but also to plant food crops to feed their families.

In the early 1980s, the legitimacy of the military declined with Brazil's worsening economic situation, forcing the withdrawal of state support for colonization along the Transamazon. This left colonists on their own in very precarious circumstances.

However, in the mid-1980s, prices rose for two key perennial crops, cocoa and black pepper, and colonists who were producing these commodities earned rising incomes. This stimulated a second wave of inmigration to the Transamazon corridor, expanding the population as well as forest clearing for agricultural land use.

In the late 1980s, as Brazil underwent democratization, municipal governments and social movement organizations emerged to support colonists along the Transamazon. Soon after, cocoa and pepper prices declined, as did crop production due to pests, leading again to difficulties. However, this circumstance did not halt deforestation, as colonists shifted their land use, this time to pasture for cattle, which requires much larger clearings than do crops. The availability of new credit lines for small-scale farms, including for colonists along the Transamazon, meant that many colonists had a new source of funds to expand pasture for cattle ranching, something that has continued into the new millennium.

Beginning in the late 1990s, fiscal decentralization in Brazil's government system provided greater funds and responsibilities to municipalities. This intensified local politics over roads as a means of ensuring access by rural populations to urban services and markets. Road building by local groups along the Transamazon has encouraged continued deforestation and forest fragmentation, even in indigenous reserves. The paving of the Transamazon highway west to the town of Altamira, in anticipation of construction of the Belo Monte dam on the Xingú river there, is bringing new changes to the Transamazon corridor. Capitalized interests are increasingly arriving in the area, speculating in land and timber and seeking to expel colonists. The onset of land conflicts between speculators and colonists led to the murder of Sister Dorothy Stang in February 2005, which has again called attention to the link between environmental damage and human rights abuses previously seen elsewhere in the Brazilian Amazon.

SEE ALSO: Amazon River Basin; Brazil; Deforestation.

BIBLIOGRAPHY. John O. Browder and Brian J. Godfrey, *Rainforest Cities: Urbanization, Development, and Globalization of the Brazilian Amazon* (Columbia University Press, 1997); Douglas Ian Stewart, *After the Trees: Living on the Transamazon Highway* (University of Texas Press, 1994).

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Transboundary Rivers

TRANSBOUNDARY RIVERS ARE natural freshwater systems with at least one perennial tributary crossing the political boundaries of two or more states. Also known as international rivers, the 1978 United Nations (UN) Register of International Rivers, updated in 1999, classifies them. According to this update, there are 261 transboundary rivers, which cover 45.3 percent of the earth's surface, excluding Antarctica. A transboundary river basin includes both surface water and groundwater, which contribute hydrologically to a first-order stream before finding an outlet to an ocean, a lake, or an inland sea.

As an important source of freshwater, transboundary rivers are a major environmental concern for the 21st century. This concern is not only related to the land surface included in these basins, but also to the flow generated within these basins: 87 percent of the flow of 25 of the world's largest rivers, representing almost half of the world's total runoff, is generated within transboundary river basins. Additionally, 145 nations, as small as Liechtenstein and as populous as Bangladesh, have territory within such basins.

Rivers have been historically important in determining geopolitical borders, an example is the Danube, which formed the border of the Roman Empire and now forms the boundary between Romania and Bulgaria. Rivers have also served multiple purposes, from providing drinking water, irrigation, hydroelectric power generation, and industrial uses. However, management of transboundary rivers has often proven complicated due to disagreements about river flows, each nation's contribution to that flow, historic uses, and future demand. Such disagreements also focus on the social, ecological, and economic needs of each nation. To visualize dilemmas of management and allocation of water resources in transboundary river basins, one can look at the number of countries which share a transboundary river basin: 19 of 261 basins are shared by five or more riparian countries. A total of 17 riparian countries share the Danube basin, whereas 11 share the Congo and Niger.

Such complexities, combined with increasing water stress due to increases in population, economic growth, and reductions in the quality and quantity of world's freshwater resources, have caused some studies to focus on the danger of violence and wars in the transboundary river basins. Although there has not been an incident of such violence in recent history, these environmental security studies link environmental degradation and scarcity to armed conflict.

Such studies do not usually focus on environmental problems in transboundary basins as the main factor leading to insecurity. Instead, they take environmental degradation, such as pollution, or scarcity as an accessory factory of insecurity. From this perspective, a negative change in the quality and quantity of the renewable, nonsubstitutable resources is but one factor leading to conflict. Environmental change acts as a variable of conflict, exacerbating fault lines between state and society and worsening existing political, economic, and social tensions. For example, studies have envisioned water-war scenarios in the Middle East due to tensions in transboundary rivers, such the Jordan River, which is shared by Jordan, Israel, Syria, Lebanon, and the Palestinian Authority. Water diversion plans by riparian states have been interpreted as aggravating tensions related to the region's aridity, population pressure, and political situation.

Other studies emphasize the possibility of transboundary cooperation based on historic evidence. For example, the Mekong Committee, established over the Mekong by Cambodia, Laos, Thailand, and Vietnam in 1957, continued to exchange data over river basin management throughout the Vietnam War. The Mekong, the seventh largest river in the world in terms of discharge and the 10th in length, is shared by six riparian nations (the Mekong Committee members, Myanmar, and Laos). Various international organizations, including UN institutions and the Global Environmental Facility, have supported the Mekong Committee in promoting sustainable management of the basin. The Mekong Committee has become a useful model for governance of transboundary rivers by providing an international and institutional framework for cooperation prior to the outbreak of a water crisis in the transboundary river basin. Recent studies have focused on river management and allocation of water resources by comparing different transboundary river basins in various disciplines, such as international relations, international law, geography, and environmental studies.

Nations and international organizations have formulated international conventions and established joint management committees to reduce the risk of water-related conflicts and ensure quality and quantity of river flow. Transboundary river management has evolved from the Harmon Doctrine, stating absolute sovereignty over the waters of a transboundary watercourse within the state's territory, to the doctrine of equitable utilization.

The latter doctrine has been applied since the International Law Association's 1966 Helsinki Rules. The UN Convention on the Law of the Non-Navigational Uses of International Watercourses also adopted the equitable utilization principle in 1997, which emphasized the prevention of significant harm and prior notification of planned measures related to the river basin. The convention has not been ratified by the 35 nation states necessary for it to enter into force. Although 103 countries have adopted the convention on a preliminary basis, these principles offer only general guidance and are not mandatory to riparian states.

In addition to the efforts of the international community, bilateral treaties have proven an effective mechanism in transboundary river management. Treaties such as the 1944 Colorado Treaty between the United States and Mexico, and the 1959 Nile River Treaty between Egypt and Sudan regulate the allocation of water for both the upstream and the downstream nations. Similarly, commissions among riparian nations also enable the transparent exchange of data over future development plans, and provide a forum for continuous dialogues. For example, the Indus River Commission has continued to function despite two major wars between India and Pakistan. Such mechanisms enable states to overcome differences in legislation, economic and policy goals, administrative structures, and social and cultural perceptions.

Many transboundary rivers have been dammed or diverted for irrigation, hydroelectric power production, or similar purposes. Such projects come with ecological and social costs. Before the building of the Aswan Dam, the Nile River carried over 120 million tons of sediment to the Mediterranean Sea each year and nearly 10 million tones of this was deposited in the floodplain and Nile Delta. After the construction of the dam, almost all the sediment has remained behind the dam. This caused not only coastal erosion, but also serious reduction in agricultural productivity in the Nile Delta. Moreover, 100,000 people had to be resettled from 1963 to 1969. Dam construction itself may create temporary jobs and generate income for local people. However, loss of lands and livelihoods (such as loss of fisheries after dam construction) raises questions about the social costs of water development projects. Moreover, tensions between states may increase during the filling of a reservoir when the downstream flow is cut off temporarily, especially when there is no prior notification, agreement, or institutional arrangement regarding the flow of the river.

Although the precise nature of related ecological changes is still unclear, global warming is likely to affect the availability of freshwater resources and disrupt the global supply and demand of water and arable land. Increased productivity of water use, stronger policies to regulate the use of water within territories, and the establishment of constructive dialogue among riparian states can help to sustain transboundary river cooperation. The maintenance of such cooperation is crucial in ensuring water and food security, political stability, and the protection of biodiversity.

SEE ALSO: Aswan High Dam; Mekong River; Nile River (and White Nile); Riparian Areas; Riparian Rights; Rivers.

BIBLIOGRAPHY. Stephen C. McCaffrey, *The Law of International Watercourses: Non-Navigational Uses* (Oxford University Press, 2001); Sandra Postel and Brian Richter, *Rivers for Life: Managing Water for People and Nature* (Island Press, 2003); A.T. Wolf, ed., *Conflict Prevention and Resolution in Water Systems*, vol. 5 in *Management of Water Resources* (Edward Elgar Publishing, 2002).

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Transcendentalism

TRANSCENDENTALISM WAS A series of new ideas that flourished among writers and philosophers in New England during the 19th century. The concept of transcendentalism was a state of being that was beyond the reach or comprehension of experience. These ideas centered on a belief in the essential unity of all creation, an innate goodness of man, and the supremacy of insight over logic.

The original concepts of transcendentalism came from Europe, but were also influenced by old Indian texts such as the *Upanishads* and the *Bhagavad-Gita*, Chinese ideas of Confucius, the teachings of Buddha, and work by the Muslim Sufis. Henry David Thoreau (1817–62) paid much tribute to the ideas that came from Vedic thought.

These traditions were merged with Platonism and Neoplatonism by British writers such as Samuel Taylor Coleridge (1772–1834) and Thomas Carlyle (1795–1881), as well as the Swedish thinker and mystic Emanuel Swedenborg (1688–1772) and the German philosophical mystic Jakob Böhme (1575–1624). Some of the ideas came from Prussian philosopher Immanuel Kant (1724–1804) who coined the phrase in his *Critique of Practical Reason* (1788) when he wrote, “I call all knowledge transcendental which is concerned, not with objects, but with our mode of knowing objects so far as this is possible *a priori*.” Other ideas were synthesized from a number of German philosophers.

Although transcendentalism in Europe had been an abstract philosophical concept, in New England, especially in Concord, Massachusetts, it was a liberating philosophy which drew from the Romantic movement. It encouraged the adaptation of ideas from Europe and elsewhere to form what became from about 1830 until 1855 as a battle between the younger and older generations in the United States over the emergence of a national cultural identity based around intrinsic American concepts.

The main people represented in the idea of transcendentalism were Ralph Waldo Emerson (1803–82), Orestes Augustus Brownson (1803–76), James Freeman Clarke (1810–88), Margaret Fuller (1810–50), Elizabeth Palmer Peabody (1804–94) and Henry David Thoreau. Others connected with the movement included Bronson Alcott (1799–1888), the younger W.E. Channing (1780–1842), W.H. Channing (1810–84), Christopher Pearse Cranch (1813–92), Theodore Parker (1810–60) and George Ripley (1802–80). Julia Ward was on the fringes of the group as were others like Jones Very (1813–80).

Although the ideas of the transcendentalists were being formed in the early 1830s, it was the publication of the essay "Nature," by Emerson that proved to be the catalyst for the movement. The Transcendentalist Club in Cambridge, Massachusetts, opened on September 8, 1836, with Emerson, George Putnam, and Frederick Henry Hedge as members. The height of transcendentalism saw Emerson and Fuller establish *The Dial* in 1840. It was a "little magazine" that was published until 1844 and contained many of the best writings by minor transcendentalists.

In 1841, Brook Farm was established as a cooperative community near West Roxbury, Massachusetts, nine miles from Boston. There George Ripley and others from the Transcendentalist Club tried to apply their social, religious, and political theories to a farm of 200 acres called the Brook Farm Institute of Agriculture. It came under the influence of Albert Brisbane, a prominent Fourierist, and was renamed the Brook Farm Phalanx. However, the idea finally collapsed in October 1847, and the group was dissolved.

Another cooperative experiment of the transcendentalists was Fruitlands, which was established by Alcott from 1842 until 1843 at Harvard, Massachusetts. It was planned as a place where members would labor on the land and conduct themselves in a simple manner, eating vegetarian meals and living in harmony with nature. It was even less successful than Brook Farm. It is best remembered through Louisa May Alcott's *Transcendental Wild Oats,* a fictional account of Fruitlands.

Bronson Alcott

Amos Bronson Alcott, to give his full name, was born in Connecticut in 1799 and initially worked as a salesman in the south before returning to New England as a schoolteacher. He taught at the Temple School in Boston from 1834 until 1839, becoming a school superintendent at Concord, Massachusetts, and elsewhere.

It was at the Temple School that Alcott began collaborating with Elizabeth Peabody, his assistant, who edited Alcott's *Record of a School, Exemplifying the General Principles of Spiritual Culture* (1835), which was followed by *Conversations with Children on the Gospels*, published in two volumes (1836–37). These books set forth Alcott's views on the theory and practice of education, but although he gained support from Ralph Waldo Emerson and others in the Transcendentalist Movement, some parents withdrew their children in protest against these radical ideas.

In 1842, Alcott went to England, where he met with Thomas Carlyle. The two exchanged ideas, although Carlyle found Alcott tiresome. Back in the United States, Alcott and his friends established the cooperative Fruitlands. It lasted only seven months, and the family returned to Concord in January 1845. Bronson Alcott continued to expound his political views and also managed to get singing, dancing, reading aloud, and even physiology introduced into the school curriculum.

In 1868, his daughter Louisa May Alcott (b.1832) published her book *Little Women*, which was about her childhood and included an account of Fruitlands. It gained the family the independence they needed, and allowed Bronson Alcott to push forward with the Concord School of Philosophy from 1879 until his death in 1888. Alcott has always been seen as impractical in his ideas, but with a genius for conservation. Louisa Alcott wrote many other books but none achieved the fame of *Little Women.* She died in 1888, two days after her father.

On the religious front, members of the transcendentalist movement were reacting against the 18th-century thought of Alexis de Tocqueville, Alexander Hamilton, and Thomas Jefferson. They were also reacting against New England Calvinism and the rationalist views of John Locke (1632–1704). They repudiated Unitarianism and the idea of an established order and argued in favor of major changes in school curriculum and teaching methods, the right for women to vote, better conditions for the working man, universal temperance, freedom of religious thought, and a change in fashion. These views, at their most extreme, drew many critics who saw the transcendentalists as supporters of anarchy, socialism, and even communism. Although they were certainly against slavery, their focus on New England meant that abolitionism, one of the major religious and social causes of the time, was not a central focus of the transcendentalist movement.

The transcendentalists were also the inspiration for many other writers such as Nathaniel Hawthorne, Herman Melville, and Walt Whitman, leading to the flowering of the American literary scene that critics believe to be the American Renaissance in literature. It has to be said, however, that Nathaniel Hawthorne did later parody the movement in his novel *The Blithedale Romance*, which was based on his time at Brook Farm. Still, it was also from the transcendentalists that ideas about environmental planning and architecture emerged. The environmental designs of Benton MacKaye and Lewis Mumford owe a huge debt to the transcendentalists, as do the architectural designs of Frank Lloyd Wright and Louis Sullivan. Others transcendentalist ideas can be seen in the works and thought of William James, John Dewey, and Alfred Stieglitz.

SEE ALSO: Communism; Locke, John; Religion; Socialism; Thoreau, Henry David; Vegetarianism; Wright, Frank Lloyd.

BIBLIOGRAPHY. Lawrence Buell, *Literary Transcendentalism: Style and Vision in the American Renaissance* (Cornell University Press, 1973); Rosalie Sandra Perry, *Charles Ives and the American Mind* (Kent State University Press, 1974); Joel Porte, *Emerson and Thoreau: Transcendentalists in Conflict* (Wesleyan University Press, 1966); Arthur Versluis, *The Esoteric Origins of the American Renaissance* (Oxford University Press, 2001).

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Transmissible Spongiform Encephalopathies (TSFs)

TRANSMISSIBLE SPONGIFORM encephalopathies (TSEs) are a cluster of rare degenerative brain disorders. Also known as "prion" diseases, they leave their victims with tiny holes in the brain. The tiny holes give it a "spongy" appearance that can be seen under a microscope when a section of brain is dissected. Prion is short for proteinaceous infectious particle. The particle is a protein that occurs in a harmless normal form in the body's cells. However, deadly prion proteins are the proteins that can cause the disease. TSEs are transmissible because the deadly prion protein is acquired from an alien source. Researchers are examining the possibility that TSEs are also infectious. There are many forms of TSEs including Creutzfeldt-Jakob disease (CJD), Kuru ("laughing sickness"), fatal familial insomnia (FFI), and Gerstmann-Straussler-Scheinker disease (GSS).

In addition, a new type of CJD or a variant of it was first described in the United Kingdom and in several continental countries in 1996. The new TSE (designated as vCJD to mark it as a variant CJD) had symptoms that were different from classic CJD. Also, it afflicted much younger people. The cause of the disease may have been the consumption of beef that had a bovine form of spongiform encephalopathy (BSE). The name "mad cow disease" was used to label the new form of CJD.

Besides BSE, there are other forms of TSEs in animals. Since TSEs are transmissible, infected animals can spread the disease to other flocks if sold rather than being destroyed. In sheep and goats a fatal degenerative disease is known as scrapie. The disease causes loss of production and it prevents the sale of semen, embryos, or breeding stock to other countries. That elk and deer can be afflicted with TSE was discovered in the late 1960s. Chronic wasting disease (CWD) is similar to mad cow diseases, but affects deer and elk populations. Herds in Colorado and Wyoming have been affected, and the disease is spreading. Feline spongiform encephalopathy (FSE) was found in cats in Great Britain in 1990. Since then it has been reported on the Continent as well. Transmissible mink encephalopathy (TME) was first diagnosed in 1947 in ranch-raised minks in the United States. TME affects the central nervous system. TME has been reported in Russia, Canada, Finland, and Germany.

Kuru was first identified in Papua New Guinea among the Fore people. With a Stone Age culture, they practiced ritualistic cannibalism. At funerary feasts they would eat the brains of deceased relatives, allowing infectious crystal protein to invade human cells. After the practice was outlawed in the 1970s, Kuru gradually disappeared. Fatal familial insomnia (FFI) is symptomatically similar to CJD. It is a hereditary prion disease that disrupts sleep, creating insomnia that lasts until death. The disease is due to a missense mutation at codon 178 of the prion protein gene on chromosome 20. The disease runs in families and is fatal in seven to 36 months after the onset of symptoms. Gerstmann-Straussler-Scheinker (GSS) is a very rare TSE; most cases have been inherited. It usually strikes between ages 35 to 55. As the disease progresses, symptoms resemble Parkinson's disease with dysarthria, nystagmus, spasticity, disturbances in vision, or deafness.

The appearance of cases of TSEs has produced political controversy over the safety of the food supply, blood supply, and medical procedures. The general public and the media have been fairly successful in pushing governments to exercise due regard for public safety from any threat connected with TSEs. There are no known effective treatments for TSEs. The National Institute of Neurological Disorders and Stroke (NINDS) and other organizations are working to find cures.

SEE ALSO: Bovine Spongiform Encephalopathy; Cattle; Disease; Livestock; Mad Cow Disease; Sheep.

BIBLIOGRAPHY. Harry F. Baker, ed., *Molecular Pathology of the Prions* (Humana Press, 2001); Rick Erdtmann and Laura B. Sivitz, *Advancing Prion Science: A Guidance for the National Prion Research Program* (National Academies Press, 2004); David A. Harris, ed., *Mad Cow Disease and Related Spongiform Encephalopathies* (Springer-Verlag, 2004); Robert Klitzman, *The Trembling Mountain: A Personal Account of Kuru, Cannibals, and Mad Cow Disease* (Perseus Publishing, 2001); Daniel T. Max, *The Family That Couldn't Sleep: A Social and Scientific History of Prion Disease* (Random House, 2006); Eve Sequin, ed., *Infectious Processes: Knowledge, Discourse, and the Politics of Prions* (St. Martin's Press, 2004); Barbara Sheen, *Mad Cow Disease* (Thomson Gale, 2004); Charles A. Spencer, *Mad Cows and Cannibals, A Guide to the Transmissible Spongiform Encephalopathies* (Pearson Education, 2003); Glen C. Telling, *Prions and Prion Diseases: Current Perspectives* (Taylor & Francis, Inc., 2004); Philip Yam, *The Pathological Protein: Mad Cow, Chronic Wasting, and other Deadly Prion Diseases* (Springer-Verlag, 2003).

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Transportation

EFFICIENT, CONVENIENT, AND affordable transportation systems are viewed as an essential component for social and economic development. The United Nations (UN) has called for concerted action on transport issues in its 1992 Agenda 21 Program and the 2002 Johannesburg Plan of Implementation. However, because transport is a major source of atmospheric emissions, it must be carefully designed and managed so as to be sustainable—environmentally, socially, and economically—in the long term. Transport involves the movement of people and goods, and falls into three sectors: Air, sea, and land.

AIR TRANSPORT

Air transport has only existed for approximately 100 years; however, the consistent growth of this sector has raised concerns about its environmental impacts. Airplanes release pollutants associated with the combustion of fossil fuels, such as carbon dioxide, carbon monoxide, nitrogen oxides, sulfur oxides, volatile organic compounds, particulates, and other trace compounds. These pollutants are released into the upper troposphere and lower stratosphere, where they have an impact on atmospheric composition. A report issued in 1999 by the International Panel on Climate Change summarized the ecological impacts of aviation: Aircraft emit gases and particles that alter the atmospheric concentration of greenhouse gases, trigger the formation of condensation trails, and may increase cirrus cloudiness, all of which contribute to climate change; and aircraft are estimated to contribute about 3.5 percent of the total radiative forcing (a measure of change in climate) by all human activities and that this percentage, which excludes the effects of possible changes in cirrus clouds, is projected to grow. Emissions from aircraft are not included in targets set by the Kyoto Protocol of the UN Framework Convention on Climate Change (UNFCCC), though the Protocol does state that Annex I Parties do have the responsibility to limit or reduce greenhouse gas emissions from aviation fuels.

Urban light rail systems can now be found in such cities as Cairo, Manila, Geneva, and Bangkok.

SEA TRANSPORT

Sea transport is used primarily for long-distance shipping of goods. Two prime environmental concerns are the disposal of pollutants into the sea (marine or ocean dumping), and the introduction of alien invasive species through ocean transportation. Marine dumping occurs either accidentally, as is the case with oil spills, or intentionally through dredging spoil, nuclear waste disposal, sewage outfalls, and cruise ship waste. Various international agreements have been agreed to address intentional disposal of wastes at sea, such as the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (that is, the London Convention of 1972).

Introduction of alien invasive species is the second biggest threat to biodiversity after habitat loss. In terms of marine invasive species, a common method of transmission has been through ballast water, which "is now regarded as the most important vector for trans-oceanic and inter-oceanic movements of shallow-water coastal organisms," according to the World Conservation Union (IUCN). However, species can also attach themselves to the hulls of ships and be transported in that way. Examples of the introduction of alien invasive species by ballast water or hull fouling include the spread of zebra mussels into the North American Great Lakes water system.

LAND TRANSPORT

Land transport mainly refers to road and rail modes; road transport can be further divided into motorized and nonmotorized traffic. Nonmotorized transport is comprised primarily of walking and cycling, though other forms do occur, such as wheelbarrows, handcarts, pack donkeys, sledges, and animal-drawn carts. Nonmotorized transport has a number of environmental advantages, the most obvious of which is the minimal or nil production of emissions. Nonmotorized transport is also an integral element of transport for people in developing countries, who may not be able to afford private motorized vehicles or even public transport. Nonmotorized transport has been considered one of the most viable methods of addressing social and economic development issues in developing countries. Cycling is a common form of nonmotorized transport, and infrastructure for cyclists can also be integrated into public transport networks in order to improve accessibility and convenience.

Rail transport is generally more energy efficient than road transport, but despite this, in many regions of the world, rail freight and passenger numbers are decreasing. Light rail systems are gaining popularity as an urban transportation option in many countries, and can be found in: Cairo, Egypt; Kuala Lumpur, Malaysia; Christchurch, New Zealand; Manila, the Philippines; Geneva, Switzerland; and Bangkok, Thailand. These rail systems can be in the form of trains, tramways, or trolleys/streetcars. Other rail-based urban transport systems include subways/metros (underground) and monorail (elevated) systems.

Reduced environmental impacts from motorized road transport are possible through technological improvements in two main areas: Vehicle technology and fuel quality. Fuel quality has improved greatly over the past 30 years, and is continuing to improve. Unleaded petrol, first introduced in the 1970s, is now available in most countries around the world, and many countries are reducing the concentrations of sulfur and other substances in petrol and diesel fuels. Alternative fuels have also emerged, such as biodiesel and compressed natural gas.

However, many newer and cleaner fuels require more advanced vehicle technologies. Therefore, vehicle engines have consistently become more fuel-efficient, and many countries have been implementing stricter regulations to encourage further advances in vehicle efficiency. In addition, new vehicle components have been developed that reduce the volume of pollutants that are released from vehicles, such as particulate filters and catalytic converters. Most recently, through the development of new ways of powering vehicles, low or no emission vehicles are now available, such as hybrid-electric vehicles. As research and development in this area increases, the availability, affordability, and efficiency of these vehicles will grow. Innovations in fuel quality and vehicle technology can result in substantial improvements to air quality and human health.

RURAL AND URBAN ISSUES

Transportation issues vary between rural and urban areas. Transport in rural areas is critical in that these areas tend to be inhabited by poorer segments of the population. In South Africa, for example, half of the population is rural, but 72 percent of those living in the rural areas are poor, according to the South African National Department of Transport. Because rural transport links tend to service the poor, it is essential that they are cost-effective. Provision of affordable and well-maintained transport links for people and for goods is essential, especially in terms of strategies to increase economic development and reduce poverty in these areas.

In urban areas, where there is high population density and therefore a greater need for the movement of goods and people, congestion caused by traffic is a significant problem. The built environment of urban areas is often not designed for high volumes of vehicular traffic, and prevents the dispersion of emissions, and pollutants remain in the urban street canyons, resulting in poor air quality. Moreover, increasing urbanization and personal vehicle use can result in urban sprawl. Expansion of low-density metropolitan areas outside of urban centers can reduce the cost-effectiveness and efficiency of alternative transport options such as mass transit, and exacerbate the need for personal vehicle use. Therefore, transport planning is an essential part of any urban, regional, or national infrastructure strategy. Comprehensive and forward-looking plans are necessary for a rational transport infrastructure that supports current and future needs of society and is environmentally sustainable.

Public transport is viewed as a mobility option that has environmental and social benefits. From an environmental perspective, the higher density of people being transported in less vehicles results in lower energy inputs, lower emissions, and less space required for roads and parking areas. Social benefits are also gained from efficient public transport systems: enriched social contacts, increased time for activities such as reading, and lower risk of being involved in traffic accidents. A number of cities around the world, including those in developing countries, have undertaken a range of highly innovative land transport policy and projects that promote social and economic development and that address the environmental impacts from transport.

Bogotá, Colombia has redesigned some of its transportation infrastructure to support nonmotorized traffic. For example, it has built about 120 kilometers of bicycle routes throughout the city, and has instituted a policy by which all cars are banned from over 100 kilometers of the city's main roads on Sundays and holidays, providing a safe space for cyclists. With these innovations, the number of cyclists in Bogotá has increased dramatically: the number increased from 0.1 percent of the population in 1997, to five percent of the population in 2001.

In 2003, London instituted congestion charges for driving in central London during certain peak hours. In addition, the transport strategy also has provisions for extra buses and the introduction of new routes. By early 2004, congestion levels during weekdays had fallen by one-third of the previous amount. In 1998 the Indian Supreme Court handed down a judgment with a list of measures to be taken to address air pollution. In order to comply with that judgment, all buses had to be converted to compressed natural gas (CNG) by the end of March 2001. Delhi currently has over 80,000 CNG vehicles on the road, including 9,000 buses. Pressured with quickly growing urban populations, Curitiba, Brazil started implementing express bus lanes in 1974. As of 2001, 75 percent of Curitiba's commuters used the bus system (over 1.9 million passenger trips each day), and the city's transport network included 58 kilometers of express bus lanes, 270 kilometersof feeder routes, and 185 kilometers. of inter-district routes.

SEE ALSO: Automobiles; Bicycles; Cities; Fate and Transport of Contaminants; Flight; Highways; Hybrid Vehicles; Marine Pollution; Oil Spills; Pollution, Air.

BIBLIOGRAPHY. *Aviation and Emissions: A Primer* (Federal Aviation Administration, 2005); N.J. Bax et al., "The Control of Biological Invasions in the World's Oceans," *Conservation Biology* (v.15/5, 2001); R.G. Bell et al., "Clearing the Air: How Delhi Broke the Logjam on Air Quality Reforms," *Environment* (v.46/3, 2004); J.K. Brueckner, "Urban Sprawl: Diagnosis and Remedies," *International Regional Science Review* (v.23/2, 2000); Andres Duany, Elizabeth Plater-Zyberk, and Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* (North Point Press, 2000); *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (IUCN, 2000); M.A. Miller and S.M. Buckley, *Institutional Aspects of Bus Rapid Transit—A Macroscopic Examination* (University of California Press, 2000); *Significance of Non-Motorised Transport for Developing Countries: Strategies for Policy Development* (World Bank, 2000); A.P. Tsai and Annie Petsonk, *Tracking the Skies: An Airline-based System for Limiting Greenhouse Gas Emissions from International Civil Aviation* (Environmental Defense, 2000); M. Velasquez-Manoff, "Look at What the Cargo Ship Dragged In," *Christian Science Monitor* (October 16, 2006); D. Van de Walle, "Choosing Rural Road Investments To Help Reduce Poverty," *World Development* (v.30/4, 2002).

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Trichloroethylene (TCE)

TRICHLOROETHYLENE (TCE) IS a clear, colorless liquid with a sweet, chloroform-like odor. Long used in the 20th century in many industries, TCE is now considered a hazardous substance. Its production, transport, storage, and use are strictly controlled because of growing recognition and evidence that TCE is dangerous and even carcinogenic.

TCE has many synonyms: Acetylene trichloride, ethylene trichloride, ethinyl trichloride, trichloroethene, and colloquially "trike" and just "tri." Its chemical formula is CICH=CCl2. It was widely produced after Word War I and was used in numerous ways in the following decades: In the food industry, it helped extract vegetable oils from plants such as soy and coconut and prepare flavoring extracts from spices; in the mid-20th century, it was also used as a dry cleaning agent, an industrial solvent to remove grease from metal parts, a refrigerant, a fumigant, a basic component in the pharmaceutical industry, and even in hospitals as a mild gas anesthetic. These direct uses of TCE stopped in the 1970s and 1980s when awareness of its toxicity was raised, together with concerns of its carcinogenic potential. Presently, TCE is only found as an ingredient in adhesives, paint removers, and typewriter correction fluids.

Although TCE does not occur naturally, because of past use and careless disposal it can be now found in the environment, especially in the soil and groundwater. A third of the drinking water supply sources tested in the United States are said to have some slight TCE contamination. Direct exposure to TCE is unsafe and possibly lethal; its effects on health include skin irritation, headache, and dizziness, lack of coordination, hypotension, nausea, stupor, coma, and even death. Ingestion, inhalation, and skin contact require immediate medical treatment. Hazards include breathing air contaminated through household products containing TCE or swimming in contaminated water.

TCE is also regarded as particularly dangerous because of growing medical evidence, from both animal research and human population studies, that it can cause cancer. In its 11th report on carcinogens in 2005, the National Toxicology Program determined that TCE is "reasonably anticipated to be a human carcinogen." Other agencies concur: The International Agency for Research on Cancer has also concluded that TCE is "probably carcinogenic to humans." The Agency for Toxic Substances and Disease Registry has laid out particular guidelines to deal with exposure to TCE. In 2006, a report from the National Academies' National Research Council stressed that enough information exists for the Environmental Protection Agency to complete a credible human health risk assessment, although more research is still needed to improve understanding of precisely how TCE causes cancer and other adverse health effects.

SEE ALSO: Carcinogens; Environmental Protection Agency (EPA); Pollution, Water.

BIBLIOGRAPHY. Agency for Toxic Substances and Disease Registry, *Managing Hazardous Materials Incidents. Volume III—Medical Management Guidelines for Acute Chemical Exposures: Trichloroethylene TCE* (U.S. Department of Health and Human Services, 2003); Ginger L. Gist and Jeanne R. Burg, "Trichloroethylene: A Review of the Literature From a Health Effects Perspective," *Toxicology and Industrial Health* (v.11/3, 1995); National Academy of Sciences, *Assessing Human Health Risks of Trichloroethylene: Key Scientific Issues* (National Academies Press, 2006); National Toxicology Program "Trichloroethylene," *Report on Carcinogens, Eleventh Edition* (U.S. Department of Health and Human Services, 2005).

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Tropical Forests

TROPICAL FORESTS (COMMONLY referred to as *tropical rain forests*) are found in a narrow band around the equatorial belt. This belt experiences a huge amount of rainfall, which averages about 80 inches and varies from 50 to 260 inches (125 to 660 centimeters) a year. The vegetation is always lush and green, with dense growth and tall trees with giant buttresses. Vines and epiphytes such as orchids and bromeliads grow in the upper canopy on larger trees to reach sunlight. On average, temperatures within the rain forest range from 68 degrees F (20 degrees C) to 93 degrees F (34 degrees C) and humidity is between 77 and 88 percent. Although rain falls throughout the whole year, there is usually a brief season with less rain, and in some monsoonal regions a substantial dry season is often experienced.

It is estimated that rain forests cover less than seven percent of the earth's surface, about the size of the United States. The forests are scattered in a few geographical regions of the world along the equatorial belt, including: The Amazon River basin in South America, by far the largest portion of the rain forest accounting for two-thirds of tropical forests; the Congo basin in Africa, with a small area in west Africa and also eastern Madagascar; in Indo-Malaysia—the west coast of India, Assam, and portions of southeast Asia; New Guinea; and Queensland in Australia.

Scientists believe that these areas contain half of the world's plant and animal species (estimated at five to 10 million). To illustrate the richness of the tropical rain forest biome, in one tree in Brazil there may be as many as 40–50 species of ants. Scientists have counted anywhere from 100 to 300 species of trees in one hectare in South American rain forests. While on the (mainland) continent of Africa there is only one species of the majestic Baobab tree, in the tropical rain forest found on the island of Madagascar, there are seven different species of this tree. These forests also contain well over 95 percent of primates that are found nowhere else in the world. Scientists continue to discover new species of fauna and flora in the tropical rain forests of southeast Asia and Latin America. No one knows how many species of plants and animals are actually in the tropical rain forests. Some estimates indicate that there may be over 50 million species. Of the five to 10 million species that are suspected to be in the tropical rain forest, only six percent have been discovered, and of the six percent only a tiny proportion (about one-sixth) have been intensively studied.

Tropical rain forests are fast disappearing, cut or burned for short-term profit. Tropical rain forests in South America, Africa, and southeast Asia are felled at ever-increasing rates, with thousands of hectares of pristine forests lost every year. This loss is largely blamed on conflicting economic interests for control over forests and land that has made it hard to use the forests on a sustainable basis. As a local issue, the wholesale destruction of the tropical rain forest implies the removal of an important protective cover for the soil that results in severe soil erosion, impeding forest regeneration. Soil erosion also implies the reduction in the life expectancy of the many dams that have been built throughout the tropical areas (for example, in India, the Philippines, Ecuador, Colombia, and Brazil) to generate electricity for industrialization. In places where there has been massive deforestation in upland areas, silting has reduced the life expectancy of dams downstream by half, from an estimated 50 years to only 25 years.

Another local consequence of deforestation of tropical forests is flash flooding downstream. The tropical rain forest canopy absorbs rainfall like a sponge, and without this sponge flooding of farms and built-up areas downstream becomes a common occurrence. About 40 percent of farms are in river valleys in tropical environments. Tropical forests also act as an engine of rain locally through transpiration. Rain forest destruction in parts of Central America has led to a decline in amounts of rainfall. For example, Panama has experienced a decline of 17 inches of rainfall over the past 50 years, ushering in an era of ecological backlash.

Another important local consequence is the survival of indigenous peoples and their livelihoods. It is estimated that there were 230 ethnic groups in Amazonia in 1900 with a population of about one million people whose livelihoods depended on what the forests provided. It is estimated that this number has declined to about 140 ethnic groups with about 50,000 people. Many have lost their lives to newly introduced diseases such as flu and measles for which they had no immunity. Aggressive settlers that have moved into their habitats have wiped others out. The loss of the indigenous peoples is tragic for humanity, as their knowledge of the treasures the tropical forests hold, such as medicines, is also lost.

At the global level, tropical forest deforestation does not auger well for humanity. There will be loss of useful genetic materials, for example. About 25 percent of all medications are derived from rain forest plants. Curare comes from a tropical vine, and is used as an anesthetic and to relax muscles during surgery. Quinine, from the cinchona tree, is used to treat malaria. A person with lymphocytic leukemia has a 99 percent chance that the disease will go into remission because of vinblastine that is made from the rosy periwinkle from Madagascar. More than 1,400 varieties of tropical plants are thought to be potential cures for cancer. For example, a magic bullet for HIV might be hiding in the forests of Borneo or Central Africa. In 1991 University of Illinois at Chicago researchers brought a sample of a smooth barked gum tree (*Calophyllum lanigerum*) from Borneo. The National Cancer Institute determined the sample was effective against HIV, including strains resistant to AZT and Nevirapine. When the researchers went back to get more samples of the tree, the forest stand where the tree came from had disappeared due to logging.

Other global consequences of the destruction of the tropical rain forest include the release of huge amounts of carbon dioxide (CO_2) into the atmosphere due to widespread burning. CO_2 is a major contributor of global warming. Photos from the U.S. Space Shuttle have indicated that at any one given time there are over 5,000 fires burning in Amazonia as forests are cleared for plantation crops and pasture for beef cattle. The debate rages on as to who is responsible for the massive destruction tropical forests are experiencing. The major agents of deforestation are commercial logging, plantation agriculture, cattle ranching, charcoal and fuel wood production, open pit mining of mineral ores, dams, and the growing of narcotics such as coca. Tropical hardwoods such as teak and mahogany are prized for furniture in highly developed countries.

Plantation agriculture has resulted in the clearing of thousands of acres of pristine tropical forests to give way to the growing of cash crops such as coffee, cocoa, oil palm, coconuts, coca, and rubber as well as to create pasture for the export beef industry. During the economic crisis of the early 1990s, land speculation in Brazil was seen as a way to hedge against runaway inflation. The government encouraged people to develop and improve the forestlands they had acquired by turning them into pasturelands, a phenomenon that has been termed the "cheeseburgarization" or "hamburgarization" of the rain forest in Central America and South America. To the ranchers, this is improved land, but in so doing the ecological balance is upset through the widespread use of herbicides and burning before pasture grass is sown.

Although it has been shown that shifting cultivation is a scientifically sound system of cultivation that makes sure that the forests are preserved, many governments in South America, Africa, and Southeast Asia continue to place blame on rain forest farmers as the culprits to the destruction of the tropical forests. Government departments responsible for forest management ignore the knowledge of indigenous forest farmers about the forest's ecology. In countries of southeast Asia, governments have actively encouraged resettlement of converted forestland for farming by landless settlers who then often cross the unmarked boundaries into permanent forested areas.

It is in this context that conflicting economic interests have resulted in large-scale deforestation of tropical forests. It has been suggested that the reserve solution would be an excellent way of preserving the tropical rain forests. Areas could be set aside for exploitation of forest products by indigenous peoples on a sustainable basis, such as rubber tapping, collection of Brazil and cashew nuts, and other forest products. These could then be processed and packaged for export to international markets. This approach was fervently campaigned for by Chico Mendes, a brave and persistent rubber tapper who challenged the people and institutions responsible for the devastation of the forest in Brazil. He galvanized local and international support for his vision of a self-sustained economy of the Amazon and was subsequently assassinated in December 1988 by those opposed to his vision. A New York Botanical Garden study found that money earned from collecting nuts on a hectare of forest land was more profitable, yielding $6,000 over a 50 year period, versus $3,000 if the trees were cut down for pasture, which would be productive for only three or four years given the infertile nature of tropical rain forest soils.

SEE ALSO: Climate, Tropical; Cloud Forests; Deforestation; Forests; Mendes, Chico; Nontimber Forest Products (NTFPs); Plantation Forestry; Rain Forests; Shifting Cultivation; Tropical Medicine; Tropics.

BIBLIOGRAPHY. E.F. Bruenig, *Conservation and Management of Tropical Rainforests: An Integrated Approach to Sustainability* (CAB International, 1996); Eldredge Bermingham and C.W. Dick, *Tropical Rainforests: Past, Present and Future* (University of Chicago Press, 2005); David Carr, Laurel Suter, and Alisson Barbieri, "Population Dynamics and Tropical Deforestation: State of the Debate and Conceptual Challenges," *Population and Environment* (v.27/1, 2005); Marcus Colchester and Larry Lohmann, *The Struggle for Land and the Fate of the Forests* (ZED Books, 1993); Amy Ickowitz, "Shifting Cultivation and Deforestation in Tropical Africa: Critical Reflections," *Development and Change* (v.37/3, 2006); C.C. Park, *Tropical Rainforests* (Routledge, 1992); S.E. Place, *Tropical Rainforests: Latin American Nature and Society in Transition* (Scholarly Resources, 1993); Andrew Revkin, *The Burning Season: The Murder of Chico Mendes and the Fight for the Amazon Rain Forest* (Island Press, 2004); H. Thompson and D. Kennedy, "Ecological-Economics of Biodiversity and Tropical Rainforest Deforestation," *Journal of Interdisciplinary Economics* (v.7/3, 1996); Michael Williams, *Planet Management* (Oxford University Press, 1993).

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Tropical Medicine

TROPICAL MEDICINE IS the branch of medical science that aims to combat health issues primarily related to diseases prevalent in tropical areas. Tropical medicine was developed during the age of European colonialism, especially during the 19th century when large-scale colonization of tropical areas occurred. European scientific methods were superior to those available to inhabitants of most tropical areas and so expertise to deal with health issues developed outside these regions. Local people wishing to contribute to this science found it necessary to travel to the colonizing power's home territory, since this is where scientific establishments were customarily established.

Toward the end of the 19th century, a number of important discoveries were made which greatly improved the health of people in tropical regions. This included the identification of the role of mosquitoes in transmitting malaria and the role of the tsetse fly in transmitting sleeping sickness, as well as the causes of yellow fever.

These discoveries were being made at the same time that large-scale transformation of the tropical lands was undertaken for economic purposes. This led to the draining of swamps, moving of people to different residential areas, and the creation of new economic industries and activities. Similar activities previously undertaken in the developed countries had helped to reduce the impacts of such diseases in some cases. The continued prevalence of some diseases in this category is more properly the result of poverty and poor infrastructure rather than specific climate or location, even though the environment contributes. Additionally, tropical regions contain poisonous or otherwise hazardous plants or animals that require specialized medical knowledge.

Local and indigenous health knowledge in tropical areas can be extensive. While in some few cases local information can be misleading (sometimes dangerously so), many indigenous systems of treatment have proven extremely effective. Much of this knowledge is endangered, however, through its displacement by modern techniques, technology, and expertise. The disappearance of local, contextual, and appropriate medical knowledge represents a serious potential loss as traditional systems and groups are absorbed through modernization.

The increasing importance of migration in the modern world, and the enhanced possibilities for cheap international travel has lent an additional importance to tropical medicine. Those traveling to tropical regions need high quality information on their destinations and public health officials wish to be aware of the health implications of people having traveled to a tropical region interacting with the home population. The competencies obtained from studying tropical medicine have proved useful in tackling outbreaks of new problems such as SARS and avian influenza. As global warming increases the extent of territory that might be considered tropical, the application of tropical medicine knowledge is becoming newly relevant.

SEE ALSO: Climate, Tropical; Malaria; Mosquitoes; Tropical Forests; Tropics.

BIBLIOGRAPHY. Michael Eddleston, Robert Davidson, Robert Wilkinson, and Stephen Pierini, *Oxford Handbook of Tropical Medicine* (Oxford University Press, 2002); John Farley, *Bilharzia: A History of Imperial Tropical Medicine* (Cambridge University Press, 2003).

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Tropics

THE TROPICS ARE the region of the Earth that lie between the Tropic of Cancer (23.5 degrees north latitude) and the Tropic of Capricorn (23.5 degrees south latitude). This region receives the most intense vertical rays of the sun and is characterized by the presence of a persistent low pressure trough, the Intertropical Convergence Zone (ITCZ). Climate in the region is characterized by high monthly average temperatures (in excess of 18 degrees C throughout the year) and high amounts of rainfall. On the northern and southern edges of the region, the subtropical high pressure brings dry conditions during the winter, and these marginal regions experience a dry season of up to six months. Due to the high levels of precipitation, soils are highly leached and heavily oxidized. Oxisols are the predominant soil order, with Ultisols and Alfisols occurring on the drier margins of the zone. Due to the heavy leaching, most of the nutrients within these ecosystems are bound within the vegetation.

Due to the high levels of precipitation, the biomes of the tropics have some of the greatest net productivity and biomass of any biome on Earth. Tropical rain forest, tropical deciduous forest, and savanna are the dominant biomes of the region, with nearly every biome represented along the slopes of tall mountains such as the Andes. The tropical forests are highly structured into multiple canopy layers, providing a wide range of niches for species to occupy. Also, because the environments of the tropics were relatively stable throughout the last glacial maxima, species in this region have had sufficient time to become highly specialized and occupy very narrow niches. As a consequence, the tropics have greater biodiversity than higher latitudes, but the specialization of these species renders them sensitive to perturbations to habitat. Tropical deforestation threatens many species with extinction, and occurs in all geographic regions within the tropics. The vast majority of threatened tropical species are stenophagous insects that are often specialized to individual tree species, but larger creatures, such as many primate species within Africa, Madagascar, and Indonesia are threatened by loss of forest habitat as well.

The persistence of extractive activities that threaten tropical habitat are legacies of the colonial and postcolonial periods of development and globalization. The tropics were the site of most of the European colonies during the colonial period, with the high productivity of these regions making them attractive for various plantation crops as well as other primary products such as timber. Western thought had long regarded the tropics as being particular harsh climates. Classical Greek geographers regarded the tropics as the uninhabitable Torrid Zone. Belief in a particularly harsh climate not ideally suited for people persisted into the colonial period and found expression in Environmental Determinism, which asserted that tropical environments caused the people living there to have evolved into lazy and unproductive races, and, by contrast, European races of the temperate climates evolved to be more productive. European colonists employed these racial ideologies as a rationale for the exploitation of these people and environments. Although the colonial model of globalization and development gave way to modernizing discourses meant to bring prosperity to these tropical countries, persistent poverty and power inequalities continue to drive extractive activities in the tropics.

Environmental issues in the tropics revolve around the interconnected issues of primary resource extraction, biodiversity conservation, and social justice. Demand for tropical hardwoods has driven deforestation (in some cases in violation of local logging laws) throughout the tropics and allowed for the rapid expansion of agricultural plots into the cleared land, contributing to loss of soils and impeding reforestation. Gold mining in places such as the Amazon and Papua New Guinea have contributed to deforestation, erosion of soil and stream banks, and contaminated the water with mercury and other toxic chemicals, affecting the health of local people and bringing these people and miners into conflict.

Conservationists are seeking to establish more conservation parks and corridors throughout the tropics in response to deforestation. Indigenous people and immigrants often inhabit areas targeted for conservation. Contemporary parks in the tropics often include indigenous people; disequilibrium ecological models suggest that disturbance is an integral component of ecosystems, and thus they are tolerant of low levels of human use.

SEE ALSO: Andes Mountains; Biodiversity; Biome; Climate; Colonialism; Conservation; Deforestation; Environmental Determinism; Globalization; Habitat; Intertropical Convergence Zone (ITCZ); Rain Forests; Soil Erosion; Tropical Forests; Tropical Medicine.

BIBLIOGRAPHY: Edward B. Barbier, "Economic Aspects of Tropical Deforestation in Southeast Asia," *Global Ecology and Biogeography Letters* (v.3, 1993); Robert W. Cristopherson, *Geosystems* (Pearson Prentice Hall, 2006); Glen M. MacDonald, *Biogeography: Space, Time and Life* (John Wiley and Sons, 2003); Richard Peet, "The Social Origins of Environmental Determinism," *Annals of the Association of American Geographers* (v.75, 1985); Marcus Power and James D. Sidaway, "The Degeneration of Tropical Geography," *Annals of the Association of American Geographers* (v.94, 2004); Karl S. Zimmerer and Kenneth R. Young, eds., *Nature's Geography: New Lessons for Conservation in Developing Countries* (The University of Wisconsin Press, 1998).

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Tsunamis

A TSUNAMI IS a wave (sometimes improperly called a *tidal wave*) generated by an earthquake that can do substantial damage to property and create considerable loss of life when the wave crashes ashore. Tsunamis are created when an earthquake creates a pressure wave that moves ocean water upward, creating a generally small (sometimes as small as a few centimeters), but highly energetic wave that moves rapidly from the epicenter of the earthquake. The wave can be generated along the entire rupture zone of the earthquake, which, in the case of the 2004 Sumatra earthquake and tsunami, was over 100 kilometers long.

The size of the waves that hit the shore depends on the bathymetry of the coastal area—that is, the contours of the undersea topography. Deeper waters result in shorter waves, while a gently rising shoreline will see very large waves as the wave slows. Much of the bathymetry in less developed areas, and even in some developed nations, is not well known, which makes risk assessment difficult.

In 1946, a tsunami originating in the Aleutian Islands killed over 170 people on Maui. Because of this tsunami, the Pacific Tsunami Warning center was established in Hawaii in 1949. In 1960, 61 people were killed on Hawaii and over 160 on Honshu, Japan, from a tsunami that came from the coast of Chile. Many of the fatalities in the 1964 earthquake in Alaska were caused by tsunamis at Valdez, Alaska; near the epicenter in Kodiak, Alaska; and as far away as Hawaii and in Crescent City, California, where 11 people were killed. In 1998, a huge tsunami killed 10,000 in Papua New Guinea. Another destructive tsunami was generated by the 2004 magnitude 9.0 Sumatra earthquake, which struck Indonesia, Thailand, Burma, India, and Sri Lanka. Wave heights were highest in Indonesia, at 40 meters (about 130 feet); in other nations, the waves were smaller, but even a three-meter (10-foot) wave can damage property and drown people. The total death toll was over 200,000 people. Another tsunami hit Indonesia in 2006.

Keeping people safe from tsunami waves is a challenge, but some progress has been made. Perhaps the most effective method is warning systems. Such systems would need to integrate individual nations' tsunami monitoring networks and must ensure that information reaches where it is needed at the coastal areas, which may not be anywhere near a national capital.

Other ways to reduce the hazard to people is through disaster planning and hazard mitigation. Such efforts include hazard signage, informing people about the tsunami hazard and what to do if a tsunami happens, warnings (through the news media and sirens), and evacuation plans and drills (such as those conducted in communities in Oregon and Alaska). Public education is important for informing people of the natural precursors of a possible tsunami, such as a local earthquake that would cue people to move to higher ground, or the rapid outflow of ocean waters that often precedes a major tsunami wave. Mitigation efforts include buildings designed to be strong enough to withstand tsunamis, and tall enough to allow people to "vertically evacuate" into the upper floors of buildings. Such measures would eliminate the need to run inland if a warning is received or if one detects natural tsunami precursors. Some communities may choose to adopt set-back requirements to keep at least some buildings, like schools or hospitals, far away from the possible inundation zone.

Protecting the public from tsunamis is challenging because of the relatively low probability of such an event, and the widespread lack of knowledge about them. In the United States, for example, southeastern states have jointed the National Tsunami Hazard Reduction Program (NTHRP), because of the remote chance of a distant earthquake triggering a tsunami that would traverse the Atlantic. Historic evidence suggests that such events have happened in the past.

SEE ALSO: Disasters; Earthquakes; Floods and Flood Control; Hazards; Indonesia; Ring of Fire; Sri Lanka.

BIBLIOGRAPHY: E.N. Bernard, *Developing Tsunami-Resilient Communities: The National Tsunami Hazard Mitigation Program* (Springer, 2005); Thomas Aaron Green, "Tsunamis: How Safe Is the United States?" *Focus on Geography* (v.48/4, 2006); J.F. Lander, P.A. Lockridge, and M.J. Kozuch, *Tsunamis Affecting the West Coast of the United States 1806–1992* (National Oceanic and Atmospheric Administration, 1993).

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Tuna Fishing

TUNA FISHING AS a major industry did not exist before the 20th century, although there were some catches of "giant" mackerel off areas such as the British Isles that may have been bluefin tuna. Industrial tuna fishing began in the United States in 1903, when tuna was seen as a possible replacement for dwindling sardine catches, but the industry really took off during World War II, when canned tuna became an important source of protein. Tuna have been caught with driftnets, purse seine nets, long lines, and traps. The United States and Japan are currently the two largest consumers of tuna, accounting for 31 percent and 36 percent of the world catch, respectively. In 2000, an estimated 3.6 million tons of tuna were caught, 66 percent from the Pacific Ocean, 20.7 percent from the Indian Ocean, 12.5 percent from the Atlantic, and 0.8 percent from the Mediterranean and Black Seas.

Tuna belong to the teleost family Scombridae. Major target species include bluefin, albacore, skipjack, bigeye, and yellowfin. The largest of these are bluefin tuna (*Thunnus thynnus*), which typically grow to 20 feet (6 meters) and 1,102 pounds (500 kilograms), but some specimens have weighed over 1,499 pounds (680 kilograms). Bluefin in the south Pacific are estimated to be at 15–20 percent of their historic stock size due to overfishing. Moreover, recent research suggests that bluefin quotas in the Atlantic have been set too high, and due to the wide-ranging migration patterns of these fish, individuals from depleted populations may move to areas of high fishing pressure. Bluefin tuna are primarily traded with Japan and sold for consumption as sushi and sashimi.

Albacore tuna (*Thunnus alalunga*) are subtropical and have distinctive long pectoral fins but are much smaller than bluefin, at two feet (0.7 meter) in length and 22–44 pounds (10–20 kilograms), although they can grow up to five feet (1.4 meters) long and weigh 132 pounds (60 kilograms). This species was depleted by driftnet fisheries but may now be recovering with the introduction of large-scale driftnet bans. This species is frequently targeted for the canned tuna industry.

The main target species for canned tuna are the smaller skipjack (*Katsuwonus pelamis*), which are typically one foot (35 centimeters) long and about seven pounds (three kilograms) but can grow up to 40 pounds (18 kilograms), and the bigeye (*Thunnus obesus*). Bigeye tuna typically grow to about three feet (0.9 meter) and 33–44 pounds (15–20 kilograms) but have been caught at weights of up to 734 pounds (333 kilograms). This species dwells in deep, cool water and has a thick fat layer for insulation, making it a favorite of the sashimi market.

Yellowfin tuna (*Thunnus albacares)* are found in tropical and subtropical waters, growing up to eight feet (2.4 meters) and 441 pounds (200 kilograms). Yellowfin in the eastern tropical Pacific (ETP) are typically found swimming underneath schools of spinner (*Stenella longirostris*) and spotted dolphins (*S. attenuata*).

DANGERS TO DOLPHINS

It is not certain why yellowfin tuna swim under schools of dolphins, but it may be that the dolphins provide the tuna some protection from predators (the dolphins appear to gain no benefits from the tuna). This association is so strong that purse seine fishing operations targeting yellowfin set their nets around dolphin schools to catch the associated tuna, but also catch and kill many dolphins. Indeed, this method of tuna fishing has killed more dolphins than any other human activity.

It is estimated that six million spinner and pantropical spotted dolphins alone were killed as bycatch before conservation measures were introduced, with up to half a million dolphins killed a year in the 1960s and 1970s. This high level of dolphin mortality was one of the key factors behind the introduction of the U.S. Marine Mammal Protection Act in 1972 (MMPA). The MMPA helped to reduce the amount of dolphin by-catch, and due to strict limits on mortality, fewer and fewer U.S. fishing vessels participated in the ETP fishery, although vessels from other nations remained in the region.

In 1990 the concept of "dolphin safe" tuna was introduced, which had a major effect on purchases of tuna worldwide, through consumer choice. Dolphin safe tuna was initially defined as tuna caught by methods other than setting purse seine nets on dolphins—it was an effort to eliminate a fishing method considered inherently harmful to dolphins. After use of the "dolphin safe" label became widespread, first voluntarily by tuna companies and later by law in the United States, fishers in the ETP made efforts to reduce dolphin mortalities, achieving a 95 percent decrease, but nonetheless did not cease setting purse seine nets on dolphins.

Furthermore, to reduce dolphin mortality, the Inter-American Tropical Tuna Commission (IATTC), the body governing tuna fishing in the ETP, adopted the International Dolphin Conservation Program (IDCP) in 1992, a voluntary by-catch reduction scheme codified in the so-called La Jolla Agreement. Nations fishing in the ETP agreed to voluntary limits on the number of dolphin deaths (the dolphin mortality limit, or DML) that could be inflicted by each vessel in the ETP tuna fishery. The aim was to reduce these limits each year until a zero mortality level was reached. Measures to monitor and reduce dolphin mortality included an onboard observer program to record dolphin kills, and the "backing down" of purse seine vessels, that is, sinking the top of the net to allow encircled dolphins to swim over the top and escape. In 1995, the Panama Declaration made these measures mandatory.

The Panama Declaration also introduced a new definition of "dolphin safe" that used an "observed mortality" standard rather than a "fishing method" standard. If observers did not see any dead dolphins in a net set, then the tuna from that set would be considered "dolphin safe." The U.S. Dolphin Conservation Act of 1997 stated that the United States would adopt this new definition, if the government made a final finding that the chase and encirclement of dolphins were not having a significant adverse impact on depleted stocks. In 1999, and again in 2002, the government tried to make such a finding, but both times the finding was challenged in court. In both cases, the courts ruled against the government, which means the original definition of "dolphin safe" has so far been retained.

The court challenges were based on the fact that, although dolphin mortality levels have been greatly reduced in this fishery, the dolphin populations have not recovered as expected. Scientific evidence strongly suggests that chasing and herding dolphins prior to setting nets separates mothers from calves and leads to debilitating stress, even when dolphins are released alive during the "back-down." Also there was evidence of underreporting of dolphin mortalities. The scientific data and underreporting evidence were vir-

In 2000, an estimated 3.6 million tons of tuna were caught; 66 percent were from the Pacific Ocean.

tually ignored when the U.S. government made its findings, a decision heavily criticized by the courts.

MERCURY CONTAMINATION

Another controversial environmental issue related to tuna fisheries is a high level of mercury contamination in some species. A quarter of canned albacore tuna examined in a recent study exceeded U.S. health regulation limits. Other species found to be highly contaminated include blackfin tuna (*Thunnus atlanticus*) and little tunny (*Euthynnus alletterus*) off the coast of Florida, of which 81 percent and 75 percent, respectively, contained more mercury than U.S. health regulation limits. As a result of possible health risks from mercury contamination in large predatory fish such as tuna, in March 2004 the U.S. Food and Drug Administration (FDA) issued guidelines recommending pregnant women, nursing mothers, and children limit their weekly intake of some tuna products. Other countries, such as those of the United Kingdom, have issued similar warnings.

SEE ALSO: Animal Rights; Dolphins; Fisheries; Habitat Protection; Mercury; Minamata; Overfishing.

BIBLIOGRAPHY. D.H. Adams, "Total Mercury Levels in Tunas from Offshore Waters of the Florida Atlantic Coast," *Marine Pollution Bulletin* (v.49, 2004); F. Archer et al., "Annual Estimates of the Unobserved Incidental Kill of Pantropical Spotted Dolphin (*Stenella attenuata*) Calves in the Purse-Seine Fishery of the Eastern Tropical Pacific," *Fishery Bulletin* (v.102, 2004); B.A. Block et al., "Electronic Tagging and Population Structure of Atlantic Bluefin Tuna," *Nature* (v.434, 2005); J. Burger and M. Gochfeld, "Mercury in Canned Tuna: White versus Light and Temporal Variation," *Environmental Research* (v.96, 2004); V. Gewin, "Pacific Dolphins Make Waves for U.S. Policy on Mexican Tuna," *Nature* (v.427, 2004); R.A. Myers and B. Worm, "Rapid Worldwide Depletion of Predatory Fish Communities," *Nature* (v.424, 2003); John R. Twiss, Jr. and Randall R. Reeves, *Conservation and Management of Marine Mammals* (Smithsonian Institution Press, 1999); U.S. Tuna Foundation, www.tunafacts.com (cited January 2006); U.S. Department of Health and Human Services and U.S. Environmental Protection Agency, "What You Need to Know about Mercury in Fish and Shellfish" (March 2004), www.cfsan.fda.gov (cited May 2006).

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Tundra

TUNDRA, A TERM derived from the Finnish word *tunturia* and/or the Saami word, the genitive of *tundar*, both meaning "treeless plain," is the coldest and least species-rich ecosystem on earth. It is found both in areas of high latitude (Arctic and Antarctic tundra) and altitude (alpine tundra).

Arctic tundra technically refers to the areas of high latitude permafrost in the Northern Hemisphere. This includes large areas of Russia and Canada. Permafrost is permanently frozen ground, an ecosystem characteristic that—in addition to low water and temperatures—contributes to the high stress of plant and animal survival. The predominant flora is mosses, heath, and lichen. Mammals include wolf, fox, musk ox, polar bear, rabbit, vole, and caribou. In many of these permafrost areas the winter low temperatures dip to negative 60 degrees F. This does not, however, result in a frozen and unproductive ecosystem. The short window of summer—perhaps two months in length—provides ample warmth and extended daylight for the tundra to be highly productive for the native plants and animals and also for swarms of migratory birds and other fauna that flock there to reproduce and gorge on the tundra's ecological bounty.

Most of Antarctica is ice field except for a few areas of the continent, particularly the Antarctic Peninsula, whose rocky soil supports tundra. Its flora is made up of mosses, lichens, liverworts, and aquatic and terrestrial algae. Fauna are restricted to sea mammals and birds, most notably the penguin. Alpine tundra occurs wherever the altitude reaches above the tree line. It is devoid of permafrost and includes animals such as elk, marmot, mountain goat, pika, and sheep.

The tundra ecosystem—a biome of extreme temperature, daylight and moisture regimes—has historically been considered a barren wasteland. These regions, however, contain many diverse ecological and physical environments. For example, the high arctic deserts are home to colonizer flora (e.g., lichens and mosses) and highly adapted fauna (e.g., caribou and spiders). The finite bounds of these diverse yet fragile ecosystems are limited because of the physical environment (i.e., low temperatures) for reasons such as: Lack of nutrients cycling, light availability, limited freshwater availability, and slowed biological process. These limiting factors make arctic ecosystems slow to recover from disruptions and impacts caused by invasive human development and resource exploitation practices. Furthermore, the faunal adaptive reliance on stored energy (i.e., fat) and long lifespan strategies makes food chains more susceptible to contaminants, such as persistent organic pollutants and radionuclides.

The adaptations and diversity of the tundra are not limited to flora and fauna. Arctic indigenous peoples represent an integrated part of the ecosystem who have developed modes of subsistence that include reindeer herding, sea mammal hunting, taiga terrestrial animal hunting, and settled river fishing.

In the 21st century the processes of global warming are being felt most acutely in tundra regions of the world. This process is most poignant in the Arctic tundra due to the melting of the permafrost and its effects on the plants, animals, and humans who have adapted to an ecosystem based on water in its solid state. Melting permafrost also involves the potential release of high amounts of methane, a potent greenhouse gas, from the bog that results. Although warming is already in progress, humans must take responsibility to forestall global warming before irreversible change occurs.

SEE ALSO: Antarctica; Arctic; Biome; Global Warming.

BIBLIOGRAPHY. David A. Wharton, *Life at the Limits: Organisms in Extreme Environments* (Cambridge University Press, 2002); Sarah J. Woodin and Mick Marquiss, eds., *Ecology of Arctic Environments* (Cambridge University Press, 1997).

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Tunisia

TUNISIA IS A country in the center of North Africa. It has an area of 63,170 square miles and a population of approximately 10 million. The capital of the country is Tunis, a city located near the once powerful city of Carthage. Tunisia is bordered by Libya and Algeria and has a long Mediterranean shoreline to the north and east. Physically, the country is dominated by the Sahara to the south and low mountains surrounded by large agricultural areas in the north. Most of the population lives either near the coast or in the major northern agricultural areas. The south, though intermittently dotted with oases, is considerably less inhabited. More than half of Tunisia is covered by pastoral land forests that are used for agriculture, supporting such crops as olives, dates, oranges, almonds, grain, sugar beets, wine grapes, poultry, beef, and dairy. Its main profits, however, are derived from industries such as the mining of phosphates and iron ore. The petroleum and textile industries of Tunisia are also significant.

The main environmental and conservation issues throughout North Africa is desertification, and Tunisia is not exempt from this problem. Poor farming techniques, such as overgrazing, along with deforestation, soil erosion, and a limited supply of natural sources of freshwater, are all contributing to the problem of desertification. Agricultural land is decreasing, not only because of desertification, but also because of increased salinization and siltation due to the increased erosion of the soil. Ineffective disposal of toxic and hazardous materials and water pollution from raw sewage (a problem common in North Africa) are posing risks to the well-being of Tunisia's citizens. Like many countries, Tunisia has fallen far short of the ideal global total of 10 percent of its land under some sort of environmental protection, protecting less than half a percent of its land. The people of Tunisia are mostly of Arab and Berber ethnicity. The official language of the republic is Arabic; however, there is a strong French language influence from the days of French colonization. Religiously, 98% of Tunisians are Muslims.

Unlike its neighbors, Libya and Algeria, Tunisia does not have abundant oil resources, thus Tunisia has a fairly diversified economy. The service industry, including the important European tourist sector, accounts for over half of the economy and agriculture counts for less than 15 percent, with industrial jobs constituting the remainder. That said, agriculture still employs the greatest number of people and remains an essential part of the economy especially with high value products such as olives and dates. However, like other North African countries, unemployment is a continuing problem as the mean average of the population continues to get younger. This has fueled a migration of young people to Europe, both legal and illegal, in search of jobs. Politically, Tunisia is considered stable in relation to most other Middle Eastern countries. This in spite of President Ben Ali having not allowed any real democratization for fear of an Islamist party taking hold in the country and having effectively becoming a "president for life."

SEE ALSO: Desertification; Pollution, Water.

BIBLIOGRAPHY: Mounira Charrad, *States and Women's Rights: The Making of Postcolonial Tunisia, Algeria, and Morocco* (University of California Press, 2001); Leonard Cottrell, *Hannibal: Enemy of Rome* (Da Capo, 1992); Dwight L. Ling, *Tunisia: From Protectorate to Republic* (Indiana University Press, 1967); Kenneth J. Perkins, *A History of Modern Tunisia* (Cambridge University Press, 2004); Dirk Vandewalle, ed., *North Africa: Development and Reform in a Changing Global Economy* (St. Martin's Press, 1996).

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Turkey

GEOGRAPHICALLY, TURKEY IS a Euro-Asian country. About three percent of Turkey is in the Thracian area of southeastern Europe. Ninety-seven percent is in the western areas of Asia called the Near East (Middle East). About the size of Texas and Louisiana combined, it has an area of 301,384 square miles (780,580 square kilometers) and a population of over 68 million people in 2004.

Turkey has seven major regions: The Black Sea region, the Marmara region, the Aegean, the Mediterranean, Central Anatolia, East Anatolia and Southeast Anatolia. The Black Sea coast extends from the Bosporus Strait to Georgia. Along the coast are the Northern Mountains running east until they meet the Pontic Mountains about mid-way along the Black Sea coast. The Northern and Pontic Mountains receive enough moisture for them to be heavily wooded and rugged.The Thracian part of the Marmara region is covered by the Northern Plains, an area of gentle rolling grass lands and farms. Historic Istanbul (Constantinople) is located in European Turkey on a peninsula at the intersection of the Bosporus and the Sea of Marmara. An estuary called the Golden Horn separates it from newer areas.

European Turkey is separated from Asiatic Turkey by three connected water ways: The Bosporus Strait, a narrow outlet from the Black Sea to the Sea of Marmara, and the Dardanelles. The Sea of Marmara is a saltwater sea, almost completely surrounded by land. It opens onto the Dardanelles strait formed by the Gallipoli Peninsula and the Northern Plains.

The Aegean Coast has many bays, peninsulas, coves, islands, and sandy beaches. Its narrow coastal plains rise through the broad fertile western valleys to the Anatolian plateau. The Aegean Sea changes off the Island of Rhodes to the Mediterranean Sea. The southern Mediterranean coast of Turkey has a narrow belt of plains that run to the border with Syria. The southern mountains include the Taurus Mountains (Toros Daglari) parallel the Mediterranean coast.

The Central Anatolian Plateau is a region of small rivers fed by occasional rainfall. There are several salt lakes in central Turkey. The Cappadocian volcanic tuff region is in the south. The Eastern Anatolian Plateau region is an area of rugged towering mountains. The area lies east of the Euphrates River and extends to Mount Ararat and the borders with Armenia and Iran. It also contains the large freshwater body, Lake Van, which is part of the original homeland of the Armenians.

The Southeastern Anatolian region is part of Mesopotamia and has fertile plains and river valleys that lie between the Euphrates and Tigris Rivers. The Euphrates rises near Erzurum in the Eastern Plateau not far from Mount Ararat. The Tigris rises in the Taurus Mountains near Lake Hazer in the Eastern Plateau. Its eastern border is shared with Iran, Azerbaijan, Armenia, and Georgia.

Turkey's environment is varied and rich in natural beauty. Significant efforts at reforestation and land improvements have been made. However, Turkey's industrialization especially since the 1990s has caused a number of environmental problems. Expanding industry has consumed higher levels of energy and the damming of the Tigris and Euphrates Rivers and their tributaries has caused ecological concerns. Currently coal fired electrical plants are being replaced with natural gas fired plants. Maritime pollution is of grave concern to environmentalists as is the greatly increased flow of oil tanker traffic through the Bosporus Straits and the Dardanelles. In addition overfishing and pollution runoff have fouled the Black Sea.

With prosperity has come smog from factories and automobiles. Under its comprehensive environmental laws promulgated first in the 1980s, attention is being paid to environmental issues. However, Turkey's pollution control efforts have been severely criticized as inadequate by European agencies.

SEE ALSO: Armenia; Azerbaijan; Black Sea; Iran; Iraq; Syria; Tigris and Euphrates Rivers.

BIBLIOGRAPHY. Rashid Ergener and Resit Ergener, *About Turkey: Geography, Economy, Politics, Religion, and Culture* (Pilgrims' Process, 2002); William Spencer, *The Land and People of Turkey* (HarperCollins, 1990).

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Turkmenistan

TURKMENISTAN DECLARED INDEPENDENCE from the Soviet Union on October 27, 1991. The president of Turkmenistan, the former communist insider Saparmurat Niyazov, used the Turkmen title Turkmenbashi: Leader of the Turkmen. Remarkably, however, Turkmenistan was until recently a collection of fragmented, interwarring tribes divided by dialect, ancestry and geography.

The environment of Turkmenistan, mainly a vast, untamed steppe in the heart of Central Asia, encouraged semi nomadic lifestyle that was not territorially defined. Trained and disciplined in war and eager to seize booty, it was the Turkmen, along with other steppe peoples to the East like the Mongols, who rained down from the East, conquering large swaths of territory in the Middle East and Eastern Europe during the Middle Ages. In this sense, the environment of Turkmenistan, the vast, dramatic and forbidding steppe and the need for open pasture and freedom of movement, has had a very significant impact on the social and historical identity of Turkmen. Today in contrast, most Turkmen today are settled in cities or on cultivated land. They participate in the growing industrial and gas sector, or cultivate cotton. Nevertheless, there remains a significant minority who live an almost exclusively nomadic life. They are often held with the highest respect and are considered "more Turkmen" by the rest of the population.

The forced cultivation of cotton, a single cash crop, was to benefit of the ruling elite in Moscow and their representatives in Ashgabat, the main city in Turkmenistan. Cotton, of course, was impossible to eat. This made Turkmen farmers and former nomads dependent on the central power for their food supply, leading to periods of famine and starvation. Moreover, the Soviet authorities often set the price for cotton artificially low, preventing the Turkmen from taking advantage of cotton as a source of economic growth.

Although it could be argued that the nomadic lifestyle of the Turkmen and the people of the steppe in Central Asia have had a long-term, millennial impact on the environment, preventing reforestation, and causing possible damages from long-term overgrazing, major economic projects with immediate environmental consequences have only been implemented very recently. Turkmenistan is in the process of signing contracts for Caspian Oil lines that will link the Oil of the Caspian Sea on the Western side of Turkmenistan, with China, a vast country thirsty for cheaper oil to fuel economic expansion. New damns are being built on fragile and usually temperamental rivers to fuel a plan of industrial and economic expansion orchestrated by the central authority. As Turkmenistan transitions rapidly into a settled, industrial economy, the traditional relationship between Turkmen society and the environment will need to be reconsidered. Although the political situation in Turkmenistan is fairly totalitarian and centralized, it is possible that the nationalist character of Turkmenistan's steppe tradition, the closeness to the land and the interest in preserving identity, will help prevent an over-zealous exploitation of resources.

Turkmenistan and Uzbekistan sit on large reserves of oil and natural gas reserves yet both countries face challenges in getting those reserves to world markets. Neither country prefers to export their resources through Russian-controlled pipelines, and so each must seek to obtain capital and political support for pipelines either through Iran or through Turkey.

SEE ALSO: Caspian Sea; Natural Gas; Uzbekistan.

BIBLIOGRAPHY: Jacob Black-Michaud, *Sheep and Land: The Economics of Power in a Tribal Society* (Cambridge University Press, 1986); Adrienne L. Edgar, *Tribal Nation: The Making of Soviet Turkmenistan* (Princeton University Press, 2004). Robert Lewis, ed., *Geographic Perspectives on Soviet Central Asia* (Routledge, 1992); Oliver Roy, *The New Central Asia: The Creation of Nations* (I.B. Tauris, 2000).

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Tyler vs. Wilkinson

EBENEZER TYLER VS. Abraham Wilkinson was a court case decided in 1826 that continues to have important implications for the management of water resources in the United States. The case is also widely known as the Sargent's Trench Trial, as this was the name of the stretch of water above the water wheel over which the case was fought.

Tyler versus Wilkinson centers on the ownership of riverine water resources and the legal power to use them when they act as a finite resource. During the 19th century, water wheels had become an important source of power and were employed both in family farms and, increasingly, in larger-scale industrial enterprises. Development had already had a negative impact on the Sargent's Trench as it had previously been so blocked by construction waste as to obstruct the migration of fish traveling upstream to spawn. Even so, economic growth in the period meant that more people were attempting to draw power from the rivers and pressure was being placed on the extant legal regulations. Because access to such power also had numerous implications for economic and social opportunities, the precedent drawn in this case had significance for the whole country. However, it was also rooted in specific local circumstances and antagonism among the protagonists and among various coalitions of local interests. By exploring whether water resources should be made freely available to all or whether certain individuals or organizations should have privileged access, Judge Story was in part helping to determine the fate of traditional users of the river—fishers, farmers, and urban residents dependent on fresh river water for hygiene and sustenance. His decision was to allocate water resources among either upstream or downstream users and any excess or surplus. Only the surplus water resources could be sequestered by any subsequent claim to use of resources, although this principle was modified by the presence of any pre-existing claims or usages of the water, which were in turn to be reevaluated.

The consequence is that no individual was to be considered in possession of a permanent or inalienable right to water that would deny the use of that water to any other person. Such a principle has underlined a great deal of legal attitude toward the environment and its management in the United States.

Recognizing public interest in this case, Judge Story made sure the facts of the case and of his decision entered into the public domain. He wrote the decision for the newspapers personally to avoid possible distortion or bias by reporters or other intermediaries. The precedent came to be widely regarded and followed.

SEE ALSO: Riparian Rights; Rivers; Water Law.

BIBLIOGRAPHY. *Opinion Pronounced by the Hon. Judge Story in the Case of Ebenezer Tyler and Others vs. Abraham Wilkinson and Others: at the Last June Term of the Circuit Court, for the Rhode-Island District* (Randall Meacham, 1827).

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Typhus

TYPHUS IS A disease caused by two different species of *Rickettsia* bacilli and associated with human crowding and poor sanitary conditions. Humans may contract two different types of typhus: Endemic or murine typhus, caused by *R. typhi,* which is transmitted by the rat flea; and epidemic typhus, caused by *R. prowazekii,* which is transmitted by the human body louse. Typhus causes very high fever, severe aches, delirium, vomiting, and a characteristic rash. Untreated, epidemic typhus presents a death rate of up to 60 percent; murine typhus is typically milder and less fatal.

Epidemic typhus has long been common in refugee camps, in times of war, in prisons, and after environmental disasters. Then called the "Hungarian disease," typhus swept through central and western Europe during the Thirty Years' War (1618–48); tens of thousands of civilians died in several German and French cities. During some wars in Europe, most famously the Napoleonic wars, typhus killed more soldiers and civilians than did warfare itself, leading some to claim for typhus a key role in history. Weakened from the potato famine and displaced from their communities, many Irish died of typhus in the 1840s. Between two and three million people died of typhus during World War I, primarily Polish, Romanian, and Russian soldiers and civilians; many more would have died had the louse vector not been discovered and delousing practices implemented. Thousands of prisoners in German concentration camps during World War II died of typhus.

Campaigns to prevent or eradicate typhus helped cement the role of DDT as a public health tool. Allied forces used DDT to kill lice during typhus outbreaks in Naples, Italy, in 1943. The exposure of residents to DDT on their clothing and skin has been cited as evidence of the chemical's safety. The threat of murine typhus has also spurred public health agencies to initiate rodent control campaigns. Laborers in Depression-era work-relief programs in the United States killed millions of rats in Georgia, Mississippi, and Texas in an effort to stop the spread of murine typhus and prevent more infected rats from entering the country via seaports. Murine typhus persists in low levels throughout much of the southern United States.

Today, typhus may be treated with antibiotics, most effectively in murine typhus but also with considerable success in epidemic typhus. A vaccine for typhus has also been used to protect vulnerable populations. In recent years, however, epidemic typhus has appeared in refugee camps following wars or disasters when public health aid is unavailable or limited. International public health observers and disease surveillance agencies suspect that recent civil unrest, refugee movements, and environmental disasters have set the stage for increasingly severe typhus epidemics to reemerge among vulnerable populations. Some epidemiologists believe that louse infestations are increasing worldwide as a result of a web of deteriorating social, political, economic, and environmental conditions.

Poor hygiene in refugee camps presents the greatest concern, and high percentages of lice found there carry the *Rickettsia* that causes epidemic typhus. Since the 1970s, refugee camps in central and eastern Africa have suffered the most severe outbreaks of epidemic typhus. During the 1990s thousands of refugees in Rwanda, Burundi, and what was then Zaire suffered typhus epidemics. In 1997 Burundi experienced the largest typhus epidemic since World War II, with 24,000 cases. The World Health Organization and other public health groups controlled the outbreak by treating patients with the antibiotic doxycycline. Since 1995 smaller outbreaks have also been reported in Russia, Peru, and Algeria.

SEE ALSO: DDT; Disasters; Disease; Poverty; World Health Organization (WHO).

BIBLIOGRAPHY. Pierre-Edouard Fournier et al., "Human Pathogens in Body and Head Lice," *Emerging Infectious Diseases* (v.12, December 2002); William H. McNeill, *Plagues and Peoples* (Random House, 1976); D. Raoult and V. Roux, "The Body Louse as a Vector of Reemerging Human Diseases," *Clinical Infectious Diseases* (v.29, October 1999); World Health Organization, "1997—Louse-borne Typhus in Burundi" (May 1997), www.who.int (cited May 2006); Hans Zinsser, *Rats, Lice, and History* (Little, Brown, 1934).

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Udall, Morris King (1922–98)

BORN IN ST. Johns, Arizona, on June 15, 1922, Morris K. Udall would go on to be one of the foremost political leaders in environmental protection over a long and illustrious career. At an early age, he showed great leadership potential; he was not only the student body president of his high school, but also the school's valedictorian and basketball team co-captain. Udall graduated high school in 1940 and attended the University of Arizona in Tucson, Arizona, where he studied law. He left college two years later to serve in World War II from 1942 to 1945 in the U.S. Army Air Corps, where he was honorably discharged as a captain. After graduating college in 1949, he played professional basketball for the Denver Nuggets and also achieved the highest score on the state bar exam. He practiced private law with his brother Stewart and eventually worked as the county attorney in Pima County, Arizona, from 1953 to 1954.

Udall was elected as a Democrat to the 87th Congress and was subsequently reelected to the 15 succeeding Congresses until he retired in 1991. In 1976 he vied for the Democratic Party presidential nomination, only to lose to Jimmy Carter. From 1977 to 1991, he served as the Chairman of the Committee on Interior and Insular Affairs (95th through 102nd Congresses), where he worked on many issues related to the environment and public land policy. The Committee on Interior and Insular Affairs is now referred to as the Committee on Resources, and works on a diversity of environmental issues that include but are not limited to energy, forests, public lands, fish and wildlife, Native Americans, and water and power. Significant legislation passed with the help of Morris Udall includes:

- The Strip Mining Reclamation Act: requires coal companies to reclaim their strip-mined land;
- Archaeological Research Protection Act: secures protection of archeological resources on public lands;
- Southern Arizona Water Rights Settlement Act: outlines Indian water rights claims;
- Arizona Wilderness Act of 1984: designates 1.5 million acres of wilderness lands in Arizona;
- Arizona Desert Wilderness Act of 1990: designates 2.4 million acres of wilderness land in Arizona;
- Tongass Timber Reform Act: revokes the artificially high timber targets and protects over one million acres of watersheds.

Both Morris and Stewart Udall had a great appreciation for the natural environment that shone through in their political careers. Morris Udall, John Seiberling (D-Ohio), and 75 cosponsors successfully introduced the Alaska Lands Act of 1980 into Congress. The bill was heavily fought by mining, timber, and oil interests as it ultimately designated 55 million acres of new protected wilderness, expanded the national park system in Alaska by about 43 million acres (22.3 million hectares), creating 10 new national parks, and greatly expanded and created National Wildlife Refuge lands, Wild and Scenic River designations, and National Forest System lands.

Morris Udall spent much of his career promoting the environmentally detrimental $4.4 billion Central Arizona Project (CAP), the most expensive water project in U.S. history. Originally supporting the damming of two areas of the Colorado River for the project, Udall eventually sided with environmentalists after a massive public outcry; the dams were not built.

Later in his career (after the CAP was constructed) Udall made statements of regret over the water project and worried that he wrongly supported it: "Now we have cotton farms selling out and taking their money to enjoy in La Jolla [California]—and cities building lakes so people will have lakefront homes in the desert … If I had to do it over, I think I'd say, 'Leave the water in the river.' " Udall died December 12, 1998, due to complications from Parkinson's disease.

SEE ALSO: Dams; Forest Service; National Parks; National Wild and Scenic Rivers Act; Native Americans; Public Land Management; United States, Alaska; Water Law.

BIBLIOGRAPHY. Donald Carson and James Johnson, *Mo: The Life and Times of Morris K. Udall* (University of Arizona Press, 2001); Morris K. Udall Foundation, "About Morris K. Udall," www.udall.gov, February 2006 (cited May 2006); National Parks Conservation Association, "ANILCA Fact Sheet," www.npca.org (cited February 2006); U.S. Congress Biographical Directory, bioguide.congress.gov (cited February 2006); U.S. House of Representatives Committee on Resources, resourcescommittee.house.gov (cited February 2006); "Udalls Prod Environmentalists to Tackle Growth Water Issues," *Arizona Daily Star* (April 14, 1987).

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Uganda

A DECADE AFTER achieving independence from Britain in 1962, the Republic of Uganda began a 14-year period marked by dictatorial governance, civil war, mass murders, atrocities, and extensive human rights abuses that sapped the country of both human and physical resources. By the end of that period, some 400,000 Ugandans had lost their lives. In 1987, many young Ugandans came under the influence of Joseph Kony, who further drained the country of its resources by recruiting soldiers for what he called The Lord's Resistance Army. Kony's tactics involved kidnapping children between the ages of eight and 12 and coercing them to be soldiers by threatening their lives and the lives of their families. Even after Kony was expelled, he continued to reinforce this children's army from neighboring Sudan. International organizations are currently involved in a massive effort to rescue and rehabilitate these children and bring an end to Kony's influence in Uganda. By the 1990s Ugandans had begun to recover politically and economically, dispensing with political parties to elect a new president and legislature.

Uganda's abundant natural resources include sizable deposits of copper and cobalt, hydropower, limestone, and salt. Nearly 26 percent of Uganda's land area is arable, and 82 percent of the work force is engaged in some form of agriculture. The abundant rainfall and fertile soils make it easy to grow a variety of products. Coffee is the major export crop, accounting for the lion's share of export revenue. Since 1986, international agencies have been assisting the Ugandan government in economic reform. In 2000, Uganda qualified for debt relief through funding from the Heavily Indebted Poor Countries initiative and the Paris Club. The return of exiled Indian-Ugandan entrepreneurs has also had a positive affect on the Ugandan economy.

With a per capita income of $1,700, Uganda is ranked 190th in world incomes. Income disparity exits, with the richest 10 percent holding more than one-fifth of the country's wealth and the poorest 10 percent sharing only four percent of resources. Over a third of Ugandans live in poverty, and nearly one-fifth of the population is seriously undernourished. The United Nations Development Programme's Human Development Reports rank Uganda 144 out of 232 countries on general quality-of-life issues.

While landlocked, Uganda has an abundance of lakes and rivers that provide 36,330 square miles of water resources. The largest body of water is Lake Victoria, which Uganda shares with Tanzania. Uganda also borders the Democratic Republic of the Congo (DROC), Kenya, Rwanda, and the Sudan. The terrain of Uganda is comprised of an alluvial plateau rimmed by mountains. Elevations range from 621 meters at Lake Albert along the border of the DROC to 5,110 meters at Mount Stanley. Most of Uganda experiences a typically tropical climate that is marked by two dry seasons from December to February and from June to August. The climate of northeastern Uganda is semiarid.

The population of 28,195,754 faces major environmental health hazards, including an HIV/AIDS adult prevalence rate of 4.1 percent. Some 530,000 Ugandans live with this disease, and another 78,000 have died from it since 2003. Forty-four percent of the population do not have sustained access to safe drinking water, and 59 percent do not have access to improved sanitation. Therefore, Ugandans have a very high risk of contracting food and waterborne disease that include bacterial diarrhea, hepatitis A, and typhoid fever and the waterborne disease schistosomiasis. In some areas, the population has a high risk of contracting African trypanosomiasis, popularly known as the "sleeping sickness." Ugandans have a lower-than-normal life expectancy (52.67 years) and growth rate (3.37 percent), and higher-than-normal infant mortality (66.15 deaths per 1,000 live births) and death (12.24 deaths per 1,000 population) rates. Ugandan women produce an average of 7.1 children each. The female literacy rate of 60.4 percent makes disseminating health information somewhat difficult.

The wetlands of Uganda have been repeatedly drained to gain land for agricultural use. Agricultural mismanagement has also led to overgrazing with extensive loss of vegetation, which has produced soil erosion. The process of eradicating tsetse flies has led to toxic pollutants being released into the environment. Water supplies have been contaminated by industrial effluents, including mercury released in mining operations. Even though over one-fifth of land area is still forested, deforestation is occurring at a rate of 2 percent per year. Lake Victoria is experiencing water hyacinth infestation that interferes with marine life and the fishing industry.

Uganda is rich in wildlife, and the government has protected almost a fourth of land area. These areas include a vast network of national parks, wildlife reserves, wildlife sanctuaries, and community wildlife areas. Nevertheless, biodiversity and habitats are threatened by extensive poaching. Of 345 identified mammal species, 20 are endangered, as are 12 of 243 bird species. In 2006, scientists at Yale University ranked Uganda 78 of 132 countries on environmental performance, above the comparable income and geographic groups. The overall ranking was decreased by the poor showing in environmental health.

The 1995, Ugandan Constitution established the right to a clean environment and created the Ministry of Water, Land, and Environment, which is the governing body charged with promoting sustainable development and protecting the environment. Specifically, under the framework of the National Environment Plan, the ministry implements and enforces laws and polices relating to the management of land, water, forestry, and wetlands and to weather and climate, and atmospheric pollution. The ministry also provides oversight for three statutory bodies: The National Environment Authority, the National Water and Sewerage Corporation, and the Uganda Land Commission.

Uganda participates in the following international agreements on the environment: Biodiversity, Climate Change, Climate Change–Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Life Conservation, Ozone Layer Protection, and Wetlands.

SEE ALSO: Colonialism; National Parks; Pesticides; Poaching; Victoria, Lake; Water Hyacinth.

BIBLIOGRAPHY. Central Intelligence Agency, "Uganda," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: a Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, Africa's *Ecology: Sustaining the Biological and Environmental Diversity of A Continent* (McFarland, 1993); Uganda Ministry of Water, Land, and Environment, www.mwle.go.ug (cited April 2006); United Nations Development Programme, "Human Development Report: Uganda," hdr.undp.org (cited April 2006); World Bank, "Uganda," *Little Green Data Book*, lnweb18.worldbank.org (cited April 2006).

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Ukraine

AFTER A BRIEF period of independence from 1917 to 1920, the Ukraine was brought under repressive Soviet domination. After achieving independence in 1991 following the dissolution of the Soviet Union, the Ukraine continued to struggle with massive corruption that stymied efforts at economic and political reform. The "Orange Revolution" of 2004 precipitated a reform movement whose effects are still unclear. The struggle over the position of Ukraine in global politics, oriented either toward Russia or toward Western Europe, remains unresolved. The second-largest country in Europe, the Ukraine has a population of 47,425,336. With a per capita income of $6,800, the Ukraine is ranked 114th in world incomes. Some 29 percent of the population live below the poverty line. The United Nations Development Programme Human Development Reports rank the Ukraine 78th among all nations in overall quality-of-life issues.

Bordering on the Black Sea, the Ukraine has 1,725 miles (2,782 kilometers) of coastline. The climate is Mediterranean along the southern coast and temperate continental elsewhere. Precipitation is most frequent in the west and north. In the east and southeast, winters are cool around the Black Sea but inland temperatures are colder. Summers are generally warm, although it is hotter in the south. The Carpathian Mountains in the west and the Crimean Peninsula in southernmost Ukraine are major geographical features. The rest of the country is composed of fertile plains and plateaus.

The Ukraine is rich in natural resources that include iron ore, coal, manganese, natural gas, oil, salt, sulfur, graphite, titanium, magnesium, kaolin, nickel, mercury, and timber. Over 56 percent of the Ukraine is arable, and Ukrainian farmers export milk, grain, vegetables, and meat to neighboring countries. Agriculture generates almost one-fifth of the Gross Domestic Product (GDP). Despite the high level of agricultural activity, 67.3 percent of the population live in urban areas. With only 108 cars per 1,000 people, the Ukraine produces 1.5 percent of the world's carbon dioxide.

The Ukraine suffers from a lack of potable water. Air and water pollution are common in industrial areas, and deforestation is widespread. Residue from the explosion at the Chernobyl Nuclear Power Plant in 1986 continues to contaminate areas in the northeast. The past haunts the Ukraine in other ways. Like most former Soviet republics, the Ukraine was exploited with little care for the environment. Long-lasting environmental damage was ubiquitous after the Soviet withdrawal. For instance, elevated levels of dioxin-like polychlorinated biphenyls (PCBs) were identified in samples of human milk. Likewise, high concentrations of pesticide residues were found in water samples of the Black Sea. Emission experts have identified the Ukraine as one of the heaviest contributors to European pollution because half of the pollution generated in the Ukraine has been ultimately deposited in other European countries.

In 2006, a study conducted at Yale University ranked the Ukraine 51st among 132 nations in environmental performance, slightly higher than the relevant income and geographic groups. Ratings were particularly low in sustainable energy, biodiversity and habitat, and air quality. Only 3.9 percent of land area is protected, but plans to increase such areas are under way. Sixteen of 108 mammal species endemic to the Ukraine are endangered, and eight of 215 endemic bird species are in a similar situation.

The Minister for Environmental Protection and Nuclear Safety is in charge of implementing environmental policy in the Ukraine. Operating under the National Action Plan on Environmental Protection, the Ukraine has developed policies that target all levels of government by seeking to integrate sustainable development with economic growth. Since 1998 environmental policy has focused on exacting payments for nature resources and environmental pollution. With the Chernobyl accident always in mind, preventing future accidents is a priority in Ukrainian planning, and particular attention is paid to licensing procedures for hazardous activities.

The Ukraine has joined the environmental efforts of the global community by participating in the following agreements: Air Pollution, Air Pollution–Nitrogen Oxides, Air Pollution–Sulfur 85, Antarctic–Environmental Protocol, Antarctic–Marine Living Resources, Antarctic Treaty, Biodiversity, Climate Change, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, Marine Dumping, Ozone Layer Protection, Ship Pollution, and Wetlands. The Ukrainian government has signed but not ratified the Air Pollution–Persistent Organic Pollutants, Air Pollution–Sulfur 94, and Air Pollution–Volatile Organic Compounds agreements.

SEE ALSO: Black Sea; Chernobyl Accident; Drinking Water; Pesticides; Pollution, Air; Polychlorinated Biphenyls (PCBs); Urbanization.

BIBLIOGRAPHY. Central Intelligence Agency, “Ukraine,” *The World Factbook,* www.cia.gov (cited April 2006); Winston Harrington et al., *Choosing Environmental Policy: Comparing Instruments and Outcomes in the United States and Europe* (RFF Press, 2004); Kevin Hillstrom and Laurie Collier Hillstrom, *Europe: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Minister for Environmental Protection and Nuclear Safety, “Ukraine: Implementing Environmental Reforms,” www.mem.dk/aarhus-conference (cited April 2006); United Nations (UN) Development Programme, “Human Development Reports: Ukraine,” hdr.undp.org (cited April 2006); UN Environment Programme, *Europe Regional Report: Chemicals* (Global Environment Facility, 2002); World Bank, “Ukraine,” *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, “Pilot 2006 Environmental Performance Index,” www.yale.edu/epi (cited April 2006).

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Uncertainty

THE NOTION OF uncertainty is used to characterize how well future events or scientific truths can be predicted or known. It is used in both social and natural science disciplines from mathematics to philosophy to risk assessment and public policy. If probability is a measure of likelihood, then uncertainty is a measure of how well the probability is known. Uncertainty can be classified into known and unknown probabilities. Events with known probabilities are referred to as events with statistical uncertainties. Events with unknown probabilities are often called events with true uncertainty.

In chemistry and quantum physics, the Heisenberg uncertainty principle is used to characterize the wave/particle duality of electrons. It postulates that the position and momentum of a particle cannot be simultaneously predicted. This has nothing to do with the experimental design as it is often suggested, but because as the scale gets smaller, it becomes less useful to model particles as spheres. The multiple wavelengths associated with the wave model of these particles add inherent uncertainty to the questions of position and momentum.

Uncertainty in the context of the environment mainly refers to scientific uncertainty. Here, science generates truths through the testing of hypotheses. But often the affirmation of hypotheses involves a certain degree of uncertainty due to the method or research design. Scientists often use the benchmark of 95 percent certainty when deciding whether or not cause and effect have been correctly identified. Scientists often report confidence limits based on research design and sampling error in their studies to account for uncertainty.

The significance of uncertainty for environmental policy makers is quite different. For example, the precautionary principle is often invoked under conditions of uncertainty, particularly when the consequences are irreversible or permanent. This differs from the choice that scientists make when deciding what to do under conditions of uncertainty. Typically scientists are interested in avoiding false negatives because science is epistemologically conservative. Scientists do not want to suggest something as truth when in fact it may not be. In public or environmental policy, however, because the consequences are not epistemological but ethical, there is desire to avoid false positives and be ethically conservative.

In public and environmental policy it is important to understand how to make decisions in the absence of perfect information. Knowing the degree of uncertainty is particularly important when questions about risk arise. Risk assessment is a policy approach that deals with uncertainty. Risk assessment is widely used by the Environmental Protection Agency (EPA), but mainly focuses on known probabilities. Because of difficulties with codifying the precautionary principle into policy, the EPA has yet to include true uncertainty in environmental policy.

Schrader-Frechette describes four classes of scientific uncertainty dealt with by scientists and policy makers: Farming uncertainty, modeling uncertainty, statistical uncertainty, and decision-theoretic uncertainty. In framing uncertainty, scientists often use a two-value frame to accept or reject a hypothesis. Frechette argues that in public policy it is more appropriate to adopt a three-value frame that creates a category to deal with situations where significant uncertainty and serious consequences suggest adopting the precautionary principle. Modeling uncertainties involve those involved in the prediction of future scenarios. These are highly speculative despite claims of verified and validated models. In public and environmental policy, statistical uncertainty should be dealt with in such a way that highlights the difference between epistemological consequences and ethical ones. When faced with decision-theoretic uncertainty, scientists are forced to distinguish between using expected value rules and the minimax rule. The former argues that a decision should be based on the expected value, while the latter seeks to prevent the worse case scenario. More recently Bayesian statistics has been used to help evaluate data under conditions of uncertainty by adding updating the probabilities as new data come in to view. A Bayesian approach involves the introduction of prior knowledge into statistical models.

There are many environmental policy debates where questions about uncertainty are raised. In debates about global climate change, for example, scientists typically agree that there is significant uncertainty in the projection of future climate change models. Climate change skeptics often highlight uncertainty to discredit climate change science. In debates about genetic engineering, uncertainty about the prediction of how transgenic organisms will behave in the environment, or uncertainty about how markets will react to the adoption of transgenic organisms, is cited as a reason to invoke the precautionary principle. In debates about nuclear waste disposal at Yucca Mountain, uncertainty about how the storage facility will perform in the long term is cited as reason to question the suitability of the nuclear waste repository.

SEE ALSO: Genetically Modified Organisms (GMOs); Global Warming; Precautionary Principle; Risk, Perception, Assessment, and Communication; Yucca Mountain.

BIBLIOGRAPHY. Daniel Bodansky, "Scientific Uncertainty and the Precautionary Principle," *Environment* (v.33/7, 1991); John Lemons, ed., *Scientific Uncertainty and Environmental Problem Solving* (Blackwell Science Press, 1996); Allison MacFarlane and Rodney C. Ewing, *Uncertainty Underground: Yucca Mountain and the Nation's High-Level Nuclear Waste* (MIT Press, 2006).

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Underdeveloped (Third) World

THE "UNDERDEVELOPED WORLD" is a term used to describe the "third world." The *third world* was a common term used to differentiate between countries that aligned with neither the West nor the

East during the cold war. In academic literature, several terms such as the South, underdeveloped, less developed, and developing have since been used interchangeably to describe these countries.

While it should be recognized that there is a great deal of diversity among underdeveloped countries in relation to geographical location, climatic conditions, religion, population size, resource endowments and the extent of dual economy, in broad terms they share several common characteristics. These are: Low standards of living, low levels of productivity, high rates of population growth, high levels of unemployment, strong economic dependency on agricultural production and export of primary products, and high foreign debt. Most underdeveloped nations are unable to provide for the developmental and economic needs of their citizens. This has left underdeveloped countries dependent and vulnerable in the turbulent arena of international relations.

MEASURING SOCIOECONOMIC STATUS

Policy makers and academic experts measure the socioeconomic characteristics of a nation using the Human Development Index (HDI) and the Human Poverty Index (HPI). The HDI index was developed by the United Nations (UN) to differentiate and compare the relative economic and social well-being of nations. Annual HDI reports are published to establish the comparative economic status of a nation by comparing and contrasting the value of significant social and economic indicators including, mortality rates, education levels, health statistics, and income levels.

Countries with an HDI measurement of over 0.8 are categorized as developed world nations, while those with a measurement below 0.8 are described as being underdeveloped. Low HDI scores indicate low per capita income, a relatively undeveloped infrastructure (including transport and telecommunications), high mortality rates, and low levels of education and employment. The 2005 HDI Report shows that the large majority of countries with a low HDI are currently in Africa.

The Human Poverty Index (HPI), also developed by the UN, measures the extent of poverty in a country. The magnitude of poverty is used not only to reflect the level of social welfare attained by the country over time but also to rank the country on a development scale. The HPI measurement indicates the levels of material need, social need, and financial resources of a country.

The World Bank also studies global poverty rates and they have shown that poverty levels are highest in the developing world. The World Bank reported in 1996 that Asia accounted for over two-thirds of the world's 1.3 billion poorest people, and the World Development Report 2000–2001 states that 29.1 percent of people in selected developing countries live in poverty.

FOREIGN AID

It is the question of how to reduce poverty that dominates discussion between the countries of the developed and underdeveloped worlds. The allocation of foreign aid to the underdeveloped world has been the most common strategy employed by developed world nations to try to reduce poverty levels in underdeveloped countries.

Foreign aid refers to any money or resources that are transferred from developed to developing countries without expecting full repayment. The 1971 UN Conference on Trade and Development (UNCTAD) promoted the notion that one percent of the national income of developed countries should be allocated to easing third world poverty. A subsequent UNCTAD meeting in Chile, in 1972, also set growth targets for developing countries at 6 percent during the 1970s. Another initiative, the Lome I and II pacts of 1975 and 1979 between the European Economic Community (EEC) and 46 African, Caribbean, and Pacific (ACP) countries, exempted ACP exports from certain tariffs, and guaranteed income from agricultural exports.

While foreign aid can play an important complementary and catalytic role in promoting economic growth, generally the distribution of foreign aid has further strengthened the reliance of the underdeveloped world upon developed nations. Many experts suggest that conditional (foreign) aid has resulted in the delivery of overpriced technical assistance, the counting of debt relief as development aid, and the inclusion of immigration-related costs in aid figures, which has tended to serve the interests of international donor countries rather than eradicating poverty.

Conditional foreign aid has also had a profound impact upon the environments of the developing world. Costa Rica, for example, received nine International Monetary Fund (IMF) and World Bank structural adjustment loans during the 1980s. These loans were designed to encourage the competitive entry of Costa Rica into the international markets for bananas and cattle. The developmental expansion, however, came at the cost of increased use of pesticides, intense deforestation, and species extinction, resulting ultimately in a decrease of 31 percent of Costa Rica's forest cover by 1987.

There is a growing consensus in the aid community that a considerable portion of the international aid budget should be restructured to focus on human development concerns in developing countries. Experts recommend that aid be practical, targeted, science-based, and measurable. Foreign aid policies must reflect local priorities, incorporate stronger commitment and partnerships, incorporate routine monitoring and evaluation and be consistent with other developmental policies of the donor countries.

GLOBALIZATION

As demonstrated by the Costa Rican example above, underdeveloped countries do not exist in isolation, but are part of a globalized economy. Globalization refers to the expansion of local concerns—such as markets, information technology, social, cultural and political systems—into the global arena. Significant financial power is required by a country to expand local concerns and take an active and competitive role in the global economy because the international economy is dominated by rich developed countries.

For the underdeveloped world, globalization has thus necessitated the realignment of national policies to be consistent with their global counterparts in order to allow economic integration. Unfortunately, most underdeveloped countries do not possess the financial power needed to fully exploit global opportunities. Consequently, sub-economies have been established within underdeveloped countries that essentially serve industrialized markets because market control over international goods and services is primarily dominated by large multinational companies based in the developed world. This means that underdeveloped countries are controlled by the price-setting measure of those companies; this has had the effect of limiting economic activity in developing nations to a few niche sectors and is preventing them from fully exploiting resources that could help reduce poverty levels.

RESOURCE INEQUITY

The economic dominance of the developed world over underdeveloped nations in globalized markets is best demonstrated by the major inequalities in the consumption and ownership of the world's resources. Resource consumption is defined as the exploitation or use of all resources that we extract from the environment (often termed environmental resources or inputs); including minerals, fossil fuels, fish, wood, water, land, and other forms of energy. These resources (inputs) are extracted to produce the goods and services that are manufactured and consumed in the market place.

The 1998 Human Development Report highlights the starkness of the inequity of resource use between the developed and developing worlds, noting that globally, the richest fifth of the world's population has 85 percent of its income, while the poorest fifth has just 1.4 percent. The same report also shows that 20 percent of the world's people in the highest-income countries account for 86 percent of total private expenditure in consumption of goods and services, while the poorest 20 percent account for just 1.3 percent. Further, the richest fifth of global nations consume 45 percent of all meat and fish, consume 58 percent of total energy, and own 87 percent of the world's vehicle fleet.

GLOBAL POPULATION GROWTH

The inequitable distribution and ownership of the world's resources can be demonstrated by an examination of projected global population statistics. The world population is estimated to reach 9.1 billion by 2050. Ninety-five percent of the world's population growth will be within the world's least-developed countries. Fertility rates in the underdeveloped countries will remain high, while developed countries are estimated to reach "below replacement" level by 2050. Mortality rates in developing countries remain high, however, especially in those countries within Africa and some parts of Asia that have high HIV/AIDS and other contagious disease infection rates.

Theses projected trends in population growth will have significant implications for both human populations and the environment in underdeveloped countries. First, the growth of population in these countries will place added pressure upon the agricultural industries. As the population increases the demand for food will grow. It is estimated that the total demand for agricultural products in 2030 will be approximately 60 percent higher than today. More than 85 percent of the additional demand will be from the underdeveloped world.

A second implication of population growth is a predicted corresponding demographic shift in populations from rural to urban centers. Presently, there are 20 global cities of more than 10 million people. Fifteen of the 20 are in underdeveloped countries, containing four percent of the global population. By 2015 it is predicted that there will be 22 such mega-cities, 16 of which will be in developing countries, accounting for five percent of the global population.

The growth in mega cities will be due to the displacement of people from rural communities who will be forced from their land by the application of new technologies that displace local producers in favor of large commercial farms that can cater to the increased demand for food.

As is already being witnessed in China, the displacement of people from rural centers into urban areas is having a tremendous impact upon those forced to move. Unemployment rates are high, local cultural identities are being eroded and China's entry into the World Trade Organization (WTO) is lowering rural livelihoods as small producers compete with imports from other WTO countries.

POPULATION AND THE ENVIRONMENT

Another significant impact of population growth in the underdeveloped world is upon the environment. The drive for developing countries to achieve economic equity and status with the developed world, and meet the challenge of providing for rising populations, puts intense pressure on the environment, causing environmental problems such as degradation, erosion, salinity, and conversion of natural ecosystems.

In a report by the World Commission on Environment and Development, poverty is identified as a major cause and effect of global environmental problems. For example, China's population is estimated to increase by 25 percent by 2012. Excessive erosion rates resulting from this will have significant impact on over one-third of China's fields, while the burning of crop residues to cook and provide heating will denude the soil of important organic matter.

The use of pesticides in agriculture is of major concern. The World Health Organization (WHO) has estimated that over one million cases of pesticide poisoning occur annually, with most of these instances occurring within developing countries.

Dependence on and pressure to access the world's water resources will increase, as will the environmental impacts upon them. In the past century alone, growing populations have increased demand for freshwater six-fold. Moreover, there is an increasing demand for freshwater with industrialization, irrigated agriculture, massive urbanization, and growing populations. More than one-half of available freshwater supplies are now used for domestic purposes and the world's water demand is doubling every 20 years.

Deforestation is another major environmental issue facing many developing countries. Clearing for subsistence and commercial agriculture, fuelwood, logging, and mineral extraction pay economic dividends but the impact on ecosystems is dramatic. For example, since 1960, over a quarter of the rain forest in Chile has been cleared to provide land for cattle grazing, which has been encouraged to meet the demand for beef in developed countries.

Deforestation is having a global impact causing species extinction, ecosystem service loss, and the reduction of carbon sinks resulting in increased emissions of climate changing gases. Deforestation in the Amazon is affecting weather patterns and rainfall from Mexico to Texas, while deforestation in southeast Asia impacts rainfall in China and the

Balkan Peninsula. Twenty to 25 percent of global carbon emissions come from changes to land use, primarily the degradation of forests.

Population growth in underdeveloped countries is also having a negative impact upon the marine commons. The resources of the marine environment are a vital source of food and often the sole source of nutrition for over one billion people. A vast majority of those dependent on marine resources for nutritional needs are in underdeveloped countries. This resource is threatened both by unsustainable exploitation and contamination. Algal blooms—or eutrophication—are caused by the excessive input of nutrients from agricultural runoff into marine environments. These can cause health problems, poisoning, and sometimes death. In 1987 there were 200 cases of algal poisoning in Guatemala, 26 of which were fatal.

The United Nations Environment Program estimates that over 20 billion tons of waste—including sewage, agricultural waste, and industrial runoff—are discharged into the world's oceans annually. Ninety percent of this pollution remains near the coast, where 95 percent of fish are harvested. This is why implications of expanded agricultural areas and industrialization in developing countries will have a continuing detrimental impact upon the marine environment and health of local peoples.

DEVELOPMENT'S ENVIRONMENTAL COST

In order to cope with expanding populations and to participate in the global marketplace, major development projects are taking place across the underdeveloped world, including the construction of roads, dams, and railways. These often have immense environmental implications. The Projecto Grand Carajas in Brazil, an iron and other ores project, will occupy up to 10 percent of Brazil's land mass and will cut through 900 kilometers of Amazon rain forest. Impacts upon the rivers and hydrology of the Amazon will be significant because a series of hydroelectric dams will be constructed to provide energy to power the project; additional energy will be generated by burning charcoal products extracted from Amazonian timber.

The clearing of forest for Projecto Grand Carajas will release vast stores of carbon from the soil, plus the added effect of burning the timber to generate power will greatly increase Brazil's overall emissions of climate changing gases. Significant siltation of Amazonian rivers will occur as soil from cleared land is washed by monsoonal rains into waterways.

CONFLICTS AND REFUGEES

Conflicts due to demographic change, environmental pressures, population growth, resource use and the vagaries of natural climate are common across the underdeveloped world. Conflicts over resource use and exploitation have occurred, including disputes over the most precious of resources—water. Water scarcity the world over is causing significant tension. Forty percent of the world's population depends on 214 river basins for drinking water, irrigation, and power. In India, conflicts over water have occurred, such as the 1991 civil unrest between the states of Karantataka and Tamil Nadi over access rights to the Cauvery River.

Conflict can lead to refugees, and combined with natural environmental fluctuations, environmental degradation, and over-exploitation of natural resources, the underdeveloped world regularly faces significant challenges. At the end of 2000, the number of refugees in the world stood at 16 million people. The largest numbers of refugees were in underdeveloped parts of the world including nine million in Asia and four million in Africa. Three million refugees are displaced in developed countries.

Many refugees in the underdeveloped world are considered to be environmental refugees. This is mainly as a consequence of natural disasters such as drought. For example, in 1988, over one million Ethiopians were displaced due to a serious drought that also had major impacts in other developing countries, including drought-prone northeast Brazil.

People are also made refugees as a result of development projects such as dam or road constructions. For example, the construction of a dam at the Kaptai Lake in Bangladesh displaced 100,000 people without compensation and the Three Gorges Dam project in China has displaced 1.2 million people.

Human displacement due to environmental issues and social and economic development in the underdeveloped world has been a catalyst for conflict. The arrival of Mauritanians into Senegal led to armed clashes between the two groups.

The issue of refugees is only set to get worse as the underdeveloped world faces major environmental challenges as a result of long-term environmental degradation and human-induced climate change. Estimates indicate that sea level rise and a decline of food stock, due to climate change, has the potential to create up to 173 million environmental refugees, most of whom will be residents of the underdeveloped world.

EQUITY AND THE ENVIRONMENT

As discussed above, the developed world is the major consumer of the earth's resources, but population growth is centered in the underdeveloped world. Globalization is forcing the two global spheres to interact as never before. This presents the world with a question: Is it possible to support the rights of developing countries to enjoy the same levels of affluence and quality of life as the developed world, while minimizing environmental impacts?

Globalization means that human society now shares a global commons. Developing countries play a vital role in the global economy and provide the world with cheap resources and labor. However, current global consumption is increasingly happening at the expense of the environment and the earth's climate and is doing little to alleviate global poverty.

The establishment of effective legislative environmental controls in underdeveloped countries would help to minimize environmental impacts while creating an equitable world. At present, environmental laws in many developing countries are difficult to interpret, vague, or simply nonexistent. Where environmental legislation does exist in underdeveloped countries it is not accompanied by regulation or enforcement of those laws. In Central America and Mexico, surveys of air and water pollution laws show that while laws exist to regulate these issues, financial resources have not been allocated to legal enforcement. In the African countries of Zambia, Ethiopia, Ghana, the Sudan and Kenya, penalties for infringements of environmental law are so low it is cheaper to pollute than act within the law.

Ecologically sustainable development (ESD) has been suggested as a mechanism outside of legislative frameworks that can address these problems. The concept of sustainable development is seen as an essential measure of the impact of economic activity upon global survival. The World Commission on Environment and Development (UNCED) in 1992 defined ESD as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The UNCED definition was based on the report *Our Common Future*, published in 1987 by the World Commission on Environment and Development, which called for strategies to strengthen global efforts to promote the concept of sustainability. The Commission highlighted that the political goals of socio-economic development must be treated as a crucial part of attaining sustainable development.

The Millennium Development Goals (MDGs) are another forum through which underdeveloped and developed countries can work together to minimize environmental impacts while countries develop their socio-economic structures. The MDG framework identifies eight major goals and 18 associated targets to evaluate the effectiveness of sustainable development. These goals include quantified aims in relation to achieving poverty alleviation by 2015. Furthermore, the forum acknowledges the importance of agriculture to rural development and how it may contribute toward meeting the MDGs.

Developing countries are also emerging with a collaborative voice to address some of these challenges. At the UN summit on climate change in Montreal in 2005, a coalition of 10 tropical developing countries called the Coalition for Rainforest Nations and led by Papua New Guinea and Costa Rica tabled a proposal for compensation for rain forest services that their nations provide for the rest of the world. UN figures show that the countries within this coalition collectively represent approximately 13 percent of the world's rain forest, reflecting $1.1 trillion in carbon storage. The coalition stressed the inequity of expecting developing nations, burdened by poverty, to give up income through deforestation while other countries benefit from the services derived from rain forest protection. These services include carbon storage, water filtration, biodiversity protection, climate regulation, and fisheries protection. They argued that if the developed world wished to save the rain forest, they should pay for rain forest services. Examples like these highlight the dilemmas developing countries face when resource use and exploitation are the only way a nation is able to survive economically.

Underdeveloped countries, despite aid programs and their own efforts, largely remain in poverty. Poverty combined with the pressure of competing on the international stage, population increases, environmental degradation, and unsustainable resource use indicates the underdeveloped world still faces significant challenges. Cumulatively, these factors undermine the peace and stability of the entire world. While it is crucial that poverty is effectively addressed, development per se is not the panacea it was once thought to be. Pathways must be found to reconcile development needs, eradicate poverty, and decrease inequity between the underdeveloped and first worlds in ways that are environmentally sound, socially just, and economically viable.

SEE ALSO: Debt; Developed ("First") World; Globalization; Industrialization; International Monetary Fund; Land Degradation; Markets; Population; Poverty; Rain Forest; United Nations; World Trade Organization.

BIBLIOGRAPHY. R. Butler, *Developing Countries: Pay Us to Save the Rainforests* (Monganbay Press, 2005); Global Forest Resources Assessment, www.unfpa.org (cited April 2006); F. Lechner and J. Boli, eds., *The Globalisation Reader (*Blackwell Publishing Ltd., 2004); T. Oatley, ed., *The Global Economy: Contemporary Debates* (Pearson Education, 2005); B. Ogolla, "Water Pollution Control in Africa: A Comparative Legal Survey," *Journal of Africa* (v.33, 1989); R. Ramlogan, *The Developing World and the Environment, Making the Case for Effective Protection of the Global Environment* (University Press of America, 2004); E.S. Simpson, *The Developing World: An Introduction* (Longman Scientific and Technical, 1987); H. Steinfeld, "Economic Constraints on Production and Consumption of Animal Source Foods for Nutrition in Developing Countries," *The Journal of Nutrition* (v.133, 2003); E. Tang, "China and the WTO: A Trade Union View of Social Impacts and Workers' Responses," www.union-network.org (cited April 2006); T. Tietenberg, "The Poverty Connection of Environmental Policy," *Challenge* (v.33, 1990); United Nations (UN), "The State of Human Development," *United Nations Development Report, 1998* (UN 1998); United Nations, *World Population Prospects, The 2004 Revision* (Department of Economic and Social Affairs, 2005); J. Wheeler, "The Interwoven Strands of Development," *The IECD Observer* (v.167, 1990); Worldwatch Institute, *State of the World 2001: A Worldwatch Institute Report on Progress Toward a Sustainable Society* (Worldwatch, 2002).

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Underground Storage Tanks

UNDERGROUND STORAGE TANKS (USTs) are large containers that have at least 10 percent of their volume and associated piping underground. Underground storage tanks usually contain petroleum or other hazardous gaseous or liquid materials. In 2006, there were about 680,000 underground storage tanks in the United States. The petroleum or other materials that they contain are almost always hazardous to humans, animals, or to the general environment. Whenever an underground storage tank leaks it causes damage to the environment. Quite often water wells in the area have to be shut off because of contamination. In addition to the underground storage tanks in use, there are a large unknown number of old abandoned underground storage tanks. Until the middle of the 1980s, underground storage tanks were made from plates of bare steel that had been welded together. With a high potential for rusting and leaking, the life expectancy of these older tanks is only 30–50 years.

Thousands of underground storage tanks were installed in the United States after World War II in order to supply gasoline to the growing number of automobiles that Americans were driving. Since 1950 many of these hundreds of thousands of underground storage tanks have leaked. Usually leaking gasoline, some tanks have included petroleum distillates such as diesel, heating oil, kerosene, and jet fuel. Gasoline additives pose an even more important danger than leaking gasoline. These have included lead, which can cause brain damage, and benzene, which is a known carcinogen. Just a small amount of benzene can pose a severe hazard because of its toxicity. Toluene, ethylbenzene, and xylenes are also toxic additives in gasoline that pose significant health risks when leaked into the environment. There are nearly 400,000 leaking underground storage sites in the United States that are being monitored by U.S. Environmental Protection Agency's (EPA) Office of Underground Storage Tanks.

Because over half of Americans get their drinking water from groundwater, the threat to health is very serious. In addition, leaking petroleum volatiles give off vapors that pose an explosive fire hazard that can accumulate in sewers and the basements of buildings. The EPA uses money from the Leaking Underground Storage Tank (LUST) Trust Fund to clean up the worst of the leaking underground storage tanks. Increasingly, the polluters are forced to pay for the cleanup. Since 1984, Congress has responded to the problem of leaking underground storage tanks with a range of laws. Besides the Comprehensive Environmental Response, Compensation and Liability Act ("Superfund") and the Resource Conservation and Recovery Act (RCRA), which list a large number of substances that are contained in USTs, Congress has provided cleanup funds.

In 1985 Congress banned the use of unprotected steel tanks and piping. It has also directed the EPA to publish regulations covering USTs that will require owners and operators of new tanks, as well as old tanks, to detect and clean up any releases from their tanks, and to establish financial resources to pay clean up costs in the event of a leak. The EPA works with state and local governments to manage current LUSTs and to prevent any new ones from occurring. The great number of tanks and their widespread distribution puts states and localities in the best position to supervise the regulation of USTs as a part of the powers of states to regulate the health and safety of their people. Many states have more stringent regulations than the federal government.

SEE ALSO: Drinking Water; Gasoline; Groundwater; Petroleum.

BIBLIOGRAPHY. Wayne B. Geyer, *Handbook of Storage Tank Systems: Codes, Regulations, and Designs*

Malta's Underground Grain Storage

When the Ottoman Turks attacked Malta in 1565, the Knights of Malta and the other Christians on the island were forced to retreat behind their fortifications. After bitter fighting for control of the island from May through August, the Ottoman soldiers were forced to withdraw, ending what has been called by some historians the "last battle of the Crusades."

Following the siege, the Knights of Malta decided to massively enlarge their fortifications. In particular, they were worried about having enough supplies of food should the Turks attack again and invest in a much longer siege. To that end the city of Valetta was built protecting the peninsula of Fort St. Elmo. Incorporated into the design were massive underground storage bins carved out of the rock. The view of the architect who designed the defenses, Francesco Laparelli, was that the defenses were strong enough that "if there are victuals and munitions, it will be impregnable."

Carving these underground storage bins was such arduous work that large numbers of Italian laborers had to be hired to carry out the work. Laparelli was so keen for labor that the terms he offered were very good. The contracts were for free passage to Malta and free rations at sea, and laborers were also paid a daily rate from the moment they signed up, whether they were needed for work or not. When the bins were completed, a large stone was carved and placed at the top of them to protect them from the elements and marauders. The Turks did not attack Malta again, but in World War II, with Malta being a British colony, it was attacked and bombed by the Germans and the Italians. Once again the storage bins were filled with food and withstood the German bombing raids. Laparelli's work was so thorough that even mid-20th century bombing techniques were unable to damage the underground storage bins.

(CRC Press, 2000); John P. Hartman, *Technology of Underground Liquid Storage Tank Systems* (John Wylie & Sons, 1997); U.S. Army Corps of Engineers, *Removal of Underground Storage Tanks (USTs)* (University Press of the Pacific, 2005).

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UNESCO

THE UNITED NATIONS Educational, Scientific, and Cultural Organization (UNESCO) is an agency of the United Nations (UN). It was created in 1945 to promote world peace by focusing on culture and communication, education, natural sciences, and social and human sciences in order to further universal respect for justice, the rule of law, and the human rights and fundamental freedoms proclaimed in the UN Charter. UNESCO aims to create the conditions for genuine dialogue based upon respect for shared values and the dignity of each civilization and culture.

UNESCO's principal decision-making body is the General Conference, which is composed of representatives of the 191 member states (UNESCO also has six associate members). The General Conference elects the members of the executive board and appoints the director-general. The organization's headquarters is in Paris, and it has more than 50 offices around the world. Today, UNESCO serves as a center for the dissemination and sharing of information and knowledge in the fields of education, science, culture, and communication among its member states.

Although a founding member, the United States suspended its membership of UNESCO in 1984, believing that the organization had politicized subjects it dealt with and exhibited hostility toward the basic institutions of a free society, especially a free market and a free press; and has demonstrated unrestrained budgetary expansion.

The controversy was triggered by UNESCO's 1980 report on the state of the contemporary media, a document known as the MacBride Report, which criticized commercialization and unequal access to information and communication. The U.S. withdrawal was followed by that of the United Kingdom (UK) in 1985 and Singapore in 1986. The UK rejoined UNESCO in 1997 as did the United States in 2003.

UNESCO uses conventions, recommendations, and declarations as international instruments for establishing common rules. Conventions define rules that member states undertake to comply with and are subject to ratification, acceptance, or accession by these states. Recommendations are instruments and norms that are not subject to ratification but that member states are invited to apply. Declarations, another means of defining norms, are not subject to ratification either but, like recommendations, they set out universal principles to which the community of states wish to attribute the greatest possible authority and to afford the broadest possible support.

Noting that cultural and natural heritage were threatened with destruction by changing social and economic conditions, UNESCO adopted the Convention Concerning the Protection of the World's Cultural and Natural Heritage in 1972. The document defines natural heritage as:

> Natural features consisting of physical and biological formations or groups of such formations which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

An Intergovernmental Committee for the Protection of the Cultural and Natural Heritage of Outstanding Universal Value, known as the World Heritage Committee, has been set up within UNESCO to establish, keep up-to-date, and publish, under the title of the World Heritage List, a list of properties forming part of the world's cultural heritage and natural heritage, in other words, properties considered as having outstanding universal value. The World Heritage List includes 812 places in 137 countries and regions.

In relation to the natural sciences, UNESCO adopted two documents relevant for the recognition of the interdependence of human beings and their environment: the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (1971) and Recommendation on the Status of Scientific Researchers (1974).

Among UNESCO's millennium goals is the objective of helping countries to develop national strategies for sustainable development and reverse current trends in the loss of environmental resources by 2015. UNESCO states that the world urgently requires global visions of sustainable development based upon observance of human rights, mutual respect, and the alleviation of poverty.

UNESCO has developed several international programs to better assess and manage the earth's resources. The organization helps reinforce the capacities of developing countries in the sciences, engineering and technology. UNESCO's priorities in the field of the natural sciences are: water and associated ecosystems; oceans; capacity-building in the basic and engineering sciences; the formulation of science policies and the promotion of a culture of maintenance and promoting the application of science, engineering, and appropriate technologies for sustainable development; natural resource use and management; disaster preparedness and alleviation; and renewable sources of energy.

Under its Program on Man and Biosphere, UNESCO established in 1971 the world Network of Biosphere Reserves. In 2005 the network, which operated in 102 countries, included 482 biosphere reserves, places that promote and demonstrate a balanced relationship between humans and the biosphere.

SEE ALSO: Biosphere Reserves; Hazards; Man and the Biosphere Program (UNESCO); Renewable Energy; Sustainable Development; Underdeveloped (Third) World; United Nations; Wetlands; World Heritage Sites.

BIBLIOGRAPHY. Sagarika Dutt, *UNESCO and The Just World Order* (Hauppauge, 2002); UNESCO, www.unesco.org (cited April 2006); An Zi, "Preserving the Past," *Beijing Review* (2005).

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Union of Concerned Scientists (UCS)

THE UNION OF Concerned Scientists (UCS) is an independent nonprofit alliance of more than 100,000 concerned citizens and scientists advocating environmentally sound solutions to society's problems. The UCS was founded in 1969 at the Massachusetts Institute of Technology (MIT) by faculty and students protesting the misuse of science and technology. They put forth a Faculty Statement, the genesis of UCS, calling for greater emphasis on the application of scientific research to environmental and social problems, rather than military programs. The UCS now augments rigorous scientific analysis with citizen advocacy in order to build a safer, healthier environment.

The UCS's first report, *ABM ABC,* criticized President Nixon's proposed antiballistic missile (ABM) system. This opposition was part of a broad national movement that helped build public support for the ABM treaty, signed by the United States and Soviet Union in 1972. Similarly, the UCS mobilized opposition in the scientific community to President Reagan's Strategic Defense Initiative (SDI) popularly known as Star Wars. This stance culminated with more than 700 members of the National Academy of Sciences, including 57 Nobel laureates, signing UCS's *Appeal to Ban Space Weapons*. Most recently, the UCS's *Countermeasures* report, which demonstrated that the proposed national missile defense system could be defeated by missiles equipped with simple countermeasures, forced President Clinton to abandon the system.

After failures in government tests of emergency core-cooling systems at nuclear power plants, the UCS provided the principal technical expertise at national hearings, sparking the first public concern over nuclear power safety. In 1977, the UCS publication *The Risks of Nuclear Power Reactors* played a key role in the government's ultimate repudiation of its own faulty Reactor Safety Study. The UCS proposed alternatives to nuclear power and fossil fuels with their study *Energy Strategies: Toward a Solar Future,* starting the UCS's ongoing efforts to promote safe, renewable energy supplies for the United States.

In part, the UCS support of renewable energy stems from concerns over climate destabilization due to emissions from fossil-fuel combustion. More than 1,500 international senior scientists, including 105 science Nobel laureates, signed the UCS-sponsored *World Scientists' Call for Action at the Kyoto Climate Summit*. This document, as well as other UCS work with policymakers and scientists, set the stage for the Kyoto Protocol.

Many environmental trends such as climate change have caused the world's scientists to become "concerned." This is clear in the *World Scientists' Warning to Humanity,* which presented an unprecedented appeal from the world's leading scientists regarding the destruction of the earth's natural resources. It concludes:

> We the undersigned, senior members of the world's scientific community, hereby warn all humanity of what lies ahead. A great change in our stewardship of the earth and the life on it, is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated.

The UCS has also tackled the public and environmental safety issues behind antibiotics in livestock feed and genetically engineered crops. In 2004, the union received a good deal of attention from the mass media by publishing a report titled *Scientific Integrity in Policymaking,* which criticized the George W. Bush administration for altering reports by the Enivironmental Protection Agency on global warming and West Virginia strip mining and for choosing members of scientific advisory panels based on their political views rather than scientific experience.

The UCS has become a powerful voice for change in U.S. policy. Its core groups of scientists and engineers collaborate with colleagues across the country to conduct technical studies on environmental topics. UCS experts work with citizens to disseminate their findings to influence local and national policy. In addition, the UCS Online Action Network gives citizens the means to stay informed on issues and help shape policy by expressing their views to government and corporate decision makers.

The UCS strives for a future that is free from the threats of global warming and nuclear war, and a planet that supports a rich diversity of life. Sound science guides its efforts to secure changes in government policy, corporate practices, and consumer choices that will protect and improve the health of our environment globally, nationally, and in communities throughout the United States.

SEE ALSO: Antibiotics; Bush (George W.) Administration; Clinton, William Administration; Genetically Modified Organisms (GMOs); Global Warming; Kyoto Protocol; Nixon, Richard Administration; Nuclear Power; Nuclear Weapons; Policy, Environmental; Reagan, Ronald Administration; Renewable Energy; Solar Energy.

BIBLIOGRAPHY. Henry W. Kendall, *A Distant Light: Scientists and Public Policy* (American Institute of Physics, 1999); Union of Concerned Scientists (UCS): Citizens and Scientists for Environmental Solutions, www.ucsusa.org (cited January 2006); UCS Online Action Network, www.ucsaction.org (cited January 2006).

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United Arab Emirates

IN THE ABU Dhabi of the 1950s, travelers described the capital of the United Arab Emirates (UAE) as a "small dilapidated town." Abu Dhabi—like most of the United Arab Emirates—was a completely different world just four decades ago. Modern Abu Dhabi and its sister emirate Dubai are glistening financial, commercial, transportation, and tourism centers. Dubai and Abu Dhabi have built massive, palatial malls, indoor ski rinks with artificial snow, artificial islands with seven star hotels, and one of the most modern and developed airports in the world.

Unlike most of the Middle East, which has stagnated economically since the 1960s, the United Arab Emirates—a loose confederation of different emirates, inherited "Princedoms" ruled by emirs or princes—has surpassed not only their Arab neighbors, but much of the Western world as well. The key source of this remarkable transformation seems obvious—oil. Vast amounts of easily-extracted oil continue to sell for massive profits in the West. Yet other nations, such as Libya or Nigeria, have benefited from massive oil profits without nearly the same economic success as the Emirates.

The Emirates achieved this success through a careful and planned policy of economic diversification and an open attitude to free trade and investment. Far from relying only on the revenues from oil, the Emirates from the beginning planned industrial projects, encouraged agricultural development on once barren desert, and hosted the latest innovations in technology. The leaders of the Emirates often provide tax havens for the development of lucrative, major industries and technologies.

Often, however, the almost lightening speed of development in the Emirates has led to significant and troubling environmental consequences. One early example of the unforeseen environmental consequences of unbridled development was the creation of gas refineries. Before the mid-1970s, most natural gas was simply burned away or underutilized in the process of extracting oil. To make the most of all petroleum products, Abu Dhabi built the Umm al-Nar refinery deliberately near downtown as a symbol of industrialization and progress. This was an environmental blunder as the plant used corrosive materials and chemicals that had a harmful impact on the immediate area. Although there have been recent changes, a similar disregard for public health and safety has characterized some other development and diversification projects.

The Umm al-Nar refinery is only one example of how the prestige associated with economic development was often more important than possible long-term environmental and social concerns. Dubai and Abu Dhabi, and the rest of the Emirates to a lesser extent, have learned the importance of image, symbols, and marketing in a globalized economy. The environment is often relegated to a secondary concern. As skyscrapers fill the skylines of Dubai, and as pollution and congestion increase, it is possible that the UAE will overburden its social and environmental resources, leading to the potential for profound crises—not only crises of social identity, but crises caused by seemingly unstoppable economic and environmental overstretch.

SEE ALSO: Land Reclamation; Mining; Natural Gas; Organization of Petroleum Exporting Countries (OPEC); Persian Gulf; Petroleum.

BIBLIOGRAPHY. Ronald Codrai, *The Seven Skaykhdoms: Life in the Trucial States Before the Federation of the United Arab Emirates* (London, 1990); Christopher Davidson, *The United Arab Emirates: A Study in Survival* (Lynne Rienner, 2005); Sulayman Khalaf, "Gulf Societies and the Image of Unlimited Good," *Dialectical Anthropology* (v.17, 1992).

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United Church of Christ—Commission for Racial Justice (UCC-CRJ)

THE UNITED CHURCH of Christ's Commission for Racial Justice (UCC-CRJ) helped verify the concerns and claims of the emerging environmental justice movement in the United States with its 1987 study *Toxic Wastes and Race in the United States: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Sites*. Though the environmental legislation enacted by the U.S. Congress since the 1970s, such as the Clean Air Act and the Resource Conservation and Recovery Act, had addressed pollution problems that affect communities of color, these communities remained marginal in mainline national environmental organizations. Meanwhile, grassroots groups had begun to organize in the early 1980s around local toxics issues. Many asserted that communities of color faced disproportionate health hazards due to unfair practices of siting facilities for the treatment, storage, and disposal of toxics. *Toxic Wastes and Race* was the first study to test this assertion on a national scale.

The UCC-CRJ is the civil and human rights wing of the United Church of Christ. It began providing resources and research for grassroots antitoxics groups in 1982, particularly to rural communities in Warren County, North Carolina, who believed that they had been targeted in the siting of PCB disposal facilities. The Warren County communities staged acts of civil disobedience to resist the siting of a new facility, and the UCC-CRJ intended its study to fuel further nonviolent protest.

The UCC-CRJ study sought to determine what demographic and economic variables correlated most strongly with the location of polluting facilities, especially uncontrolled hazardous waste sites, which the U.S. Environmental Protection Agency (EPA) describes as those that have been abandoned or closed by their operators and that pose serious health threats.

The study tested a variety of variables, including race, income, and housing age, and found that percentage of minority population most accurately predicted the location of these facilities. (The study counted African Americans, Latinos, Asian Americans, Native Americans, and Pacific Islanders as minorities.) In his preface to the report, UCC-CRJ Executive Director Benjamin Chavis called the disproportionate siting of these facilities "an insidious form of racism."

The report recommended, among other actions, an executive order by the president of the United States that would require that federal actions be evaluated on the basis of their environmental impact on communities of color. In 1994, seven years after the release of the report, President Clinton issued Executive Order 12989, which essentially added an environmental justice dimension to the National Environmental Policy Act.

Discussions of environmental justice since *Toxic Wastes and Race* have built on the UCC-CRJ study but have also raised questions about the processes behind the geographic distribution of toxic facilities. While it is clear in many cases that companies and governments have deliberately located facilities in communities of color because it was politically easier to do so, in many cases whites have been able to move away from older industrial areas into exclusive communities, in part because of discriminatory real estate practices, leaving behind more polluted areas for people of color. Thus, a historical examination is necessary to develop a causal explanation for these geographic patterns. Also, debates continue about whether income is a more important factor in determining exposure to toxic facilities, though many insist that issues economic and racial justice cannot be separated.

SEE ALSO: Bullard, Robert; Clean Air Act; Clinton, William Administration; Environmental Racism; Justice; Movements, Environmental; National Environmental Policy Act; Polychlorinated Biphenyls (PCBs).

BIBLIOGRAPHY. Robert Bullard, *Dumping in Dixie: Race, Class, and Environmental Quality* (Westview, 2000); Robert Gottlieb, *Forcing the Spring: The Transformation of the American Environmental Movement* (Island Press, 1993); Laura Pulido, "Rethinking Environmental Racism," *Annals of the Association of American Geographers* (2000); United Church of Christ—Commission for Racial Justice, *Toxic Wastes and Race in the United States: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Waste Sites* (UCC-CRJ, 1987).

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United Farm Workers (UFW)

THE UNITED FARM Workers (UFW) is an agricultural labor union that was founded in 1962 by Cesar Chavez and others, including Philip Vera Cruz, Larry Itliong, and Delores Huerta. Before 1962 Cesar Chavez had worked with Saul Alinsky and Fred Ross in California in community organization; together they formed the Community Service Organization (CSO). With the help of Roman Catholic leaders in southern California they organized a number of CSO units that benefited the Mexican-American population. In 1962 Chavez sought to create something more than a humanitarian organization to help unemployed workers to get unemployment insurance benefits.

The United Farm Workers Union arose from the merger of the National Farm Workers Association (FNWA) and the Agricultural Workers Organizing (AWO) committee. The farm workers who belonged to FNWA were mostly Filipinos. The members of the AWO were mostly Mexican. Both groups shared a Hispanic background. On September 8, 1965, the AWO led by Larry Itliong in Delano, California, began a strike with the grape growers. Both groups recognized their common goals and methods. Joining together they became the United Farm Workers. The strike over picking table grapes lasted five years. In the end the union won a contract with most of the grape growers in California. The UFW used the doctrine and methods of nonviolence promoted by Mahatma Gandhi and Martin Luther King, Jr. Chavez would engage in dramatic hunger strikes in order to draw attention to the union's issues. Chavez's fasting not only attracted public attention, it also gave him moral power with many of the members of the union who were often far from peaceful. Many sought to use violent methods employed in the California labor strife of the 1930s and illustrated in some of the novels of John Steinbeck.

In 1973 the Teamsters Union was able to sign a contract with many growers. The contract almost destroyed the UFW. For the next several years the UFW fought the Teamsters and the growers with strikes, lawsuits, and boycotts. Violence often occurred in the fields and a number of workers were killed. The State of California created the California Agricultural Labor Relations Board in 1975 in order to resolve labor union disputes. The new administrative agency was eventually able to move the UFW and its competitors in a more peaceful direction. In 2006 the UFW left the American Federation of Labor–Congress of Industrial Unions (AFL-CIO) and joined the Change to Win Federation, which is a coalition of unions.

The UFW has been active with a number of environmental issues. These include pesticide use and animal rights. A number of animal rights issues have been addressed by the UFW by petitioning responsible state officials about instances of abuse. In addition, boycotts of foods such as milk or meat from producers that are considered to be indifferent or irresponsible caretakers for farm animals have been instituted. Farm workers are exposed to pesticides at much higher levels than are most nonfarmers. Recent studies have suggested that Parkinson's disease may be linked to pesticide exposure. This is just one of a number of diseases that pose health hazards to farm workers and their families. The UFW battles for healthier farming conditions and for compensation for those whose health is injured by exposure to pesticides. It has in recent years found allies for its positions among scientists who work for the Environmental Protection Agency. The UFW also supports farm workers who speak out against alleged environmental hazards.

SEE ALSO: Animal Rights; Chavez, Cesar; Pesticides; United States, California.

BIBLIOGRAPHY. Richard W. Etulain, *Caesar Chavez: A Brief Biography with Documents* (St. Martins, 2002); Debra A. Miller, *Dolores Huerta, United Farm Workers Co-Founder* (Thompson Gale, 2006); Gary Soto, *Jessie de la Cruz: A Profile of a United Farm Worker* (Persea Books, 2002).

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United Kingdom

THE UNITED KINGDOM (UK) of Great Britain and Northern Ireland is a sovereign state that occupies a number of large and small islands off the west coast of the continent of Europe. The state consists of a political union of four countries, three on the island of Great Britain (England, Scotland and Wales) and one that occupies the northern part of the island of Ireland (Northern Ireland).

The state is a constitutional monarchy, in which the monarch acts as head of state for a number of affiliated territories, including the Isle of Man and the Channel Islands, and for the 15 Commonwealth states that are the remnants of the world's largest empire. The UK was the home of the industrial revolution in the 18th century and remains one of the world's major industrial powers. Political influence is maintained through membership in the Group of Eight (G8) and a permanent seat on the United Nations (UN) Security Council.

HISTORY

The union of these four countries developed over a period of 700 years, beginning with the Statute of Rhuddlan in 1284 which brought Wales under the control of the English monarchy. This relationship was formalized in 1535 with the Laws in Wales Act which made Wales subject to acts of the English parliament. In 1603, the failure of Elizabeth I to provide an heir for the English throne led to the accession of King James VI of Scotland and the union of the monarchies of England and Scotland. The Act of Union of 1707 suspended the Scottish parliament and led to the creation of a single unified parliament at Westminster. The Act of Union of 1801 achieved the same end for Ireland; however, this union lasted for only a little over 100 years and in 1922, the southern portion of the island of Ireland achieved independence as the Irish Free State and resulted in the change to the current name in 1927.

During the 16th and 17th centuries, the UK was one of the countries in Europe best positioned to take advantage of the innovations in navigation and exploration that opened up the New World to European exploitation. Unlike many European countries, colonization by the UK was not primarily driven by the crown but by independently financed merchant companies. This private entrepreneurship led to an explosion in private wealth that in turn was available as investment capital when the industrial revolution began in the 18th century. Colonization also provided raw materials and a critical mass of middle-class merchants who were accustomed to taking risks, and who formed the UK's entrepreneurial class.

The advantages of early industrialization and an expanding global empire to provide raw materials made the UK the first true world superpower in the 19th century. At its greatest extent the British Empire covered one quarter of the land surface of the earth and contained one third of the world's population. However, by the middle of the 20th century challenges from new powers such as Germany, Russia, and the United States, together with the physical and financial devastation of two World Wars led to the dismantling of the empire and the diminishing of the UK's industrial power. By the 1960s, the financial and political weakening was sufficient to persuade the UK to apply for membership in the newly formed European Economic Community. Membership was achieved in 1972 and while British membership in the European Union (EU) has never been overwhelmingly popular in the country, the current Labor government has created a much more positive working relationship with Brussels than the Conservative administration that was in power throughout the 1980s and much of the 1990s.

With new immigration, the UK now has the largest number of Punjabi and Hindi speakers outside of Asia.

GEOGRAPHY

The primary lowlands of the United Kingdom are in the midlands and south of England, with narrow lowland belts in central Scotland and along the south coast of Wales. The flattest land is in the Fens of eastern England, where land has been reclaimed from the marshes for agriculture since Roman times. The south coast and much of the midlands and southwest of England are covered with low hills that occasionally become a line of defined hills, such as the Cotswolds or the Chalk Downs. The primary highland areas of England are the limestone hills of the Peak District and the Cumbrian mountains of the Lake District, with the highest mountain in England (Scafell Peak at 978 meters) falling just short of 1,000 meters. Much Welsh terrain is very mountainous, especially in the north which contains Mount Snowden (1,085 meters). Scotland has the highest terrain in the UK, including the high-

The Great Fire of London

The Great Fire of London swept through the English capital from Sunday, September 2, until Wednesday, September 5, 1666, destroying much of the old city, some of which dated from Roman times. Altogether 13,200 houses, 87 churches, and St. Paul's Cathedral were burned down, and 70,000 of the 80,000 people in London were made homeless. The fire followed a severe outbreak of the plague in London a year earlier, which had resulted in many deaths and also a large number of people (including the Royal Court) leaving London for nearby areas and other parts of the country—the population of London before the plague being about 300,000.

The fire started in a bakery in Pudding Lane after midnight on the morning of September 2. By Sunday night the fire was out of control and the Lord Mayor, Sir Thomas Bloodworth, held back from destroying houses to make firebreaks as he was concerned about destruction of private property. On Monday, September 3, the fire spread as rumors arose that it had been the result of Dutch arsonists—Britain was at war with the Netherlands at the time—and some foreigners were attacked. On Tuesday, St. Paul's Cathedral, which dominated the skyline of London, was on fire, and attempts to use the Fleet River (on the site of present-day Fleet Street) as a firebreak failed. Eventually, the army used gunpowder to blow up enough houses to create a firebreak and save the easternmost part of the city. There are many descriptions of the fire; the most famous are by the diarist Samuel Pepys.

As a result of the fire, much of the city of London was rebuilt. The architect Christopher Wren designed and built a new St. Paul's Cathedral, as well as many other churches in the city. It is not known how many people died; some books put the numbers in single figures. Others argue that many more must have died without leaving a trace, and furthermore, many others did not survive the impromptu refugee camps built after the fire.

est peak, Ben Nevis (1,344 meters) and is almost entirely mountainous to the north and west of the Highland Line.

The largest body of open water in the UK is Lough Neagh in Northern Ireland, and there are relatively few major rivers, with all major ports now located on estuaries. The primary rivers are the Thames, the Severn, and the Humber in England and the Clyde and Forth in Scotland. The UK's other notable geographic feature is the large number of islands that surround the coast particularly in the north and west, where Scotland's major island groups, the Shetlands, the Orkneys, and the Inner and Outer Hebrides, contain over 700 islands.

Located on the western edge of Europe, the UK has a marine west coast climate with high rainfall, particularly in the winter along the west coast. The moderating influence of the Atlantic and prevailing westerly winds leads to moderate temperatures, with winter highs averaging in the mid single digits (C) and summer highs around 15–20 degrees C.

POPULATION AND CULTURE

The current population of the UK is 60.6 million people, with the highest population densities in the south of England. England makes up the largest and fastest growing component of the UK population with a little over 50 million people. Scotland has a population of five million, which has remained static over the past 100 years, and the populations of Wales (3 million) and Northern Ireland (1.6 million) exhibit alternating patterns of very slow growth and stagnation depending on economic and political conditions.

While out-migration to the colonies drew off excess population during the industrial revolution, the UK has generally been subject to net immigration. From the 1950s through the 1980s, the primary origin of migrants was former colonies, particularly India, Pakistan, the West Indies and East Africa. Since the UK's admission to the EU, however, Europe has become the major source for immigrants (as well as becoming the main destination for British migrants).

The UK does not have an official language, although English is spoken by virtually the entire population and is the main language of government, the media and education. The other indigenous languages are the Celtic languages of Wales, Southwest England, Scotland, Northern Ireland and the Isle of Man (Welsh, Cornish, Scots, Irish, and Manx Gaelic). Relatively small percentages of the population speak these languages but recent government support has ensured that both media and education resources are available in the regions in which they are most prevalent. The influx of migrants from a variety of former colonies has also meant that the UK now has the largest number of Punjabi and Hindi speakers outside of Asia, and Gujerati, Bengali, and Cantonese are also commonly spoken in cities with large ethnic communities.

While the UK has several established churches including the Church of England (Anglican) and Church of Scotland (Presbyterian), the UK currently has one of the lowest rates of church membership and attendance in the world. The Catholic Church is the second largest denomination, and there is a Jewish community that dates to the 17th century. The recent immigrants have diversified the religious community, and the UK is now home to the largest Hindu community in Europe, with growing numbers of Muslims, Sikhs, and Buddhists.

The UK is also noted for its cultural achievements, most particularly in the realms of literature, science, and education. The UK has some of the oldest universities in Europe including Oxford, Cambridge, Glasgow, Edinburgh, and St. Andrews. In 2006 the UK was reported as the second most prolific source of research in the world (after the United States) with nine percent of the world's scientific research papers.

ECONOMY AND POLITICS

As the first country to enter the Industrial Revolution, the UK dominated production and trade in textiles, heavy engineering, and iron and steel in the 19th century; however, as other countries industrialized and competition increased for labor and raw materials the UK lost its advantage and deindustrialized rapidly. Services made up 80 percent of the economy in 2004; the service sector is dominated by finance, particularly insurance, banking, and stock trading and is concentrated in the southeast of England. Tourism is also a significant contributor to the economy and the UK is the world's sixth largest tourist destination. The UK has one of the most efficient agricultural sectors in Europe, with two percent of the labor force producing over 60 percent of all food consumption needs. The UK is also unusual in having a large energy sector, with coal, natural gas, and oil accounting for over 10 percent of GNP.

The UK is a constitutional monarchy with executive power residing in the prime minster and the cabinet acting on behalf of the monarch. Legislative power resides in the Houses of Parliament which consist of a virtually powerless unelected upper chamber, the House of Lords, and the House of Commons, which is made up of 646 elected representatives. After each election (which must occur at least once within each five-year period) the largest party forms a government, and the leader of that party becomes prime minister. Power transfer occurs immediately after an election and the date of the next election is at the discretion of the government in power. The UK is unusual in that it does not have a written constitution, but relies instead on "custom" and separate acts of constitutional law.

Throughout the 20th century, the two primary political parties in the UK have been the Labor and Conservative parties, but recently there has been a rise in minor parties, in particular the Liberal Democrats, and nationalist parties in Scotland and Wales. The influence of these parties contributed to the development of separate regional legislatures for Scotland, Wales, and Northern Ireland in recent years.

SEE ALSO: Agriculture (including Agricultural Revolution); Colonialism; Industrial Revolution; Industrialization; Transportation.

BIBLIOGRAPHY. Central Intelligence Agency, "United Kingdom," *World Factbook,* www.cia.gov (cited April 2006); Huw Thomas, *Race and Planning: The UK Experience* (Routledge, 2000); World Bank, "United Kingdom," *Little Green Data Book*, lnweb18.worldbank.org (cited April 2006).

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United Nations (UN)

THE UNITED NATIONS (UN) is an intergovernmental organization made up of 191 member states. According to its Charter's Preamble, it was created with the intent to provide international peace and security through the promotion of cooperation among states of the world and "to save succeeding generations from the scourge of war." The UN officially became an organization on October 24, 1945, after a majority of the original 50 signatory states and the five permanent members of its most powerful organ, the Security Council, ratified the UN Charter. Following the devastation caused by World War II, the member states recognized the need to create a place where world leaders could regularly get together to create mutual understandings and to foster cooperation. The organization's additional goals include achieving economic and social development as well as human rights for the peoples of the world.

The UN has six main organs. The most powerful of these is the Security Council, which deals with international security issues. Its decisions are binding. The Security Council has 15 members, of which five are permanent members. These five were the victors in World War II—China, France, Russia, the United Kingdom, and the United States. The five permanent members of the Security Council have veto power over all decisions made by the council. The remaining seats are held by other nations on a rotating basis. Other UN bodies include the General Assembly (GA), in which all member states are represented and all international issues are discussed. The Economic and Social Council (ECOSOC), with 54 elected states rotating for two-year positions, deals specifically with issues of economic and social development. Other organs include the International Court of Justice, the Trusteeship Council, and the Secretariat. The Secretariat under the Secretary General is responsible for the day-to-day operations of the UN.

THE ENVIRONMENT: EARLY YEARS

The GA and the ECOSOC have been the most important bodies of the UN in addressing environmental issues. The GA sets norms and understandings of international relations between states as it is the one place where all states of the world gather to discuss issues of international concern and to make recommendations for action. ECOSOC is important not only for discussions among members states on issues related to the environment, but also for initiating environmental studies, coordinating the activities of different UN agencies, and preparing important international conventions and conferences related to environment. The Secretary General, as the chief administrative officer of the organization, ensures that the UN carries out the decisions of the Security Council, GA, and the ECOSOC on all matters including environmental issues.

During the initial years of the UN, environmental issues were not extensively addressed, yet there were several subsidiary UN organs that engaged environmental matters as they related to their particular missions. As early as 1965, the United Nations Educational, Scientific and Cultural Organization (UNESCO) started to deal with water resources and pollution, since one of this specialized agency's goals is to study, assess, and protect the world's natural resources.

UNESCO hosted the first Intergovernmental Conference on environmental issues known as the Biosphere Conference in 1968. The UN and subsidiary organizations such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) also attended this meeting. This conference was inspired by the idea that nature holds a delicate balance and human development is potentially damaging to it, thus, nature must be conserved, preserved, and protected. This conference led to the 1970 initiation of the biosphere experiment to determine human effects on the environment. During these initial years, the International Maritime Organization started to address problems with oil pollution of the seas. These were the early moves to broaden the scope of the general development issues addressed by the UN to include a clean environment and resource protection as important components of human development.

As environmental issues were highlighted by the biosphere conferences, member states in the GA and the ECOSOC also started to take notice of the importance of protecting the human environment in order to meet the UN's development goals.

In 1968, with a recommendation from ECOSOC spearheaded by Sweden, the General Assembly decided to convene the UN Conference on Human Environment (UNCHE), which took place in Stockholm, Sweden, in 1972. At the same time, the GA also asked that the Secretary General of the UNCHE conference, Maurice Strong, prepare a comprehensive report on the problems facing developing and developed countries in regard to the human environment.

In preparing for the meeting, Strong worked with an advisory committee in which disagreements surfaced. Many developing countries were threatened by and resistant to the idea of integrating environmental protection as a part of their countries' policy agendas. The economic burden of dealing with environmental problems seemed daunting given that the path to economic and social development was already very difficult for the less-developed nations. But Strong was able to convince participants that without protecting the environment in the short term, the states cannot expect to grow in the long term.

This conference, attended by representatives of 113 nations, was a watershed event. These states came to an agreement on 26 principles on the human environment. The principles included the right to clean environment, the safeguarding of natural resources, the restoration of renewable resources, the protection of wildlife and endangered species, the prevention of the exhaustion of resources, the prevention of toxic pollution and global warming, and the prevention of pollution of the seas.

As a part of the negotiations, the developing countries received special consideration. Their particular needs were addressed under the 26 principles with a call for financial and technical aid to poorer regions and a clause stating that environmental policies should not hinder development. The principles also included a call for scientific research and education, a commitment to spend resources for making improvements on the environment possible, coordination among states to use resources more rationally, better urban planning, and recognition of the need for population control. There was also a call on states to create environmental agencies within their governments and additionally a call on states to start negotiations on the elimination and destruction of all nuclear weapons.

After the first comprehensive intergovernmental conference on the environment, the United Nations Environment Programme (UNEP) was created by the GA. UNEP is designed to coordinate UN agencies regarding environmental concerns and to generally serve as the lead agency on environmental affairs. The program is charged with assessing the state of the world's environment, developing mechanisms to deal with environmental problems, strengthening institutions, conducting research and raising global awareness on environmental issues.

THE 1980S: A NEW APPROACH

In the 1980s, the UN moved from a general discussion on the environment to more specific actions through treaty agreements on the ozone layer, toxic waste, and climate control. Inspired by a report by the UNEP governing body, the GA decided to create a special commission on Environment and Development to consider world "Environmental Perspective to the Year 2000 and Beyond." This commission is commonly referred to as the Brundtland Commission, named after its chairman, a former Prime Minister of Norway. The commission's 1987 report, *Our Common Future,* defined sustainable development, a concept that would serve as the guiding principle for global environmental policy. The statement read:

> The Governing Council believes that sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs and does not imply in any way encroachment upon national sovereignty. The Governing Council considers that the achievement of sustainable development involves co-operation within and across national boundaries.

In many ways, the 1980s represented a new era for the UN in its approach toward the environment, which went beyond preservation and conservation. It explicitly recognized environmental degradation as a human-created problem that needed to be addressed along with its traditional development goals. New global treaties designed to address environmental problems were enacted. In an effort to address a growing hole in the earth's ozone layer, the 1985 Vienna Convention on the protection of the ozone layer was negotiated followed by the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer. These treaties can be considered the most successfully implemented environmental treaties relative to other treaties negotiated. The Montreal Protocol called on state parties to take action to reduce and eliminate the production and consumption of ozone depleting substances (ODS) such as chlorofluorocarbons (CFCs) commonly used in refrigeration and air conditioning. Since going into effect, the treaty has been updated and renegotiated to further the goals of the Protocol.

One hundred and eighty-nine states made a commitment to the success of the Protocol and there has been tremendous progress in repairing the hole in the ozone layer due to these agreements. While the agreement is an international agreement among states, some have argued that the success of the Protocol would not have been possible without the commitment and leadership of the United States and the cooperation from major companies that produce CFCs, who aggressively sought alternatives to this harmful substance.

In another environmentally related development, in 1988 the Intergovernmental Panel on Climate Change (IPCC) was established in collaboration with World Meteorological Organization and UNEP. These entities were designed to investigate growing concerns about temperature increases associated with carbon dioxide buildup in the earth's atmosphere. Policies regarding climate control were seen as necessary after the first Assessment Report by the IPCC. This report led to the United Nations Framework Convention on Climate Change, which provides an overall policy framework for addressing climate change issues. A third major problem area addressed starting in 1989 is toxic waste disposal. This was first discussed under the Basel Convention on the Transboundary Movement of Hazardous Wastes. The agreement bans the export of hazardous waste from rich to poorer countries.

THE EARTH SUMMIT AND BEYOND

With the wider scope of environmental issues being discussed by the countries of the world, between 1989 and 1992 the governments prepared for a UN Conference on Environment and Development. This conference is also known as the Earth Summit, or the Río Summit, and took place in Río de Janeiro, Brazil, in 1992. The conference was another watershed event for the UN as it laid the groundwork for a number of agreements and proposed an ambitious environmental and social policy agenda detailed in the final conference document, Agenda 21. The framework laid out in Agenda 21 included issues of sustainable development such as combating poverty, protecting health, human settlements, population, as well as environmental concerns such as atmosphere, land management, deforestation, biological diversity, desertification, and sustainable agriculture.

While the participating nations were able to reach agreement, there were differences in emphasis sought by nations from different regions. The developing countries wanted to focus more on freshwater, deforestation, and pollution as opposed to the advanced industrialized countries, which sought to emphasize ozone depletion, hazardous wastes, and global warming. There were several conventions and commissions created to work on sustainable development during and following the Río Summit, including the 1992 Convention on Biological Diversity, the 1992 Framework Convention on Climate Change, the 1994 Convention to Combat Desertification, the 1995 Agreement Relating to the Conservation and Management of Straddling Fish Stock and Highly Migratory Fish Stocks, the 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade and the 2000 Stockholm Treaty on Persistent Organic Pollutants.

This gathering was also significant because nongovernmental organizations (NGOs) made inroads into the UN policymaking structure, a role that had traditionally been limited to nation states and in which NGOs were largely ignored or dealt with only informally. The Global Forum was a very effective parallel summit and it was hard for the states involved in the Earth Summit to ignore this important sector. Since that time civil society organizations have been more formally integrated into the UN's policymaking process.

Although the Earth Summit is still hailed as an important event, its significance lies more in the attention paid to environmental and development issues than in the actual actions that resulted. While some agreements were reached and progress made, its goals have not been advanced nearly as rapidly as originally hoped. World leaders revisited the issues of sustainable development in Johannesburg in 2002, 10 years after the first Earth Summit, in order to discuss the lack of progress made toward meeting the goals of Agenda 21 and other agreements created under the Earth Summit.

The UN is the central organization where states of the world gather to make broad international agreements about many global issues including those related to the environment. Since its foundation, the UN and its subsidiary organizations have been working to create knowledge and awareness, set standards, and help carry out environmental policies accepted by the international community. So far these issues have been primarily addressed by the GA and ECOSOC. But, as resources become scarcer, states might start to consider environmental issues, especially those related to energy and water scarcity, as security issues and shift environmental policy responsibility to the Security Council. The goal of the UN has been to avoid environmental problems from becoming issues of international security and continue the work among member states to create a safer and cleaner environment. To this end, there have been more than 3,000 treaties signed and deposited with the UN and nearly 41 major multilateral treaties and conventions conducted under the auspices of the UN.

SEE ALSO: Agenda 21; Biosphere; Brundtland Report; Convention on Biological Diversity; Intergovernmental Panel on Climate Change; Montreal Protocol; Ozone and Ozone Depletion; Río Declaration on Environment and Development; Sustainable Development; Underdeveloped (Third) World; UNESCO; United Nations Conference on Environment and Development; United Nations Environment Programme; United Nations Framework Convention on Climate Change.

BIBLIOGRAPHY. Agenda 21, www.un.org (cited April 2006); Christopher Flavin, Hilary French, and Gary Gardner, *State of the World Report 2002: Special World Summit Edition* (Worldwatch Institute, 2002); Karen A. Mingst and Margaret P. Karns, *The United Nations in the Post–Cold War Era* (Westview, 2000); United Nations, *Basic Facts about the United Nations* (United Nations, 2004); United Nations, "Sustainable Development, Human Settlements and Energy," www.un.org (cited April 2006); United Nations Environment Programme, www.unep.org (cited April 2006); Thomas G. Weiss, David P. Forsythe, and Roger A. Coate, *The United Nations and Changing World Politics* (Westview 2004).

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United Nations Conference on Environment and Development (Earth Summit 1992)

THE UNITED NATIONS Conference on Environment and Development, also known as the "Earth Summit," was a major international conference held in 1992 at which representatives of almost every nation of the world participated in an effort to forge a plan for economic development and environmental protection. For many years prior to the meeting, conflicting views about the value of economic development versus environmental protection stood in the way of international progress on environmental issues in negotiations between states of the world. In 1987, a new understanding of the problem of environment versus development was introduced, and proposals for simultaneously dealing with problems of the environment and poverty were offered in a report called *Our Common Future*. The report was prepared by a United Nations (UN) special commission on Environment and Development headed by Prime Minister Gro Harlem Brundtland of Norway as a response to worsening environmental problems and the bleak environmental future of the world. According to this new understanding, sustainable development was defined as "development that meets the needs of the present without compromising the ability of future generation to meet their own needs."

After this report, between 1989 and 1992, member states of the United Nations started to prepare for a global summit to address sustainable development comprehensively. There was a preparatory committee created under the General Assembly of the UN to gather and prepare documents to be discussed and agreed to during the 1992 conference. After a very thorough preparation process, the UN Conference on Environment and Development (the Earth Summit) took place June 3–14, 1992, in Río de Janeiro, Brazil. The conference was headed by General Maurice F. Strong of Canada, who also headed the UN Conference on Human Environment in 1972. There were 172 governments participating, of which 108 were represented by their highest government officials. There was also participation on the part of nearly 2,400 representatives from roughly 1,000 nongovernmental organizations (NGOs) who were among 17,000 people attending a parallel forum designed to coincide with the UN event. This injected perspectives from civil society into a policy forum at which only nation states had traditionally had input. This conference was the biggest and one of the most important environmental events in history.

A number of documents, prepared only by the official state participants, came out of the conference, including Agenda 21, a plan of action for advancing sustainable development. In addition, the Río Declaration on Environment and Development served as a set of guiding principles. Other official declarations included the Statement of Forest Principles, the UN Framework Convention on Climate Change and the UN Convention on Biological Diversity. The conference attendees also created institutions that would function as follow-up mechanisms for these documents, including the Commission on Sustainable Development, the Inter-agency Committee on Sustainable Development, and the High-level Advisory Board on Sustainable Development.

FIRST VERSUS THIRD WORLD

During the preparatory meetings and the conference, major compromises were made in order for all parties to reach a consensus. The central debate between the industrially developed "North" and the less developed "South" regarding the value of economic development versus environmental protection continued throughout the preparation process and during the conference. The developing countries were primarily concerned with issues such as the alleviation of poverty through financing of development from developed countries, access to technology for sustainable development as well as a focus on issue areas of freshwater, desertification, deforestation and pollution.

The issues were difficult to resolve even among the less-developed nations. For example, developing countries face a difficult dilemma in regard to deforestation. Forests are important to prevent landslides, which affect poor people disproportionately. Additionally, plants and animals in the forests can be a source of livelihood for the subsistence of the poor communities. Thus, the loss of these habitats affect the lives and livelihoods of people in the South. Yet, while protection of forests is an important issue, states are also hesitant to treat issues such as deforestation as global problems given sensitivity toward the protection of their sovereignty and the rights of state to exploit resources within their own borders. During the negotiations between and among developed and less-developed nations, these types of conflicts were difficult to manage. There were also pressures from NGO groups felt by governments before and during the conference.

In looking at the other major constituency, the advanced industrialized countries wanted to focus on the problems of ozone depletion, the production and disposal of hazardous wastes by industry, and global warming. These were issues that the less-developed countries blamed on the high levels of consumption by the wealthy nations of the North. Dozens of such topics had to be addressed throughout the four years and five rounds of negotiations between states before the conference.

RÍO DECLARATION

In Río, the final document was negotiated. Some, including conference president Maurice Strong, characterized the outcome of the Earth Summit as falling short of its originally envisioned goals. Yet many also felt it was a great accomplishment to have such a large meeting of world leaders and come to an agreement on a set of principles and an action plan that satisfied and reflected the concerns of such disparate groups. In the 27 principles of the Río Declaration on Environment and

Development, the states emphasized the importance of state sovereignty, the rights of states to equitable sustainable development, and the need for more aid for developing nations with a priority on the least-developed countries.

The advanced industrialized countries were acknowledged as responsible for global environmental problems and called for states to eliminate unsustainable patterns of production and consumption. The importance of technology, women, youth, and indigenous groups were recognized for their role in achieving sustainable development as well as citizens' right to know about their environment. The states were declared responsible for enacting legislation on environmental standards and protection of their citizens. The importance of transparency and cooperation between states on environmental issues was also emphasized.

AGENDA 21

The main document emerging from the conference, Agenda 21, lays out a comprehensive plan of action for global sustainable development. The document has four major subheading areas with a total of 40 chapters. The first area covers social and economic issues including poverty, consumption, population, health, human settlements, and the development of policies to be able to deal with these issues, especially in the developing nations. The second area on conservation and management of resources dealt with major environmental problems in the context of development. The areas of focus were atmosphere, land resources, deforestation, desertification, mountain development, sustainable agriculture and rural development, biological diversity, biotechnology, oceans, freshwater resources, toxic chemicals, and different kinds of hazardous wastes. The third section dealt with the strengthening of major groups necessary for the achievement of sustainable development. Women, children, indigenous people, NGOs, local authorities, workers and their trade unions, business and industry, and the scientific and technological community as well as farmers were recognized as important groups in bringing about sustainable development.

In the last section of the document, the means of implementation and financing sustainable development initiatives were discussed. The rich states reaffirmed their commitment to providing 0.7 percent of their Gross National Product (GNP) in aid to fund sustainable development in the less-developed nations. But there were no new commitments made by the rich countries to meet the goals set up by Agenda 21.

OTHER DOCUMENTS

Among the other major documents to come out of the conference was the Convention on Climate Change. This was negotiated and signed in Río with the goal of stabilizing greenhouse gas concentrations in the atmosphere. This was agreed upon without specific limitations set for nation states, but nevertheless this convention led to the Kyoto Protocol, which sets specific targets for different countries. Another agreement, the Convention on Biodiversity, was less successful in gaining acceptance due to disagreements on funding, but 158 signatories of the convention have agreed to conserve biological diversity. A final document created during the conference was the Forest Principles, which calls on states to further cooperate on forest issues.

SEE ALSO: Agenda 21; Brundtland Report; Kyoto Protocol; Río Declaration on Environment and Development; Sustainable Development; United Nations; United Nations Environment Programme; United Nations Framework Convention on Climate Change.

BIBLIOGRAPHY. Agenda 21, www.un.org (cited April 2006); S. Halpern, *United Nations Conference on Environment and Development: Process and Documentation* (Academic Council for the United Nations System, 1992); Karen A. Mingst and Margaret P. Karns, *The United Nations in the Post–Cold War Era* (Westview, 2000); E.A. Parson, P.M. Haas, and M.A. Levy, "A Summary of Major Documents Signed at the Earth Summit and the Global Forum," *Environment* (v.34/4, 1992); United Nations, *Basic Facts about the United Nations* (United Nations, 2004); Thomas G. Weiss, David P. Forsythe, and Roger A. Coate, *The United Nations and Changing World Politics* (Westview, 2004).

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United Nations Environment Programme (UNEP)

THE UNITED NATIONS Environment Programme (UNEP) was created in 1972 following the United Nations Conference on Human Environment (UNCHE) in Stockholm, Sweden. The General Assembly (GA) of the United Nations (UN) set the goals and mandate of the UNEP in its resolution 2997 (XXVII). The mission of the UNEP is "to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations."

In general, the UNEP serves as a forum in which the member states of the UN can discuss environmental issues of international scope. For this, 58 member states are elected by the GA to serve as the governing body of the UNEP, which meets biennially and reports to the GA through the Economic and Social Council. The governing council has representation from different regions of the UN: 16 African, 13 Asian, 10 Latin American, six East European, and 13 Western European and other states.

The mandate of the organization evolved over time with amendments adopted at the United Nations Conference on Environment and Development in 1992 and during the 1997 session of the UNEP Governing Council meeting. Currently, the specific mandates of the organization include raising awareness about the environment globally and incorporating environmental considerations into all aspects of UN programs and activities from peacekeeping to disarmament and health to education.

The UNEP is charged with conducting scientific research and issuing reports about the human environmental problems and developments. When environmental threats are identified, UNEP monitors, gathers information, and calls for action to overcome these problems. The UNEP is the central coordinating body of all UN agencies on environmental issues. When the environment ministers from around the world met for the first time in Malmö, Sweden, they issued a declaration affirming the mandate of the organization and called for the institutional and financial strengthening of the UNEP in 2000.

One of UNEP's most important roles is to help states develop international environmental law by facilitating conventions among states and meetings among scientists to provide expert guidance. The first convention coordinated by the UNEP was in 1973 on International Trade in Endangered Species (CITES). Subsequently, there have been several conventions facilitated by the UNEP on issues ranging from migratory species, depletion of the ozone layer, climate change, transboundary movement of hazardous wastes, biological diversity, pollution of the seas, persistent organic pollutants, and biosafety and genetically modified organisms.

The UNEP has nearly 600 staff members who work to accomplish the mandate of the organization and the goals set by its governing body. Half of the staff works at the UNEP headquarters in Nairobi and the other half are stationed in various offices around the world to fulfill organization's global and regional goals. The UNEP has eight functional divisions for assessment of environmental threats, policy development, policy implementation, helping developing nations adopt environmental policies, regional cooperation, finding synergy between multilateral conventions, communication and education on the environment, and funding environmental programs.

Because UNEP does not have the field experience, institutional capacity, or the funding to carry out all of its goals, the organization cooperates and coordinates with other UN organs to accomplish its goals through these functional divisions. For example, the Division of Global Environment Facility (GEF) is a joint effort between UNEP and the World Bank. GEF is a trust fund established by the World Bank in 1991. An advisory panel of experts from the UNEP examines the GEF funded projects. These projects are established with the goal of making progress on one of the major treaty areas on the environment. Another functional division of the UNEP, Early Warning and Assessment, works in collaboration with several global networks of nongovernmental organizations (NGOs), private companies, and state agencies to monitor emerging environmental threats.

Since its foundation the UNEP faced several challenges. First it was difficult to build consensus on issues due to conflicts between the advanced industrialized countries and the less-developed countries with competing opinions about environmental protection versus economic development. The UNEP has also been marginalized by donor countries whose financing is necessary for the success of the organization. Thus UNEP still lacks money and the organizational capacity to make significant progress toward meeting its mandate. The most important role of the organization still remains setting international norms on the environment and coordinating the overlapping environmental responsibilities of different UN agencies.

SEE ALSO: Convention on International Trade in Species of Wild Flora and Fauna (CITES); United Nations; United Nations Conference on Environment and Development.

BIBLIOGRAPHY. Christopher Flavin, Hilary French, and Gary Gardner, *State of the World Report 2002: Special World Summit Edition* (Worldwatch Institute, 2002); "Malmö Ministerial Declaration," www.unep.org (cited April 2006); "Nairobi Declaration of UNEP Governing Council," www.unep.org (cited April 2006); United Nations, *Basic Facts about the United Nations* (United Nations 2004); Thomas G. Weiss, David P. Forsythe, and Roger A. Coate, *The United Nations and Changing World Politics* (Westview, 2004); UNEP, www.unep.org (cited April 2006).

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United Nations Framework Convention on Climate Change (UN FCCC)

UNITED NATIONS FRAMEWORK Convention on Climate Change (UN FCCC) was signed during the 1992 Earth Summit in Río de Janeiro, Brazil. Climate change was introduced as an area that required special attention warranting a separate convention during the preparations to the Earth Summit. The UN FCCC was a first attempt to create a way to deal with climate change resulting from human activity. The states acknowledged that carbon emissions and greenhouse gasses do not recognize national borders, thus states need to cooperate to address climate change. Because the consensus on global warming due to human activity was not yet achieved among the expert communities and state parties, the convention was precautionary rather than proactive. The differential impact of advanced industrialized countries on bringing about this environmental problem was also recognized by the convention, giving more responsibility to the industrialized nations of the North. Eventually, 189 countries ratified the convention, which went into effect March 1994.

The Conference of Parties (COP) is the governing body of the UN FCCC. The COP meets every year to discuss climate change and develop new measures to deal with the evolving issue of global warming. The states in the convention have kept negotiations alive by working on the Kyoto Protocol of UN FCCC in 1997. This Protocol, using the same mechanisms included within the convention, assigns states legally binding targets to reduce or limit emissions.

Keeping in spirit with the differential responsibility of pollution, the convention separates countries into different categories. The Annex 1 countries include advanced industrialized countries, such as the United States and those of Western Europe, and countries in economic transition, mostly Eastern and central European countries. These are also the largest polluters in the world and are required to cut emissions on average at least 5.2 percent from their 1990 levels by 2008–12. Developing countries and the least-developed countries, on the other hand, are expected adopt environmental policies that will limit the increase in emission from a base of 1995 levels.

In accordance with the terms of the implementation of the agreement, the Protocol would take effect when more than 55 parties to the convention, who accounted for 55 percent of the total carbon dioxide emission based on 1990 figures, signed and ratified the treaty. This occurred in 2005 and the Protocol formally took effect at that time. The United States never ratified the Kyoto Protocol and withdrew from it in 2001. Since the United States was the largest carbon emitter in 1990 with 36.1

percent of the share of the world, every other large emitter had to ratify the Protocol in order for it take effect. The nations of the European Union (24.2 percent of total global emissions) and Japan (8.5 percent) had ratified the treaty in 2002 and with Russia (17.4 percent) joining the treaty in 2004, the treaty went into effect in February 2005.

The Protocol identifies the human sources of greenhouse gases such as energy consumption, fuel combustion, manufacturing, construction and other industries, transport, and production of minerals, metals, halocarbons, and sulfur hexafluoride. The Protocol allows for states to "trade" six greenhouse gasses: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, thus creating some flexibility in emissions.

The Convention is funded by financial mechanisms that ask the economically affluent countries to contribute to make compliance to the treaty possible by all parties. The Global Environmental Facility (GEF), a fund run by World Bank jointly with UN Environment Programme (UNEP) review, is also involved in funding for making progress toward meeting the treaty goals. Although the Kyoto Protocol represents progress in terms of strengthening international cooperation, most scientists believe that the limits set on greenhouse gasses by the Protocol are not sufficient to address global warming.

SEE ALSO: Carbon Trading; Global Warming; Greenhouse Gases; Kyoto Protocol; United Nations Conference on Environment and Development; United Nations Environment Programme.

BIBLIOGRAPHY. Seth Dunn, *Reading the Weathervane: Climate Policy from Rio to Johannesburg,* Worldwatch Paper 160 (State of the World Library, 2002); Seth Dunn and Christopher Flavin, *Moving Climate Change Agenda Forward* (State of the World Library, 2002); EarthSummit+5, "Special Session of the General Assembly to Review and Appraise the Implementation of Agenda 21, New York, June 23–27, 1997," www.un.org (cited April 2006).

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United States, Alaska

ALASKA IS THE northernmost, westernmost, and "easternmost" state in the United States (parts of the Aleutian Islands cross the 180th meridian). Because of its size and location, it encompasses many different geophysical areas, from rainy spruce and fir forests in southeast Alaska, to the desert of the Arctic. Alaska also contains many natural resources, and the exploitation of those resources has often been a point of controversy throughout its history.

Before its "discovery," the Inuit people, Eskimos of non-Inuit origin, Aleuts (of the Aleutian Islands), and Native Americans populated Alaska. These included the Athabascans of central Alaska and the Tlingit and Haida tribes of southeast Alaska. Unlike most of the United States, the indigenous peoples of Alaska were not forced into reservations. The Alaska Native Claims Settlement Act (ANCSA) of 1971 was an attempt to avoid the mistakes of past national policy toward indigenous peoples. ANCSA is also central to understanding the politics of land conservation in Alaska.

Russia, Spain, and Britain were the major powers in Alaska until 1876. Russia was most influential. Vitus Bering, a Dane working for the Russian Czar, "discovered" Alaska in about 1728, although there is evidence suggesting earlier Russian exploration. The Russian influence in Alaska is seen in numerous towns and villages throughout the Aleutians and coastal Alaska, many of which still have small and distinctive Russian Orthodox churches. The name of the state comes from the Russian interpretation of the Aleut *Alyeska* meaning "great land" or "mainland." Russian exploration extended to northern California, raising concern in Spain, which pressed its explorations north to Alaska. Spanish names in Alaska still exist, including the cities of Valdez (pronounced Val-DEEZ) and Cordova. British explorer Captain James Cook, seeking the inside passage, explored what later became known as Cook Inlet, and named Turnagain arm, near Anchorage, because, having failed to find the northwest passage, he had to "turn again."

Russians fur traders hunted sea otters to the brink of extinction. Timber and fish were also important, particularly as the otters became scarce. The Russian America company established its headquarters

Tourism, such as this cruise through Tracy Arm Fjord to view glaciers, has grown considerably since the early 1980s and is the second most important sector in the Alaskan economy after oil.

at Sitka (New Archangel), which was the center of Russian colonial government until 1867, when the United States, at the urging of Secretary of State William Seward, purchased Alaska from Russia for $7.2 million dollars, or about two cents per acre. This purchase was made well after the otter population had withered. Of course, there was widespread ridicule of "Seward's Folly," but most enlightened citizens and officials realized that Alaska contained considerable natural resources and provided strategic benefits for the United States in its competition with Great Britain over the Pacific Northwest.

AMERICAN DEVELOPMENT

After 1867, most Americans and the national government paid relatively little attention to the territory. The region remained under army control until the Organic Act created civil government in 1912. The formation of a territorial government was hastened by gold discoveries in the region, including the Klondike Gold Rush in Canada's Yukon. The most direct route to the Yukon was via Skagway, Alaska, and then over the treacherous Chilkoot Trail. Alaska had its own gold discoveries: At Juneau in 1880, along the beach in Nome in 1898, and near Fairbanks in 1902.

Gold was mined in Juneau until World War II, and gold panning is still a popular tourist activity. In the 1880s, John Muir visited Alaska (Muir Glacier bears his name), and became one of the earliest proponents of saving Alaska's natural treasures from development. The conservation movement of the early 1900s led to the creation of the Katmai National Monument in 1918, and Mt. McKinley National Park in 1917, both of which were expanded under the Alaska National Interest Lands Conservation Act (ANILCA).

Despite gold rushes, the population grew slowly, and was concentrated in southeast Alaska. The federal government completed the Alaska Railroad, which connects Seward, Whittier, Anchorage, Denali Park, and Fairbanks, in 1923. It is now owned by the state. The major supply port for the railroad, Anchorage, started as a tent city in 1914 and was incorporated in 1920. The first major population boom in Alaska came in the 1940s, during World War II. It continued through the cold war, as military spending increased Alaska's population and built key infrastructure. The Alaska Highway, linking the state to the lower 48, was completed as a military supply route in 1943, although it was not a reliable year-round road until the 1950s. The World War II and postwar period also saw the shift of population from southeast Alaska to Anchorage and the "railbelt" from Anchorage to Fairbanks.

In 1935, the Department of Interior and the Federal Emergency Relief Administration established Matanuska Colony about 45 miles north of Anchorage to encourage farmers from Wisconsin, Michigan, and Minnesota to develop agriculture in Alaska. The Matanuska valley soon became famous for its outsized vegetables—the long summer daylight makes crops grow quite rapidly—but the success of the colony was mixed, at best. Some dairy farming and relatively small-scale vegetable farming remains, but since the late 1980s, the Matanuska-Susitna area has become a major population center and, in essence, a suburb of Anchorage. Other industries that remain important in Alaska are fishing, timber, mining, and tourism. Tourism in particular has grown considerably since the early 1980s, and tourism is particularly important to the economies of southeast Alaska cities, and, to a lesser extent, Anchorage and Fairbanks.

The most important event in Alaska's economic history was the discovery of oil on the North Slope. In the late 1950s, some oil was discovered on the Kenai Peninsula and in Cook Inlet, but the potential of the North Slope discoveries was far greater. In 1969, the state sold oil leases for $900 million, a huge windfall in a poor state with a budget that in 1968 only exceeded $100 million. The ensuing construction of the Trans-Alaska pipeline created a boom in Anchorage and Fairbanks, and swelled state coffers. When oil started flowing through the pipeline in 1977, the importance of yearly royalty income became clear. Over 85 percent of the state's revenue comes from oil, and Alaskans pay no income tax or state sales tax. While the oil economy has paid substantial benefits to Alaska, it has also come at a cost. During the oil price crash of the late 1980s, state revenues plummeted, the economy suffered, and many people left the state. In 2006 state revenues (from oil royalties) were sharply higher due to increases in the world price for oil, although demands on state government remained quite high.

Increased oil wealth has increased expectations of state services to "rural" (that is, remote) Alaska, from airports, to state-subsidized television services (discontinued in 1996), to state-supported local schools, which have helped keep communities together because children no longer need to go to big cities or regional boarding schools. The erosion of native traditions is palpable in these communities, as modernity replaces, or is melded with, tradition. As snowmobiles ("snowmachines" in Alaska) and outboard motors replace dog sleds and oars, some might bemoan the loss of traditions; but many rural Alaskans appreciate how technology eases a very difficult way of life, even as modern conveniences take a cultural and environmental toll.

ENVIRONMENTAL ISSUES

Alaska has long experienced conflict over the exploitation of its rich natural resources. Like many other places in the western United States, Alaska's resource exploitation history involves periods of extreme overexploitation of species (otters), followed by near extinction and slow recovery. Improved management techniques avoided the worst environmental abuses, and Alaska's early economic potential was found in fish and timber, not gold and furs. These industries remain extremely important. Entire communities in Alaska, such as Cordova and Kodiak, are highly dependent on the fishing industry. At the same time, other industries have overtaken these traditional industries. Tourism is the second most important sector in the Alaska economy, after oil. This juxtaposition of industries is important, because Alaska has many industries that, for most of the time, are compatible with each other, but when an environmental crisis occurs, interests clash.

For example, some travel agents and other industry sources reported that bookings for Alaska tours dropped after the *Exxon Valdez* oil spill, which, while vast, still affected a relatively small part of Alaska, and was nowhere near the primary tourism markets in southeast Alaska and Denali Park. However, the exploitation of natural resources worries some in the tourism industry because they know that people visiting Alaska expect not to see clear-cut forests or oil spills. Oil is also incompatible with fishing if large oil spills occur. Fishing is an iconic Alaskan industry, but it is also a much smaller part of the economy than is oil.

The most heated environmental controversy in Alaska, or centered on Alaska, was the fight over what were called the "d-2" lands, so called after section 17(d)(2) of the ANCSA, This provision allowed the Secretary of the Interior to reserve 80 million acres of land for the "national interest." Many Alaskans were outraged by the very idea of allowing such designations of land, believing it interfered with the state's powers to select state lands—which then could be made available for development—under the Statehood Act. These Alaskans feared that the land would be "locked up" and forever unavailable for mineral or other development. The Congress did not take up an Alaska lands bill for years after ANILCA was enacted, so the issue came to a head when, in 1978, President Carter set aside over 100 million acres to protect them from development—40 million under ANCSA, and the balance under his powers to declare national monuments. This induced Congress to enact ANILCA, which created and expanded national parks, preserves, and monuments, including Denali, Katmai, Kenai Fjords, Glacier Bay, and Gates of the Arctic.

A continued environmental challenge in Alaska is one that is shared by many western states: The increased growth of the urban areas. Population growth is somewhat limited in Anchorage because there is not much available land. Much of the land to the north and east of the city is military or parkland. This has led to a form of suburban sprawl in the Matanuska-Susitna valley, as people move there to avoid expensive housing in Anchorage. They choose to commute as far as 100 miles round trip. Amidst these environmental challenges, Alaska faces the usual challenges of any economy based on natural resources: The commodity may run out, or prices may drop, or the environmental cost of extracting the commodity may exceed its benefits. Alaskans and Americans have met and addressed these challenges in the past, and have adapted to changes in their economy and to changes in perceptions of the value of the environment.

SEE ALSO: Alaska Pipeline; Arctic; Arctic National Wildlife Refuge; *Exxon Valdez*; Muir, John; Native Americans.

BIBLIOGRAPHY. P.A. Coates, *The Trans-Alaska Pipeline Controversy: Technology, Conservation and the Frontier* (University of Alaska Press, 1993); J.S. Hammond, *Tales of Alaska's Bush Rat Governor* (Epicenter Press, 1994); Anne Hanley and Carolyn Kremers, *The Alaska Reader: Voices from the North* (Fulcrum Publishers, 2005); S.W. Haycox, *Alaska: An American Colony* (University of Washington Press, 2002); S.W. Haycox, *Frigid Embrace: Politics, Economics, and Environment in Alaska* (Oregon State University Press, 2002); S.W. Haycox and M.C. Mangusso, *An Alaska Anthology: Interpreting the Past* (University of Washington Press, 1996); Larry Kaniut, *Tales from the Edge: True Adventures in Alaska* (St. Martin's Griffin, 2005); Orlando Miller, *The Frontier in Alaska and the Matanuska Colony* (Yale University Press, 1975).

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United States, California

CALIFORNIA IS THE third largest U.S. state in terms of area. In 2005, California's estimated population was 36,132,147, making it the most populous state in the country. Approximately 68 percent of Californians live in the greater Los Angeles and San Francisco Bay Areas.

The discovery of gold in 1848 led to the California Gold Rush, which marked the opening of the Sierra Nevada region to European-American occupation and development. What began as amateur mining with simple technologies in the early years transformed by the 1860s into large-scale mining, including the excavation of mines with hydrologic operations. A federal injunction put an end to immense on-site and downstream environmental impacts of hydrologic mining during the 1890s. Mining in California, however, did not stop with the end of the Gold Rush. In 2004 California ranked first in the nation in nonfuel mineral production, accounting for nearly 8 percent of the national total.

California's diverse physical landscape is now managed through a mosaic of private, federal, and state landholdings. In 1890 Sequoia National Park became California's first national park. In 1902 Big Basin State Park became the first state park in California. Today, 47 percent of the land ownership in California is under the control of the federal government (20 percent Forest Service, 15 percent Bureau of Land Management, 8 percent National Park Service, and 4 percent military), while 5 percent of California's land ownership is under the jurisdiction of the state. The other 48 percent falls under private ownership.

Located at the interface of the Pacific and North American tectonic plates, California experiences frequent seismic activity. The San Andreas Fault runs the length of California and is one of the state's most active fault lines. One of the most destructive earthquakes along the fault was the 1906 San Francisco Earthquake. In 1989 the Loma Prieta Earthquake struck along the San Andreas Fault, causing widespread damage to the San Francisco Bay Area.

There are many other active fault lines in California. The 1994 Northridge Earthquake in Southern California, which is considered by many to be the most costly earthquake in U.S. history, occurred along the Santa Monica Mountains Thrust Fault. In reaction to California's vulnerable position, the California Legislature passed a landmark law in 1972 requiring the identification of seismic hazard zones. In these zones, special geologic studies are mandatory before structures can be assembled for human occupancy.

AGRICULTURE

California's Central Valley is the state's true agricultural breadbasket and one of the most productive agricultural regions in the country. In 2002, California ranked first in the nation in agricultural product sales, amassing a market value of $25,737,173,000. A significant portion of California's agricultural employment is composed of immigrants. Cesar Chavez, a Mexican American labor activist who founded the National Farm Workers Association (later the United Farm Workers), was central in the fight for immigrant worker rights throughout California and the United States. Chavez encouraged labor unions and fought for workers' rights, including reducing worker exposure to harmful pesticides. Through these efforts, Chavez brought the plight of immigrant workers to the public's attention and organized a number of important environmental justice agreements.

MEETING WATER DEMAND

Water has traditionally been the most contested natural resource in California. A number of factors complicate its use and management. First, California only receives precipitation nine months out of the year, leaving summers without a consistent water supply. Second, although the state contains a number of underground aquifers, many of them are over drafted, too deep to access economically, or contaminated by toxins such as MTBE. Third, the majority of precipitation in California falls in the northern portion of the state and in the Sierra Nevada Mountains, while a majority of the population resides in the southern portion of the state. Fourth, demand is high with a population of over 36 million and the nation's most productive agricultural sector.

All of these factors have necessitated the formation of a large-scale system for redistributing water across the state. The two key elements of this statewide system are the storage of runoff from mountain snow pack in reservoirs in order to control the timing of water delivery and the construction of waterways to control the geographic distribution of water.

In 1960 the California State Water Project commenced, enabling the production of a large water storage and transport system across the state. The Central Valley Project, containing 21 primary reservoirs and the 450-mile (725-kilometer) California Aqueduct, has enabled the delivery of water to Central Valley farmers and residents of Southern

Golden Gate

The strait connecting San Francisco Bay to the Pacific Ocean was first known as the Boca del Puerto de San Francisco ("Mouth of the Port of San Francisco") and was first recorded by José Francisco Ortega, the head of a surveying party that approached the bay by land. On August 5, 1775, Juan de Ayala steered his ship *San Carlos* through the strait, dropping anchor inside the bay; the *San Carlos* was the first recorded European ship to make the passage. A year later the Spanish, recognizing the potential military importance of the bay, established a military port at the tip of the San Francisco Peninsula as well as the small Dolores Mission.

San Francisco was a part of Spanish America until 1821 when it became a part of Mexico. It had one of the most isolated Spanish garrisons until it was withdrawn and replaced with a Mexican one. Most trade at the time took place in the more commercially successful settlement at Monterey. In 1848 the whole of California was ceded to Mexico, at which time San Francisco was a town of just 900 people.

The name "Golden Gate" appears to have been given to the strait just before the 1849 gold rush in California, which saw tens of thousands of prospectors heading through the strait in their search for gold. San Francisco boomed during the gold rush and the period that followed, developing from a frontier town to a thriving metropolis. It was a city of great wealth when much of it was destroyed by an earthquake on April 18, 1906. Nevertheless, the city recovered and in 1937 the Golden Gate Bridge was constructed across the strait. Until 1964, it was the longest main span bridge in the world.

California. Today, the system supplies water to over 23 million residents and 750,000 acres (303,514 hectares) of irrigated farmland.

Other significant water storage and transport systems include the Los Angeles Aqueduct and the O'Shaughnessy Dam at Hetch Hetchy. The Los Angeles Aqueduct was completed in 1913 under the jurisdiction of the Los Angeles Department of Water and Power. The controversial aqueduct devastated the Owens Valley but was instrumental to the growth of Los Angeles and the San Fernando Valley. Today, the aqueduct still carries water southwest from the Owens Valley to the city of Los Angeles. The controversial O'Shaughnessy Dam at Hetch Hetchy in Yosemite National Park was completed in 1923, much to the chagrin of preservationists like John Muir. Water from the Hetch Hetchy Reservoir serves the San Francisco Bay Area, which owes much of its early prosperity and economic growth to the reservoir.

LANDMARK POLICIES

California is home to a number of landmark policies including the California Environmental Quality Act (CEQA), which is a state-led version of the National Environmental Protection Act (NEPA). Enacted in 1970, CEQA requires that all projects undertaken or requiring approval by state and local governments be made public and reviewed for their potential environmental impacts. Projects deemed to have significant environmental effects are required to complete an Environmental Impact Report (EIR). CEQA requires these agencies prescribe ways of minimizing and/or mitigating deleterious environmental impacts.

The California Endangered Species Act (CESA) of 1970 (revised in 1984) remains a progressive piece of environmental legislation. The act was created to protect endangered and rare flora and fauna threatened by rapid statewide development. The CESA has resulted in the listing of numerous plants and animals that would not otherwise be protected by the Federal Endangered Species Act. As of mid 2006, California contained 155 listed endangered and threatened animal species with 31 only listed under the California Endangered Species Act. California lists 98 plant species under the sole protection of the CESA.

The passage of the California Clean Air Act in 1988 signaled a new era of statewide stringent air quality regulations. Under this act, California's am-

The San Francisco Bay Area owes much of its early growth to the Hetch Hetchy Reservoir in Yosemite National Park.

bient air quality standards are generally stricter than federal standards. Despite tough measures, Los Angeles was ranked in 2003 as the most polluted metropolitan area in the United States by the American Lung Association in terms of particulate matter and smog levels. Although other regions of California also experience elevated pollution on occasion, the Los Angeles Basin is particularly vulnerable due to low precipitation and a persistent inversion layer.

With over 28,000,000 registered vehicles as of 2000, transportation is responsible for roughly 35 percent of California's energy consumption and over 85 percent of total petroleum use. California is also one of the most progressive states in terms of setting strict motor vehicle efficiency standards. For example, California passed legislation in 2002, known as the Pavley Bill, requiring automakers to limit greenhouse gas emissions from motor vehicles in the state. The effects of California's progressive automobile legislation are far-reaching. By 2006, 10 other states adopted these strict California standards, which in turn put pressure on car manufacturers to fill this growing market.

In 2004 California produced 80 percent of its electricity with 10.6 percent from renewable sources. The other two major energy sources in California are petroleum and natural gas. In 2004, California produced 41 percent of its petroleum and 15.5 percent of its natural gas. The rest of California's energy needs are imported from other states. California deregulated its electricity market in 1996. A significant outcome was the 2000–01 California electricity crisis resulting in rolling blackouts, extremely high energy prices, numerous energy sector bankruptcies, a State of Emergency Declaration, and the eventual ousting of then governor Gray Davis.

SEE ALSO: Automobiles; Beaches; Earthquakes; Endangered Species; Gold; Hetch Hetchy Dam; Los Angeles River; Mining; Mulholland, William; National Parks; Owens Valley; Pollution, Air; Water Demand; Yosemite National Park.

BIBLIOGRAPHY. Marc Reisner, *Cadillac Desert: The American West and Its Disappearing Water* (Penguin Books, 1993); State of California, www.ca.gov (cited April 2006); University of California, *The Sierra Nevada Ecosystem Project: Final Report to Congress* (1996).

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United States, Central South

THE STATES OF Arkansas, Kentucky, Missouri, and Tennessee are located in the central south region of the United States. They cover a vast area stretching from the Appalachian Mountains across the middle of the Mississippi River's course westward to the beginning of the Great Plains. Geologically, the central south region covers a diverse topography of mountains, plateaus, hilly regions, and plains. Most of the region was submerged under shallow seas during several geological periods and is now covered in limestone rocks, which have eroded to make numerous caves in some areas and sweet soils for grass and crops.

TENNESSEE

Tennessee is named for the Over-the-Hills Cherokee Indian village of Tenasi. Tennessee's eastern borders are with the states of Virginia and North Carolina. In the north, it borders Kentucky; its southern border bounds Georgia, Alabama, and Mississippi. It stretches over 500 miles from east to west. The state is usually described as the areas of East Tennessee, Middle Tennessee, and West Tennessee, which are each marked by distinct land formations.

East Tennessee begins in the Blue Ridge Region which includes the Great Smoky Mountains and other ranges. The area from Franklin westward has numerous springs and forested areas. The boundary with Virginia runs along some of the highest peaks of the Appalachians. The area has numerous rivers and quiet mountain coves where small groups of people farm as the Cherokee did before them.

The Southern Appalachians that are in Tennessee include beautiful natural forests and wildlife that includes black bears. The upper altitudes are usually above 4,000 feet (1,220 meters) in height. The flora of the area includes numerous rhododendrons that flower profusely in the spring; there is striking fall foliage in the autumn. Because of the altitude, the flora is closer to that of Canada than to the flora of the Mississippi River Valley.

Among the rivers either beginning or flowing through East Tennessee are the Clinch, Holston, Ocoee, Hiawassee, and the French Broad. These rivers join the Tennessee River in a transition from the Appalachians to the Tennessee River Valley west of Knoxville. The transition is to the last of the valleys of the Ridge and Valley region of the Appalachians. Several ridges run in parallel lines from Georgia to Kentucky through the East Tennessee Valley. The area between Chattanooga and Knoxville is relatively flat and is excellent farmland.

The Tennessee River flows south from Knoxville to Chattanooga where it passes through a gorge and then continues in a looping circle through much of northern Alabama. At Florence, Alabama, it turns north again and flows to Tennessee where it separates the western part of the Highland Rim from West Tennessee. It continues flowing north to join the Ohio River in western Kentucky.

The third landform in the East Tennessee region is the Cumberland Plateau. It is a part of the vast Appalachian Plateau that runs from north of Birmingham and Gadsden, Alabama, into Kentucky. In Tennessee, the plateau in most places has rocky cliffs, which range from 1,500 to 1,800 feet (457 to 549 meters) in height. In the center are the Orchard Mountains, which are a range of peaks on top of the Cumberland, west of Knoxville. The area was extremely remote until the advent of modern automobiles and roads.

Middle Tennessee begins with the dramatic end of the escarpment that is the Cumberland Plateau. The area is part of the Highland Rim, which is a plain stretching to the Tennessee River at the boundary of West and Middle Tennessee. Nashville is located in a basin called the Nashville Basin.

The Cumberland River, flowing through the Highland Rim region, has left many eroded hills. The Cumberland River begins in the Appalachians near the junction of Tennessee and Kentucky. It flows through East Tennessee to Nashville where it turns to flow north. It joins the Tennessee River in Kentucky in the "Land-between-the-Lakes" a few miles from where the Tennessee River flows into the Ohio River.

The area of Middle Tennessee extending from north of Alabama north to Kentucky that lies between the Cumberland Plateau and the Nashville Basin is a garden area where enormous numbers of nursery farms are located.

West Tennessee is an extension of the Gulf Coastal Plain. It is an area of gentle undulations with rich farmland. In the northwestern corner of Tennessee lies Reelfoot Lake. The Lake was formed during the Mississippi River Valley earthquakes in late 1811 and early 1812. The quakes were centered along the New Madrid Fault. The severity of the earthquakes formed the shallow natural lake; it was filled by water from the Mississippi that for a while flowed north rather than south. Most of it is more like a swamp, however.

KENTUCKY

Eastern Kentucky is famous as an Appalachian region explored by frontiersman Daniel Boone. The area has also produced enormous quantities of coal. The eastern area is part of the Appalachian Plateau; in Kentucky, the area is triangle-shaped with many mountain ridges and deep canyons through which rivers flow. The area is a maze of narrow valleys caused by stream erosion. The two major mountain ridges in Kentucky are the Pine Mountains and the Cumberland Mountains. Between these ranges lies the Middleboro Basin. It is near Black Mountain, which is the highest in the state at 4,145 feet (1,263 meters).

The Bluegrass Region lies in the north-central area of the state and extends from the middle of the state to the Ohio River. In the northern part of the Bluegrass Region is a land that has a gentle roll and in which horses are raised for racing. Tobacco is also a major crop in the area. Surrounding the Bluegrass Region on the southern, western, and eastern boundaries are cone-like sandstone knobs. These are composed of light soils that easily erode, so much of the zone has been left wooded.

The southern and western areas of Kentucky are part of the Mississippian Embayment, or the Pennyroyal Region. The region has two arms that extend north to the Ohio River and west to the Mississippi River. The name Pennyroyal comes from an herb of the mint family that is widespread in the region. The southern part of the Pennyroyal region has very productive limestone soils. Further north in the center of the Pennyroyal region is an area called the Barrens. The name was given by the first pioneers who found the area treeless and barren. The northern part of the Pennyroyal rises in elevation and has rocky ridges and bluffs. It also has numerous limestone caves, the most famous of which is Mammoth Cave.

The western coal field region has rolling lands under which are beds of coal that are strip-mined. The region also is very productive farmland. The far western end of Kentucky is called the Jackson Purchase Region. It is part of the Gulf Coastal Plain. It is also an area of rich Mississippi River flood plains. It acquired its name in 1818 after Andrew Jackson participated in the purchase of the land from the Native Americans. The area has numerous ox bow lakes and swampy areas.

ARKANSAS

Arkansas lies across the Mississippi River from Tennessee and south of Missouri. In the south, it is bounded by Louisiana and Oklahoma and in the west by Texas. The Arkansas River flows from Oklahoma across the state to the Mississippi River. The eastern area of Arkansas is occupied by the Mississippi Alluvial Plan. The region is very flat and, in some areas, wooded and swampy. It is also very productive agriculturally. Rice and soybean fields stretch for vast distances during growing season. The area is also attractive to wildlife: Many migrating geese and ducks feed in the fields on their way south.

In the middle of Arkansas's eastern alluvial plain is a strange formation called Crowley's Ridge. It is a narrow ridge between half a mile and 12 miles wide that runs north and south for over 150 miles from the Missouri state line to near Helena. Its elevations reach nearly 550 feet at its northern end. The ridge was once covered with loess. Some geologists have explained Crowley's Ridge as a product of the Mississippi River's changes in its bed. This view contends that the ridge is the remains of a much larger formation eroded by the Mississippi before it shifted its course to the east. Other geologists believe that the ridge is the product of the earth's folding. Its elevation has increased over the decades in which measurements have been taken. Crowley's Ridge has flora that is different from the surrounding alluvial plain; its flora is much more like that of the Appalachians. It also is a source of garnet gemstones.

The southern part of Arkansas is a part of the West Gulf Coastal Plain. From Monticello west to the Texas state line, the area has reddish sandy soils and is forested with pines. Significant oil and gas discoveries have been worked at El Dorado and surrounding areas. In the area of the Red River at Hempstead County, the soil in prairies is a gumbo type of clay that expands and contracts significantly with increases and decreases in moisture. Across Hempstead and Howard Counties and other areas is a line of sandy hills that are believed to be the sand dunes of prehistoric times. At Murfeesboro are several volcanic pipes, which form the Crater of Diamond State Park. Patrons can mine for diamonds and keep whatever they find.

The small area west of the Red River is in Miller County. The area was a swampy no-man's-land before the Mexican-American War. Today, very rich farmland produces cotton and other crops.

Between the Arkansas River Valley to the north and the Gulf Coastal Plain in the south are the Ouachita Mountains. The mountains are a series of ridges that are heavily forested. The highest peak is Blue Mountain at 2,623 feet (799 meters). Hot Springs lies at the eastern extremity. Quartz crystals are mined in the area, as is novaculite, which is a type of chert or flint used for sharpening whetstones. The Arkansas River Valley also produces rice and other crops and has deposits of gas and oil. Large vessels travel its waters to Tulsa, Oklahoma.

The Ozark Plateau covers the area of northern Arkansas from the western edge of the Mississippi alluvial plain to Oklahoma. It is an area of rugged ridges and eroded valleys. The Buffalo River, which flows through the area, is a favorite place for canoeing. The Boston Mountains form the southern boundary with the Arkansas River. The region is heavily forested and filled with man-made lakes.

MISSOURI

Missouri has four major land regions. First, in the southwest is the Missouri boot heel, which is a part of the Mississippi alluvial plain. It is also where the New Madrid Fault is centered. This seismic zone has historically had several major earthquakes. Second is the Ozark Plateau, which extends in southern Missouri from Arkansas to about the Missouri River. It is heavily wooded with narrow river valleys, numerous caves, and springs. Its elevation is about 500 to 1,700 feet (150 to 518 meters) above sea level.

Third are the Dissected Till Plains in northern Missouri, which was covered with glaciers during the ice ages. The soil is deep and rich, which makes it a major corn-growing region. Fourth are the Osage Plains, which lie roughly in the triangle formed by the Osage and Missouri Rivers. It is a plain with several areas of low hills.

Lead mining has played an important role in the economy of Missouri; the eastern Ozark region is the location of the Old Lead Belt.

SEE ALSO: Appalachian Mountains; Coal; Lead; Mississippi River; Mountains; Petroleum; Rivers; Wetlands.

BIBLIOGRAPHY. James Lane Allen, *Blue Grass Region of Kentucky and Other Kentucky Articles* (Reprint Services Company, 1989); Richard B. Drake, *A History of Appalachia* (University of Kentucky Press, 2003); Ann Heinrichs, *Arkansas* (Capstone Press, 2006); James Kavanagh, *Tennessee Birds* (Waterford Press Ltd, 2001); Charles P. Nicholson, *Atlas of the Breeding Birds of Tennessee* (University of Tennessee Press, 1998); John B. Rehder, *Appalachian Folkways* (Johns Hopkins University Press, 2004); Henry R. Schoolcraft, *View of the Lead Mines of Missouri: Including Some Observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, Population, and Productions of Missouri and Arkansas, and Other Sections of the Western Country* (Arno Press, 1972); Charles W. Schwartz and Elizabeth R. Schwartz, *Wild Mammals of Missouri* (University of Missouri Press, 2001).

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United States, Great Plains

THE GREAT PLAINS region of the United States stretches in a broad band from Mexico in the south to Canada in the north and includes the states of Kansas, Nebraska, North Dakota, Oklahoma, and South Dakota. It is a region characterized by wide, flat lands with few trees similar to the steppes of Central Asia and the pampas of Argentina. The term *prairie* is often used, particularly in Canada. The Great Plains are part of a larger geographical area that extends to Texas and other more easterly states. It is possible to divide the Great Plains from the High Plains region approximately along the line of the 100th meridian. Land is more fertile to the eastern side, where the more generous rainfall supplements the ability of the land to sustain livestock, particularly cattle, as well as cereal crops and vegetables. The High Plains region to the west receives significantly less rainfall and the land is subject to drought and dustbowl effects, most notably during the 1920s and 1930s when, in combination with the effects of the Great Depression, depopulation of the area became a major trend as farm failures became endemic. In addition to the geographic features of the Great Plains, this region of land is characterized in modern culture by the perception of the people who have settled and lived there. Given the hardships of farming the often-difficult land, the remoteness, and the extremes of weather, the Great Plains has given rise to a notion of its people as being hardy, self-reliant, and stoic.

The Great Plains regions may be further divided into a number of different sub-regions, each with its own pattern of settlement and geography. These range from the Black Hills area of the Dakotas, which are composed of dark, igneous rock related to the Rocky Mountains, to the heavily eroded Red River Valley of Texas. The topography affects wind flow and this in turn affects rainfall and attendant plant life. For example, the warm air that flows up the Mississippi River Valley helps contribute to the moister climate of the east and bypasses the western region altogether. This makes for significant variation of conditions across the Great Plains, which in turn leads to some extreme weather conditions. Intense thunderstorms rage across the interior of the region and many settlements are threatened by seasonal tornadoes that erupt on an annual basis. The tornadoes are generally small but occur frequently. Other forms of extreme weather also mitigate against extensive population settlement and successful agriculture.

It is believed that the Great Plains were created as a byproduct of the geological processes that created the Rocky Mountains. Before recorded history, they were the home of many native animal species such as the buffalo (American bison) and other large mammals subsequently hunted to extinction. Tribes of indigenous peoples used the Great Plains on either a temporary or semi-permanent basis by building earth mounds or log houses of various types. Because their lifestyles relied on hunting and gathering more than sedentary agriculture, the indigenous tribes moved their residences on a rotating, seasonal basis to follow food sources. The peoples who were present in the Great Plains included the Sioux, Cherokee, Cheyenne, Arapaho, and many others. Low population densities meant that conflict between different tribes did not generally lead to high-intensity warfare, although raiding was a common occurrence. The horse was introduced by the Spanish and this revolutionized the lives of the native peoples whose long-range transportation abilities increased enormously; the ability to conduct hunting at long-range and to move further away from regular water supplies were significant.

With the arrival of European settlers, the lifestyles of the indigenous peoples became antithetical to new uses to which the land was being put. Settlers sequestered large parcels of land for private, household use and would not permit passage to any others. From Texas in the south, large cattle ranches were created with the animals driven north for fodder on a yearly basis. Both of these forms of agriculture yielded no space for indigenous tribes and warfare became inevitable.

The superior technology of the Europeans proved decisive, although not immediately or without great losses on either side. The remaining indigenous tribes were forcibly removed from the lands on which they had traditionally lived and required to live on circumscribed reservations where they were obliged to modify their lifestyles to the new situations in which they found themselves. Many have found it difficult to adjust and poverty and very low opportunity have been the result for many generations.

The new settlers were not automatically successful in their attempts at establishing farms; those who had experience with comparatively difficult situations tended to do better than others. This led to the tendency toward ethnic homogenization of the Great Plains as those with the skills to succeed in agriculture there typically came from similar geographical locations. The Homestead Act of 1862 in the United States and the Dominion Land Act of 1871 in Canada made provision for any settler to claim up to 160 acres of land (in America) on the basis that he and his family lived and worked the land for a specified period of time. Subsequent legislation strengthened the rights of farmers and regulated the rights of individuals and organizations to use and control water resources and other significant inputs. Water resources were of particular importance in the western Great Plains because of the low rainfall levels and the persistent threat of drought. The *Tyler versus Wilkinson* case of 1826 had been instrumental in creating a regulatory regime in which the equitable and sustainable distribution of water resources became possible. Although the Civil War of 1861–65 was fought mainly in the eastern part of the United States, it had a significant impact on the Great Plains both in terms of actual military action and in the disruptions to patterns of supply and demand. Slave labor was not generally used on an intensive basis owing to the marginal profitability of many farms and their inability to feed many mouths. Nevertheless, slave labor built and developed the Great Plains just as it did the rest of the country.

As the railroad spread across the country, ranchers became accustomed to driving their cattle up from southern ranches to the railheads in the Great Plains where fodder was available for the livestock, which could then be transported east for slaughter and consumption in the eastern and coastal cities. The large-scale nature of this activity effectively prevented any change of land use in the intervening territory. However, drought and disease made the practice susceptible to external environmental shocks and it was more or less ended by the 1886 drought and famine, which witnessed thousands of over-crowded cattle starved and frozen to death. After this date, ranchers tended to move toward growing their own crops to support livestock throughout the winter.

While this had little positive effect on the Great Plains region, it did permit the wider spread of more intensive and scientific agricultural systems across the land. This was necessary since the hardy prairie grasses utilized deep root systems, which formed dense, interlocking sods that required multiple teams of oxen to plough for the first time. However, scientific advances ultimately contributed to the dustbowl conditions during the 1930s that led to the depopulation of the area. Decades of decline have followed, interspersed with some revivals as technology has suggested improvements in land use.

In recent years, since the 1950s in particular, the intensive use of the Ogallala aquifer has enabled widespread irrigation of much of the Great Plains area and this has made it possible for previously marginal or unusable land to be brought under agricultural land use. While this irrigation has revived many parts of the region, the use of the water may be unsustainable as presently organized since it is believed that more is being extracted than can be replaced by natural means. When aquifers are depleted in this way, the ultimate effects include subsidence, desertification, and the salinization of the remaining water as saltwater creeps in to replace the freshwater. However, steps have been taken since the 1970s to reduce the amount of water extracted and these have been partly successful. Even so, there has been a long-term tendency toward the depopulation of the region and the abandonment of its many small towns and villages.

Owing to the interaction of a number of different factors, including the failure of many farms, falling family sizes, the increased ability to use personal transportation to obtain paid income elsewhere, and the lack of enthusiasm for farming among younger generations, population density has gradually declined. When towns become insufficiently large to sustain their own infrastructure of schools, government agencies, and private sector firms, they are often amalgamated with neighbors for the purposes of providing such services and the cycle of depopulation intensifies as jobs disappear from the towns.

There are now many thousands of abandoned, or ghost, towns studding the Great Plains regions and many of those that have survived pose significant problems of rural poverty, isolation, and lack of basic services. However, research into agricultural practices suitable for the region have suggested a number of new options for agricultural practice that might bear fruit and help reinvigorate the region. One alternative approach is to consider the region effectively a failed development plan and reintroduce buffalo to roam freely over it.

SEE ALSO: Desertification; Dust Bowl, U.S.; Livestock; Native Americans; Ogallala Aquifer; Prairie.

BIBLIOGRAPHY. Geoff Cunfer, *On the Great Plains: Agriculture and Environment* (Texas A&M University Press, 2005); David Elstein and Don Cornis, "Moving away from Wheat/Fallow in the Great Plains," *Agricultural Research* (v.53/6, 2005); Tim Flannery, *The Eternal*

Frontier: An Ecological History of North America and Its Peoples (Atlantic Monthly Press, 2001); Ian Frazier, *Great Plains* (Picador, 2001); Ted Steinberg, *Down to Earth: Nature's Role in American History* (Oxford University Press, 2002).

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United States, Gulf Coast South

THE UNITED STATES Gulf Coast states form one vernacular region, but several subregional areas can be delineated based on soils, characteristic vegetation, relief, and climate. These states include Alabama, Florida, Louisiana, and Mississippi. Beginning in the far southeast, subtropical South Florida encompasses the Everglades and a variety of mangrove, marsh, and forest zones, all resting on a foundation of limestone. To the west, the Gulf Coast comprises barrier islands and sounds protecting pine and palmetto forests. Coastal Louisiana, formed by deltaic sediments from the Mississippi River, consists of salt and fresh water marshes, cypress swamps, and areas of relatively high ground formed by distributary channels of the river. Heading north, the Mississippi Valley bisects the region with a broad alluvial plain of oxbow lakes, hardwood forest, and highly organic soils.

Bordering the Valley in north Louisiana and Mississippi, the Cotton Uplands, referring to their long-standing cultivation of the region's signature cash crop, are characterized by significant relief and forests of pine. This area, like much of the entire region, has red and yellow podzols which are generally less fertile than more northern soils which benefited from glacial deposits. The Black Belt, so named for its dark tertiary topsoil and for being the historic home of many African Americans, runs through eastern Mississippi and central Alabama. Northern Alabama's hills, the highest part of the region, are the southernmost extensions of those mountains.

The composition of the soils of the Gulf states is affected by the region's heat and high rainfall. These factors lead to high rates of oxidation of organic matter and a tendency toward erosion when soils are exposed. Regional soils formed under forested conditions therefore have low carbon content, especially after clearing and intensive cultivation.

The climate features hot summers, cool winters, and rainfall generally exceeding 40 inches per year. Places bordering the Gulf of Mexico have their climate mediated by the sea, but the entire region is susceptible to cold fronts from the north during the winter. The Gulf's limited circulation with the open Atlantic causes it to become very warm by late summer, making for high rates of hurricane activity along its northern coast.

This physical geography is of course much altered by human action. Native Americans lived in the region for thousands of years. Agricultural cultures extended down the river's valley, creating urban centers like Poverty Point in present-day Louisiana. Maize, originally from Mexico, formed the basis of these people's diet, as did the hunting of deer and bison. Widespread fire-setting by Native Americans to clear land and improve hunting is believed to have influenced the landscapes first witnessed by Europeans.

De Soto's expedition in the 1540s and the growing contacts with the Atlantic world that followed it brought Eurasian diseases like smallpox and malaria, which devastated native peoples and would pose barriers to European settlement in many parts of the region. Colonization moved very slowly, with the Spanish in Florida having only a minor presence and the French arriving in Louisiana in 1699, and remaining there by only the smallest margins. Unfamiliar with the territory, weakened by diseases, and unable to establish European crops to feed themselves, the French were only saved by their adoption of maize, their herds of cattle that ranged through the pastures opened up by burning the thick canebrakes that lined the Mississippi, and the introduction of rice and enslaved Africans knowledgeable in its cultivation. The French introduced the plantation system to the Gulf states, first focusing on indigo and tobacco, and then over time rice and sugar cane. Their export-oriented plantation economy, based on African slavery and leveeing the Mississippi to protect their settlements, set a precedent for the region's incorporation into global commerce.

Alongside a tiny but growing plantation sector, the trade in deerskins harvested by Native Americans grew to a great scale in the 18th century. The French and English waged a proxy war between the Choctaw and Chickasaw peoples in Mississippi and Alabama, fueled by European goods and firearms purchased with deerskins. The bison, present throughout much of the present U.S. southeast in 1700, disappeared by 1800, and other native animals like large hunting cats and parakeets declined greatly as European settlement advanced. English, then American, settlers began moving into the region from the Atlantic coast in the late 18th century. The incorporation of the Mississippi and Louisiana territories into the new United States combined with great demand for cotton made the expansion of slavery westward a compelling interest.

The Native American nations that occupied Mississippi and Alabama were an obstacle to this expansion. The successive removal of the Creek, Chickasaw, and Choctaw from the 1810s through 1830s opened the land to white settlement and plantations expended westward along the Black Belt as settlers moved into the Mississippi Valley from the north and south. A combination of inexpensive land, soil degradation, and the ambition of planters to chase new opportunities along the advancing frontier meant land was frequently abandoned, succeeding to scrub pine and extensive cattle raising.

Clearing fields contributed to erosion and their leaching from rainfall. The region's heat reduced dairy production, which worked against rotating pasture and farming and the corresponding benefits of manuring fields. The relations between antebellum land use, soil exhaustion, and the westward advance of slavery are not clear, but in the decades before the Civil War advocates for soil fertilization and conservation grew increasingly louder. Despite the massive acreages planted in cotton during this time, the staple food crop, maize, probably did more to deplete soil nutrients.

The clearing of snags in the region's rivers, levee improvements, and railroad development opened up new areas to plantation agriculture, but some areas remained isolated. The Mississippi Delta, south Florida, and much of coastal Louisiana remained inaccessible to planters due to the swampy nature of the terrain. The Swamp Land Acts in 1849 and 1850 attempted to stimulate the drainage of these places by promoting land sales that would finance reclamation.

The Civil War left many levees destroyed, farms abandoned, and investment capital in desperate scarcity. Emancipation and Reconstruction led to contestation over control of land. The counterrevolution of Redemption led to the reinforcement of monopoly over land and capital by planters and the prevention of black emigration from the region, which served to maintain a low cost rural labor force.

This period also saw increased Northern and European investment and control over land and infrastructure. The South became a principal source of lumber for the United States, as companies practiced a cut-and-get-out strategy that produced brief prosperity for lumber towns and left forests severely degraded. Market hunting decimated populations of waterfowl. The fad for feathered ladies' hats led to the slaughter of much of Florida's bird life and generated support for wildlife conservation that eventually banned market hunting and the plume harvest.

The turpentine industry spread to Florida and southern Alabama from the Carolinas and did much damage to pine forests and workers alike. The region around Birmingham became a coal and iron center and Florida became a source of phosphate fertilizers. Agriculture in the uplands became more dependent on cotton as cheaper provisions in stores undermined local produce. Diseases like malaria continued to drain the energies of many people in the countryside, while summer epidemics of cholera and yellow fever, especially in cities like New Orleans, killed thousands at a time.

The economic development of the region was marked by selective industrialization in extractive industries, dependence on outside capital, and a widening inequality relative to the United States as a whole and between localities within the region. A national depression in the 1890s contributed to the rise of the Populist movement, composed of small white farmers and black farmers, working separately or together, to break the monopoly of planter interests on state government and industrial trusts over the regional economy. The polarization of planters based in naturally rich regions like the newly drained Mississippi Delta from upland smallholders facing economic ruin on land planters didn't want temporarily fractured the political alliance based on white supremacy that maintained the Southern social order.

The boll weevil infestation that swept the region destroying cotton crops beginning in 1894 added to a wave of rural emigration propelled by economic crisis. Pellagra, a nutritional deficiency disease caused by a maize-based diet, became a serious public health problem in the 1900s as cotton dependency reduced kitchen gardens.

Increased state and federal government intervention and rapid industrialization in the coming decades made for radical changes in the Gulf states. The massive Mississippi river flood of 1927 brought federal support for comprehensive flood control. New Deal–era programs brought rural electrification and reforestation. Endemic diseases finally began to be brought under control, then eradicated altogether through a combination of better nutrition and the elimination of breeding grounds for vectors.

The mechanization of agriculture was spurred by generous subsidies for price stabilization and soil conservation begun during the 1930s, programs influenced by the political power of large planters. This had the effect of accelerating the outmigration of rural farmworkers to regional and Northern cities. South Florida began its spectacular development from an isolated backwater to vacation destination and plans to drain the Everglades were implemented, creating the huge Everglades Agricultural Area for sugar cane farming. In Louisiana, exploitation of oil and gas wealth stimulated industrialization in the form of a petrochemical corridor along the Mississippi (known to environmental justice activists as "Cancer Alley") and did great harm to the state's wetlands by dredging thousands of canals to access drilling sites in the marsh.

The Civil Rights movement focused on issues like voting rights, but also had an important component of rural development and agrarian reform advocated by leaders like Fannie Lou Hamer, harkening back to historical African-American community development and earlier rural organizing efforts. During the mid-1960s peak of activism, plantations greatly reduced their workforces in favor of highly capitalized farming, resulting in a greater exodus of black farmworkers from rural areas and the dilution of the base of the movement.

Green Revolution technologies were incubated in the American South with public-private research partnerships, and as the old plantation order unraveled land companies transformed themselves into agribusinesses or even biotechnology firms. Delta and Pine Land, once a huge Mississippi Delta plantation, created the so-called terminator sterile seed technology and is now a part of Monsanto. After World War II pine plantations proliferated and the South became the United States's largest softwoods producer. Pulp and paper mills and new forms of agro-industry like off-soil chicken raising operations and catfish aquaculture were established.

All the Gulf states experienced the transformation of the Southern arc of the United States into the Sunbelt, a region of economic resurgence, net immigration, and suburbanization, but none more so than Florida. That state's population increased fivefold between 1950 and 2000, making it the fourth largest state in the United States. Air conditioning played a role in this growth, as did coastal tourism development across the Gulf Coast and the migration of many Northern retirees in search of warmer climates and a lower cost of living.

The ecological costs of regional development in the late 20th Century are particularly evident in coastal Louisiana and south Florida, the two largest areas of wetlands in the region. Louisiana's coast lost 1,900 square miles of land since the 1930s, due to a combination of oil development, reclamation, subsidence, and sediment deprivation caused by narrowly channeling the Mississippi river. This has compounded the vulnerability of south Louisiana to tropical storms.

Much of Florida's Everglades were drained for agriculture and urbanization. The remainder was affected by the hydrological engineering of South Florida that sometimes deprived the glades of seasonal water flows or flooded it with too much. A federal multibillion dollar restoration project for the Everglades using adaptive management was approved in 2000. The plan is driven by an interest in increasing fresh water availability for urban growth as much as a desire to preserve nature. Restoring the Louisiana coast has gained new urgency after Hurricanes Katrina and Rita in 2005, but has not seen the same financial backing as Florida received for the Everglades.

SEE ALSO: Cancer Alley; Cotton; Everglades; Green Revolution; Hurricanes; Swamp Land Acts; United States, Central South; United States, Great Plains.

BIBLIOGRAPHY. E. Ayers, *The Promise of the New South* (Oxford University Press, 1992); A. Cowdrey, *This Land, This South: An Environmental History* (University Press of Kentucky, 1996); C. Woods, *Development Arrested: Race, Power, and the Blues in the Mississippi Delta* (Verso, 1998).

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United States, Hawaii

THE HAWAIIAN ARCHIPELAGO—LOCATED in the central Pacific—comprises eight larger and inhabited islands in the southernmost part, and other minor unpopulated islands, reefs and atolls, extended to the northwest along 1,000 miles (1,600 kilometers). The inhabited islands are Ni'ihau, Kaua'i, O'ahu, Moloka'i, Lana'i, Kaho'olawe, Maui, and the island of Hawaii. The northwestern islands are Kure Atoll, Midway Atoll, Pearl and Hermes Atoll, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island (Mokumanamana), and Nihoa. The islands belong to the Hawaiian Ridge, a volcanic chain of seamounts, residuals of old volcanoes, or active volcanoes with a northwest-southeast direction. It was formed in the last 30 million years from an active hot spot approximately located in the island of Hawaii, which is the youngest of the chain, as the result of the movement of the Pacific Plate.

Polynesian settlement occurred at least by 600 C.E. after long-distance voyaging across the Pacific, although first discovery might have happened three to four centuries before. Those explorers carried with them domesticated plants—at least 29 species—and animals to secure food for the journey. Once in Hawaii, their cultivation provided a source for carbohydrates that was not available in the islands. This was succeeded by the relatively late European discovery and settlement, compared to the other Pacific islands, in 1778. In his third voyage of Pacific exploration, the English Captain James Cook found the islands, which were named the Sandwich Islands. This last discovery initiated a rapid process of colonization because of their strategic position in the Pacific Ocean.

Population at the time of European contact, although still a matter of debate, was 300,000 native Hawaiians. A census completed by missionaries in 1831–32 gave an account of 130,000 and in 1876 a Hawaiian government census reported 54,000. This sharp decline of the native population was due to the period of wars and famine during King Kamehameha's mandate, the various diseases fatal to the local population introduced by the European navigators, and the migration of natives to work as sailors.

During the plantation era, a large labor force was needed and immigration was organized by the estates to supplement the diminished local force. Labor immigrants arrived from 1850 to 1950; the waves were first Chinese, then Portuguese, Japanese, Portuguese for a second time, and finally Filipino, which led to the present high ethnic diversity. About 180,000 Japanese and 168,000 Filipino departed to the islands. Thus, population begun to grow from 1876 onwards, as mortality rates dropped and birth rates increased. By 1940, the population exceeded 400,000 and rapidly doubled with the arrival of military and defense workers during World War II.

After the war population dropped with the departure of military and employees but increased again with the expansion of tourism by the mid-1950s. As of the 2000 Census, population was 1,211,537, mostly concentrated in O'ahu (73.3 percent), with population densities of 1,441 persons per square mile (547 per square kilometer); while the biggest island, Hawaii, only had 12.2 percent of the population, with a density of 36.8 persons per square mile (14.2 per square kilometer).

RESOURCE EXPLOITATION

Hawaii underwent various historical economic cycles based on different resources. Early phases based on sandalwood, whales, sugarcane, and pineapple were followed by services, military, and tourism. During the first quarter of the 19th century, the principal commodity traded was sandalwood, harvested in great quantities and traded to China, which almost depleted the forests, until cutting restrictions were issued. The Forest Reserve system was created in 1903 to protect watersheds from deforestation and subsequent erosion; trees were planted including both native hardwood koa and short rotation nonnative tree species such as pine and eucalyptus. The abandonment of sugarcane plantations was an opportunity to gain new lands for forestry. Today forests cover 1.7 million acres (690,000 hectares), or 41 percent of the state's area.

The whaling industry in the North Pacific became a foremost activity for half a century until the 1870s. It turned into an opportunity for trade and facilitated port infrastructure development, which had already begun with sandalwood commerce. These two economies were not sustainable, but extractive and resource depleting. Eventually, whale stocks began to shrink. Changes in technology and petroleum use led to the decline of the industry.

The sugarcane industry started after this eclipse as the influence of American traders and landowners grew. This influence increased especially after the short-lived Republic of Hawaii, which succeeded the Kingdom of Hawaii, was annexed as a territory by the United States in 1898. This episode took place when Queen Lili'uokalani was overthrown in 1893 by those American traders and landowners willing to join the United States.

Cultivated area increased and the sugar industry expanded; production kept steady until the 1970s. At the outset of the 20th century, pineapple and other tropical fruit cultivation began, benefiting from a sustained year-round production which, although it declined in the 1970s, still has a local and mainland market. The number of related jobs in the 1990s fell to half of the jobs in the 1970s. Plantations shaped a relatively homogeneous landscape based on agriculture that turned into a highly diversified agriculture: Vegetables for the local market, fruits, flowers, and sugarcane for export.

Hawaii's central Pacific location provided an additional resource for at least half a century. The islands had a strategic military significance as a base

The Hawaiian Volcano Observatory

Thomas Augustus Jaggar, Jr., (1871–1953) was a petrographer and volcanologist, and was born in Philadelphia, the son of an Episcopalian Bishop. He originally studied geology at Harvard University and then went to Munich, Germany, to do research in mineralogy. When Mount Pelée erupted on the French Caribbean island of Martinique, Jaggar went to visit the site, and then also travelled to Japan to see Tarumai and Asama. He then went to Kilauea in Hawaii along with his colleague Reginald Daly (1871–1957), and founded the Hawaiian Volcano Observatory. In 1912 Jaggar resigned from a position he held at the Massachusetts Institute of Technology in order to become director of the observatory, a position he held until 1940.

At the Hawaiian Volcano Observatory, Jaggar saw to the designing and building of new machines to measure volcanoes, although he was always short of funds. In 1919, the observatory was placed under the control of the U.S. Weather Bureau, which ensured its survival. Five years later, it was placed under the U.S. Geological Survey, which in 1926 established a volcanology section with Jaggar as its head.

Jaggar used the observatory as a base to study volcanoes elsewhere in the United States. He studied the Aleutian volcanic chain in depth, leading a National Geographic Society expedition. When the observatory was transferred to the National Park Service in 1935, Jaggar saw that the volcanoes at Kilauea and Mauna Loa became part of a national park. Many of the ideas introduced by Jaggar had never been tried before. He designed ways of protecting cities from lava flows, including by aerial bombing, and wrote about safety precautions and dealing with eruptions. He remained in Hawaii after his retirement and died in Honolulu.

for operations in three major wars: World War II, Korea, and Vietnam. Interest rose with the Spanish-American war at the end of the 19th century, when the United States began to look to the Pacific as an area of territorial expansion. The Pearl Harbor Naval Shipyard was established in 1908. Military expenditures of $3.2 billion represent 9 percent of the Gross State Product and the second biggest resource after tourism. The military employs 8 percent of the state population, while installations occupy 5 percent of the land, mostly on Hawaii and O'ahu islands.

Mass tourism took off with the introduction of rapid air transportation in the 1960s. Although a principal domestic destination, it has followed a process of internationalization bringing visitors from Japan, Canada, Australia and New Zealand. As many as 7.4 million visitors a year spend $11.5 billion. Tourism makes up 23 percent of the state's employment, leaving the state highly dependent on the industry. Another problem results from the high numbers of visitors (hotel occupancy rates of 81.2 percent at times) and the resulting rapidly growing demand for new infrastructure.

ENVIRONMENTAL PROTECTION

The islands' tropical location, the exposure to the dominant northeast trade winds carrying moisture, and the high elevation of some islands result in an extraordinary diversity of environmental conditions and the emergence of a number of ecosystems. Windward slopes face the northeast trades and receive rainfall that decreases with altitude, whereas leeward sides are drier with less cloud cover. This orographic effect—particularly observable in the islands of Hawaii, O'ahu and Maui—produces rapid changes in short distances, such as the Ka'u desert next to the rain forest. The western slopes of the islands pose climatic conditions—milder temperatures and many sunny days—that favor the development of tourism.

There are about 15,000 native plant and animal species, which, added to the approximately 6,000 species intentionally or accidentally introduced by human colonization of the islands over the past 1,500 years, makes for a total of between 20,000 and 22,000 species, half of them insects. As species arrived to the islands from other areas, entire families and order of fauna and flora are missing, principally those without dispersal mechanisms, like mammals and amphibians. The long period of isolation and the slow environmental changes led species to acquire slow growth and low birth rates, or become flightless. Thus, rapid changes produced by the combined effect of habitat change and the introduction of predators makes many native species vulnerable to human impact.

One thousand species have become extinct—half of the avifauna—most of them plants and invertebrates. The main threats to native plants are both indirect factors such as alien weeds or introduced mammal predators and direct factors such as wildfires, species collecting, and urban development. Agriculture and livestock breeding brought the most changes. Wetlands were drained, pasture land displaced original species, and forest and shrubland ecosystems were cleared for cattle grazing and plantation agriculture. Coastal areas, valleys, and low altitudes are occupied by agriculture and residential areas, both leading to a loss of the lowland mesic and dry ecosystems.

A total of one million acres (404,685 hectares) of federal- and state-managed areas represent 25 percent of the state extension to protect fragile ecosystems and rare and endangered species. In 1916, the U.S. Congress established the Hawaii National Park, which was then split into the Hawaii Volcanoes National Park on Hawaii island and the Haleakala National Park on Maui in 1961. The Hawaiian Islands National Wildlife Refuge—administered by the U.S. Fish and Wildlife Service—comprises the northwestern Hawaiian islands, atolls, and reefs (with the exception of Midway and Kure Atolls) to protect seabirds and marine life. It was designated in 1909 to protect the endangered Hawaiian monk seal and the Hawaiian population of threatened green sea turtles.

Hawaii's 1961 State Land Use Law was the first enacted and implemented statewide land use zoning and planning system, establishing the State Land Use Commission, responsible for the classification of lands into the four districts: Urban, conservation, rural, and agricultural. The counties determine the zoning ordinances, and development or subdivision plans for urban use, the state determines the use of conservation lands, and both share the administration of rural and agricultural lands. Ceded Lands, with an extension of 1.8 million acres (727,000 hectares), 43.8 percent of the territory, are the focus of an intensive and prolonged debate on their ownership and land use. After the Ceded Lands Act of 1963, these crown lands, which were transferred to the United States in 1898, are partly administered by the Federal and the State governments, but there has not been a final resolution to this prolonged conflict.

SEE ALSO: Biodiversity; National Parks; Orographic Effect; Plantation; Sugar; Tourism; Whales and Whaling.

BIBLIOGRAPHY. Ibrahim Aoude, ed., *Political Economy of Hawaii* (University of Hawai'i Press, 1994); David L. Callies, *Preserving Paradise* (University of Hawai'i Press, 1994); Sonia P. Juvik and James O. Juvik, *Atlas of Hawai'i* (University of Hawai'i Press, 1998); Ralph S. Kuykendall, *The Hawaiian Kingdom* (University of Hawai'i Press, 1969); Gordon A. Macdonald, Agatin T. Abbot, and Frank L. Peterson, *Volcanoes in the Sea. The Geology of Hawaii* (University of Hawai'i Press, 1983); Charles P. Stone and J. Michael Scott, eds., *Hawaii's Terrestrial Ecosystems: Preservation and Management* (University of Hawai'i Press, 1985); Ronald T. Takaki, *Pau hana: Plantation Life and Labor in Hawaii, 1835–1920* (University of Hawai'i Press, 1983); Alan C. Ziegler, *Hawaiian Natural History, Ecology, and Evolution* (University of Hawai'i Press, 2002).

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United States, Middle Atlantic

MIDDLE ATLANTIC STATES of the United States border the Atlantic Ocean or have port cities that are accessible to it. These states include Connecticut, Delaware, Maryland, New Jersey, New York Pennsylvania, and Rhode Island. All have temperate climates with four distinct seasons, though winters are colder in the western areas, with summers hotter in the coastal areas.

CONNECTICUT

Connecticut is 110 miles long and 70 miles wide. With only 5,544 square miles, it is one of the smallest of the American states. The highest point in Connecticut is Mount Frissell (2,380 feet), located in the extreme northwest corner of the state in the Berkshire Hills. Connecticut is bounded on its western boundary by New York. Rhode Island separates it from the Atlantic. To the north lies Massachusetts, with the Long Island Sound on the south.

Connecticut has five different land regions: The Taconic Section, the Western New England Upland region, the Connecticut Valley Lowland, the Eastern New England Upland and the Coastal Lowland. The Coastal Lowlands are a section of the New England Coastal Lowlands that cover the coast of New England. In Connecticut they are a narrow strip of land that is only 6 to 16 miles wide. The area is found along the southern shore beside Long Island Sound. The area has low ridges, beaches, some swampy areas, and harbors and its shoreline is 618 miles. Most of Connecticut's population lives in the Coastal Lowlands. The two major exceptions are the cities of Hartford and Waterbury.

The Eastern New England Upland area covers most of eastern Connecticut. The area is the southern end of the same land formation that extends through New England to Maine. It is a heavily forested area with many rivers, valleys, and low hills. It is a fertile region where farmers grow tobacco, corn, potatoes, oats, blueberries, and wheat. Poultry farming is also an important agricultural activity.

The Connecticut Valley Lowland runs through the center of Connecticut and is on average only 30 miles wide. The area is distinguished by basalt lava ridges and low hills. The Connecticut River is wide as it flows through the area on its way from Massachusetts to the sea. There are many small rivers that are tributaries and the area is fertile. Farmers raise potatoes, vegetables, corn, strawberries, blueberries, and other fruits. Grass is plentiful, contributing to dairy farming.

The Western New England Upland covers the western third of Connecticut and stretches into Massachusetts and Vermont. It rises from 1,000 feet to 1,400 feet above sea level and slopes down from the northwest to the southeast. It is a hilly region with many rivers and favorable conditions for the raising of beef cattle and for dairy farms. Crops grown in the area include corn, berries, and vegetables harvested as truck crops especially for urban markets such as New York City and Boston. The Taconic section of Connecticut is a small loop in the northwestern corner of the state. It lies between the Housatonic River and the New York border and extends north into Massachusetts.

Connecticut's climate is humid with abundant rains throughout the year. The proximity to the sea and the protection of the western hills provide a temperate climate with more moderate temperatures in winter and summer than are experienced by the rest of New England. Occasionally severe winter storms strike the area.

RHODE ISLAND

Rhode Island is the smallest of all U.S. states at only about 40 miles long and 30 miles wide. It has a land territory of only 1,045 square miles, but a water area of 500 square miles. It was founded by Anne Hutchinson and Roger Williams. It was also the place where the first Jewish congregation was organized in the English speaking colonies.

Located in the southern tier of the New England states, its neighbors are Massachusetts to the north and east and Connecticut to the west. The great Narragansett Bay is its opening to the sea, which lies on the south. There are two main land regions in Rhode Island—the Coastal Lowlands and the New England Upland. The Coastal Lowlands cover more than half of the mainland and include some of the islands in Narragansett Bay.

The Coastal Lowlands lie east of Narragansett Bay and are a part of the same coastal lowland area that stretches to Maine. The coastline of Rhode Island is only 40 miles long; however, its total shoreline including all of its islands and bays is 384 miles long. The Eastern New England Upland covers the northwestern third of Rhode Island. It is an area dotted with small lakes, ponds, and a terrain that is generally rough. Hay, dairy cattle, poultry and fruits are raised in the area. Jerimoth Hill is in the area and is the tallest point in the state.

The major rivers in Rhode Island are the Providence, the Sakonnet, the Seekonk, the Pawtuxet, and the Potowomut. The climate is temperate with temperatures moderated year round by the proximity to the sea.

NEW YORK

New York touches the Atlantic Ocean and the Great Lakes. It also separates New England from the Mid-Atlantic States. Its Atlantic coastline is 127 miles long. Its shorelines on Lakes Erie and Ontario are 371 miles long. Its total area is 49,108 square miles (124,189 square kilometers), which includes inland waterways, but excludes Lakes Erie and Ontario.

There are eight land areas in New York. In the east are the Atlantic Coastal Plain and the New England Upland areas. The Atlantic Coastal Plain includes Staten Island and Long Island. These islands are part of a low flat coastal plain that stretches from Massachusetts to Florida. Some of Long Island and all of Staten Island are part of New York City, which is the largest city in the United States.

Long Island, which is over 100 miles long, is a center for recreation. It is also a major farming area for truck crops along with fruit, flowers, poultry, and other crops and livestock. Its fisheries are a major source of food for New York City.

The New England Upland area is a region of low mountains and hills that forms a belt along New York's eastern mainland area. The Taconic Mountains, the lower Hudson River Valley, and the Hudson Highlands are part of this region, as is Manhattan Island.

The Hudson-Mohawk Lowland is comprised of the Hudson and Mohawk River valleys and some adjoining areas. It is the only navigable waterway through the Appalachian Mountains. The valleys are filled with fruit orchards and dairy farms as well as other agricultural operations. The Mohawk and Hudson Rivers rise in the Adirondacks. The Adirondack Upland is about 100 miles across and is roughly circular in shape. It is an area that was rugged and remote enough to have been barely explored as late as the mid-1800s. Today it is an area visited in winter for winter sports, and the Winter Olympic Games have been held at Lake Placid twice.

The Empire State Building

The Empire State Building has been declared one of the seven wonders of the modern world by the American Society of Civil Engineers. It was completed in 1931 and was the tallest building in New York City until the building of the World Trade Center towers in 1972. After September 11, 2001, it is now once more the tallest building in the city, and the second tallest in the United States after the Sears Tower in Chicago.

The site of the Empire State Building had formerly been occupied by the original Waldorf Hotel. Excavation began for the building on January 22, 1930, and construction started on March 17. Of the 3,400 workers on the project, including many European migrants, 14 died in its construction. The building work was completed in 410 days—the schedule was expedited because of the work on the nearby Chrysler Building. On May 1, 1931, it was officially opened with President Herbert Hoover pressing a button in Washington, D.C., which turned on the building's lights. The name came from the nickname for New York State (the Empire State), and it was quickly dubbed the "Empty State Building" as much of the space in it was empty during the 1940s.

Designed by Shreve, Lamb, and Harmon, the Empire State Building has 102 storeys and is 1,250 feet tall; a large broadcasting antenna added in 1952 makes it 1,454 feet tall. It has 2.2 million square feet of floor area. The building has not been without its share of suicides and accidents: In July 1945 a B-25 bomber hit the building between the 79th and 80th floors, killing 14 people but not causing structural damage to the building. The Empire State Building achieved another sort of fame in the King Kong films.

The Appalachian Plateau covers about half of New York. The plateau rises from 800 to 2,000 feet (240 to 610 meters) in the western area. In the east it rises to 4,000 feet (1,200 meters) in the Catskill Mountains. The valleys here are usually deep, as are the lakes. This area is a center for recreation and a source of New York City's water supply. The Appalachian Plateau area is generally so rugged that it supports only a few people.

The Tug Hill Plateau is a part of the Appalachian Plateau that is isolated from the main part. The Tug Hill area is flat and rocky; its northern part is across the Black River Valley from the Adirondack Upland. It is exposed to winter winds from Lake Ontario; lake effect snows often exceed 225 inches (572 centimeters) per year and have limited both farming and settlement.

The St. Lawrence Lowland lies on the south side of the St. Lawrence River, and north of the Adirondack Plateau. The area has some fertile soils and is level enough to be farmed; it produces fruit from orchards along Lake Champlain and dairy farms are common. The Erie-Ontario Lowlands are a major fruit growing region. Grapes, cherries, and other fruits are important crops. The Lowlands rise from the lakes but still have swampy areas. There are also areas in which glacial deposits called drumlins are mounded. The last ice age shaped the areas of New York with huge glaciers. The smooth flow of mountain ridges and deep lakes like the Finger Lakes are evidence of the enormous forces with which glaciers shaped the land.

NEW JERSEY

New Jersey has four land areas. In the northeast is the Appalachian Ridge and Valley Region. The highest point in New Jersey is High Point, which rises to 1,803 feet. It is a part of the Kittatinny Mountains, the state's major mountain range. The Delaware River cuts though the mountains to form the Delaware Water Gap, an area considered one of the most beautiful in the eastern United States. It is an important center for growing apples and other crops. The New England Upland region is sometimes called the Highlands. It lies to the southeast of the Ridge and Valley Region. The area is covered in many places with hard cap rock on the ridges. It also has many beautiful lakes. The Piedmont Plateau crosses the northern half of New

Jersey in a northeast to southwest direction. While the plateau is only 20 miles wide it is where about three-fourths of the people live, mainly in industrial cities.

South of the Piedmont Plateau is the Atlantic Coastal Plain. It covers most of the southern and eastern parts of the state. Most of the area is characterized by gentle rolling lowlands that are not much above sea level. Many places in the area are farmed to produce truck crops. The Delaware River forms the western border with Pennsylvania and Delaware. The eastern area is a zone in which the sandy soil produces little besides pine trees. Much of the southern area is swampy and marshy close to the coast or to the rivers, forested, and thinly populated. Along the Atlantic coast are excellent beaches such as the beach at Atlantic City. The beaches have become popular enough to stimulate the development of a number of resort cities and towns.

PENNSYLVANIA

Pennsylvania lies west of New Jersey across the Delaware River. It is bordered on the south by Maryland and on the north by New York. Its main cities are Philadelphia and Pittsburgh, which are at its western and eastern ends. It has an area of 46,058 square miles (119,751 square kilometers).

Pennsylvania's Lowlands are in the northwest and the southeast. The lowlands in the northwest are part of the Erie Lowland region that borders Lake Erie. The land has a rich soil that produces potatoes, grapes and other crops. The southeastern Lowlands area is a corner of the Atlantic Coastal Plain. The Delaware River is at sea level where the Schuykill River empties into the Delaware at Philadelphia. Beyond it to the west is the Piedmont Plateau area.

Most of Pennsylvania is covered by the Appalachian Mountains. The Blue Ridge Mountains, the Pocono Mountains, and the Allegheny Mountains are part of the Ridge and Valley Region. Much of the region has produced hard anthracite coal. The Wyoming Valley is an important area in eastern Pennsylvania and was the site of the Pennamite Wars.

In western Pennsylvania the Allegheny and Monogahela Rivers flow together at Pittsburgh to form the Ohio River. The western region is a major coal producing area. It was also in northwestern Pennsylvania that the first oil well was drilled in 1859.

DELAWARE AND MARYLAND

Delaware is bordered by the Delaware Bay and River to the east and by the Atlantic Ocean. It is bordered by Maryland to its west and by a small area touching Pennsylvania in the north that is a part of the Piedmont Plateau. Some dairy farming and large estates are located in this hilly area. The only part of Delaware that is not part of the Atlantic Coastal Plain is its northern tip. Most of the state is barely above sea level. The state produces soy beans, corn, and other crops in its sandy loam soil. Seafood is also an important product.

Maryland is a relatively small state with a varied terrain. It has five land areas: The Atlantic Coastal Plain, the Piedmont, the Blue Ridge, the Appalachian Ridge, and the Appalachian Plateau. These areas are physically similar to those of states to the north, but there are some variations in the fauna and flora due to the milder temperatures of its more southern climate.

SEE ALSO: Appalachian Mountains; Cities; Coal; Petroleum; Potatoes; United States, Northeast; Wheat.

BIBLIOGRAPHY. James Kavanagh, *New York Birds* (Waterford Press, Ltd., 2001); Rene Laubach and Charles W.G. Smith, *Nature Walks in Connecticut: AMC Guide to the Hills, Woodlands, and Coast of Connecticut* (Appalachian Mountain Club Books, 2004); Raymond Leung, *Connecticut Birds* (Waterford Press, 2001); John H. Long, ed., *Connecticut, Maine, Massachusetts, Rhode Island: Atlas of Historical County Boundaries* (Scribner, 1995); Sylvia McNair, *Rhode Island* (Scholastic Library Publishing, 2000); Glenn Scherer and Don Hopey, *Exploring the Appalachian Trail: Hikes in the Mid-Atlantic States—Maryland, Pennsylvania, New Jersey, New York* (Stackpole Books, 1998); Alex Wilson and John Hayes, *Quiet Water Massachusetts, Connecticut, and Rhode Island: Canoe and Kayak Guide* (Appalachian Mountain Club Books, 2004).

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United States, Midwest

THE MIDWEST REGION of the United States generally refers to lands that were part of the Northwest Territories during the time of the Articles of Confederation. Midwestern states include Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, West Virginia, and Wisconsin. Much of the region is flat prairie lands, but other land types surround it. The great Mississippi and Ohio Rivers flow through it.

Ohio is bounded by Pennsylvania and West Virginia in the east and southeast, Lake Erie in the north, the Ohio River in the south, and Indiana in the west. If a line were drawn across Ohio from the northeast to the southwest, the area north of the line is in the Central Plains, the area to the south is part of the Appalachian Plateau. The northern half of Ohio is part of the Till Plains and the Great Lakes Plains. The Great Lakes Plains are known for Lake Erie fruits, which include wine grapes and vegetable crops. The Till Plains are part of a great corn-growing belt. The glaciers in the ice ages flattened the land and left it a level plain with rich soils. South-central Ohio has an extension of the Blue Grass Region of Kentucky that extends across the Ohio River. Southern and eastern Ohio, as part of the Appalachian Plateau region, is hilly and rough and remains natural and wild, like West Virginia across the Ohio River.

West Virginia is a mountainous state that is sparsely settled. Its Eastern Panhandle is near Baltimore and the Shenandoah and Potomac Rivers. The Northern Panhandle is a crossroads of rivers and highways and rolling countryside along the Ohio River. Down river near Parkersburg is a region in which oil and gas were extracted in the early days of petroleum pumping. Northern West Virginia is a part of the Appalachian Ridge and Valley Region with valleys between long running ridges. It is forested with many caves and underground streams and covers the eastern sixth of the state. The Allegheny Front is a rugged divide in the Appalachian Plateau Region, which makes up most of the territory of West Virginia. The area is rugged with flat-topped plateaus. Coal is mined across the state.

The state of Indiana has an area of 36,420 square miles (94,328 square kilometers). It has a temperate climate and is flat like most of the Midwest region. Central Indiana is part of a major corn-growing belt. Its flat terrain was formed in the ice age by glaciers; the soil they left behind is the Tipton Till, which is made up of finely ground sand and gravel. While generally flat, Indiana's highest point is in the Tipton Till at 1,257 feet (383 meters) above sea level. In southern Indiana, the Southern Hills and Lowlands extend from the Ohio River to the beginning of the Tipton Till region. It is hilly because it escaped the glaciers. It is an area of caves and bedrock outcroppings of limestone, which is mined in quarries. The confluence of the Wabash and Ohio Rivers is the state's lowest point. It is also an area of coal and petroleum. Northern Indiana is part of the Great Lakes Plains. The regions were scraped flat by the glaciers, but some places were missed and remain high and hilly. The North Lake and Moraine Region in the northeast has beautiful scenery; the moraines form high ridges. The land ends in northern Indiana at Lake Michigan. The area just south of the lake has enormous sand dunes that were deposited as its waters retreated and winds from the lake have continued to build the dunes. Those dunes further south are the oldest and are wooded; those dunes next to the Lake form the Indiana Dunes National Lakeshore whose bare piles of sand are like those seen on ocean beaches—sandy, with little vegetation.

North of Indiana and Ohio is Michigan, which has a watery boundary. The Lower Peninsula is shaped like a kitchen mitten with the thumb on the eastern side. It is bordered by Lake Huron on the east and by Lake Michigan on the west. Michigan is separated from Canada by the Windsor River near Detroit. Michigan's Upper Peninsula extends from Wisconsin like an eastward pointing icicle. Lake Superior is on the northern side and Lakes Michigan and Huron are on the state's southern side. In the southeast are 35 miles of sand dunes at Sleeping Bear Dunes National Lakeshore. Cliffs are found along the 3,288-mile (5,292-kilometer) shoreline of the state in many places. The Upper Peninsula is rocky, mountainous, and heavily forested. The trees are basswood, birch, beech, butternut, elm, hickory, maple, oak, poplar, witch-hazel, and others. Moose, wolves, wolverines, porcupines, and other animals are found in the region. It was the center of copper and iron ore mining in earlier times. The Lower Peninsula is generally flat because of glacial action in the ice ages. Because of the surrounding lakes, the climate is milder in winter. However, in western Michigan, and often elsewhere, lake effect snows create large snowfalls in some areas. The two major landforms in Michigan are the Superior Upland and the Great Lakes Plains. The Superior Upland covers the western half of the Upper Peninsula. The eastern part of the Upper Peninsula and all of the Lower Peninsula are part of the Great Lakes Plains. These are a part of a larger area called the Interior Plains, which cover much of the Midwest. The Lower Peninsula, especially in the southern half, has excellent farmland where blueberries and other crops grow well.

Illinois is located in the central United States with its major city, Chicago, bordering Lake Michigan. It is bound by Indiana in the east, Wisconsin in the north, Kentucky and the Ohio River in the south, and Iowa and Missouri in the west. The state covers a land area of 56,345 square miles (145,934 square kilometers) and has five land areas. In the extreme southern tip, along the Ohio and Mississippi Rivers, is a strip that is part of the Gulf Coastal Plain. Because it is like the delta of the Nile River, early pioneers called it Egypt. The southern part of the state is flat, and rises into hills in the north.

In the north is another strip of land that extends 70 miles from where the Wabash River enters the Ohio River to the Mississippi River—a hilly area called the Shawnee Hills. The area is also occasionally called the Illinois Ozarks. This Shawnee Hills region has river bluffs, hills, valleys, and heavily wooded areas; it is also a region in which many orchards have been planted. The Shawnee Hills vary from south to north from five to 40 miles (eight to 64 kilometers). The heights of the hills vary from 300 to over 1,000 feet (91 to over 325 meters).

North of the Shawnee Hills are the Central Plains or Till Plains. It is a vast fertile region that is filled with corn, soybean, and wheat stretching to the horizon during the growing season; prairie grass covers the unfarmed areas. The plains were created by the glaciers of the ice age. The Central Plains covers 90 percent of Illinois and through it runs the Illinois River to the Mississippi. The area has been called the Great Lakes Plains because Lake Michigan once covered the area. North of Chicago is an area of small hills, marshes, and lakes. In the far northwest corner of Illinois is an area that was not covered by the glaciers, which is called the Driftless area. The Illinois section covers only a small area, but it is filled with tall hills and steep valleys.

North of Illinois is Wisconsin. It is bordered by Minnesota in the west, Lake Michigan and Lake Superior in the east and north, and by Iowa in the south. It has an area of 56,153 square miles (145, 436 square kilometers) and has moderate temperatures in the southern areas in summer but cold winters. The landforms in Wisconsin are numerous. In the southeast are the Eastern Ridges and Lowlands, which extend from Illinois north to Green Bay. These plains were formed by glaciers and glacial till covers limestone ridges. The area is fertile and extensively employed in farming—the Door Peninsula is the center of potato growing.

West of the Eastern Ridges and Lowlands in the south is the Western Uplands region, which includes the previously discussed Driftless area. It is a beautiful area of wooded hills, lakes and rivers. Dramatic sandstone and limestone bluffs line the Mississippi River. Lead was mined in the area in earlier decades. From the Eastern Ridges and Lowlands west to the St. Croix River is the Central Plains area and on its southern section is the Wisconsin Dells region, which is a scenic gorge on the Wisconsin River. Covering most of northern Wisconsin is the Northern Highlands region, which is heavily forested and dotted with numerous lakes. It slopes to a steep cliff beyond which is the Lake Superior Lowland, a flat plain along Lake Superior.

West of the state of Wisconsin and northern Illinois is Minnesota, which has a land area of 84,402 square miles (218,601 square kilometers). It borders North and South Dakota in the west, Iowa in the south, and Wisconsin in the east; Canada (Manitoba and Ontario) and Lake Superior are to the north. Along the Mississippi River, extending from Wisconsin and Illinois is the Driftless area. To the west is the Young Drift Plains, which is a region of gently rolling farmland created by glaciers. Most of the glacial deposits, called drifts, left rich farmland. However, in some areas, moraines (or their remains) are rocky, sandy, and not suited to farming. They extend across the state to the Red River and north to Manitoba. All across the state are numerous lakes left by glacial action, which act as an enormous breeding ground for birds. In the far southwest corner of Minnesota is a portion of the Dissected Till Plains. The northern Superior Upland is part of the Canadian Shield. It was scoured by glaciers but they were unable to destroy the hard, ancient rock. The northeastern Arrow Head Region pointed toward Lake Superior is the location of the Iron Ranges.

Iowa is to the west of Illinois. In the northeastern part of the state is the western part of the Driftless area. The Dissected Till Plains cover the southern part of the state to Nebraska. The whole region is filled with glacial till that has been eroded to give the land some rolling qualities. Iowa also has the Loess Hills along the Missouri River. The Young Drift Plains cover the flat central and northern sections of Iowa. This state has some of the best farmland in America.

SEE ALSO: Agriculture; Dunes; Glaciers; Great Lakes; Mining; Mississippi River; Prairie.

BIBLIOGRAPHY. Jim Dufresne, *50 Hikes in Michigan: The Best Walks, Hikes, and Backpacks in the Lower Peninsula* (The Countryman Press, 2003); James Halfpenny, *Scats and Tracks of the Midwest: A Field Guide to the Signs of Seventy Wildlife Species* (Globe Pequot Press, 2005); James Kavanagh, *Wisconsin Birds* (Waterford Press, 2001); Doug Ladd, *Tallgrass Prairie Wildflowers: A Field Guide to the Common Wildflowers and Plants of the Prairie Midwest* (Globe Pequot Press, 2005); John Madson, *The Elemental Prairie: Sixty Tallgrass Plants* (University of Iowa Press, 2005); Nature Conservancy, *The Nature Conservancy's Guide to Indiana Preserves* (Indiana University Press, 2006); Shawn Perich, *Wild Minnesota: A Celebration of Our State's Natural Beauty* (MBI Publishing Company, 2005); Stan Tekiela, *Birds of Illinois Field Guide* (Adventure Publications, 2002); Stan Tekiela, *Trees of Wisconsin Field Guide* (Adventure Publications, 2002).

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United States, Mountain West

THE MOUNTAIN WEST region encompasses four states: Colorado, Wyoming, Montana, and Idaho. These states represent the northern, middle, and southern Rocky Mountain physiographic regions in the United States. This area is one of the most diverse regions in the United States because it includes eight different physiographic provinces: The Great Plains, the northern Rockies, the middle Rockies, the southern Rockies, the Wyoming Basin, the Columbia Plateau, the Basin and Range, and the Colorado Plateau. This diversity in geology and geomorphology also translates into differences in climate, vegetation, and wildlife habitat. In addition, the natural resources in this area attracted the early pioneers and the different amenities are attracting a new and expanding western population.

This portion of the United States occupies over 432,538 square miles (1.12 million square kilometers) and stretches approximately 860 miles (1,400 kilometers) along the crests of the Rocky Mountains. The northern border of Idaho and Montana follows latitude 49 degrees north separating the United States from Canada, while the southern border is Colorado at latitude 37 degrees north. The eastern limit of this region is longitude 102 degrees west—the eastern border of Colorado—and the western edge is longitude 117 degrees west—the western border of Idaho.

The Mountain West is a region dominated by the Rocky Mountains, a complex of mountains, valleys, and basins formed during the Cretaceous Period (140–65 million years ago). However, portions of the southern Rockies were uplifted more than 3.9 billion years ago during the Precambrian Period. The backbone of the Rockies was created by a combination of igneous and metamorphic rock and the edges are tilted sedimentary layers forming long ridges or hogbacks. The movements of the earth's crust have created a series of folded and faulted mountains. The Rockies have also experienced several volcanic episodes and numerous intrusions, lava flows, and other magmatic features are evident throughout the four states. The various uplifts, folds, and faults have occurred over more than three billion years and the mountains have experienced a multitude of erosional periods creating several flat basins filled with sedimentary material, the most notable of which is the Wyoming high basin. Finally, the three ice and intermittent ice advances have scarred the mountains with spectacular glacial features and remnants still present today in Glacier, Rocky Mountain, Grand Teton, and Yellowstone National Parks.

Adjacent to the Rocky Mountains to the east is the Great Plains, an area of low relief except for outlier uplifted mountains. The majority of the geologic formations were created during the Mesozoic and Cenozoic periods (225–70 million years ago). The surface material is mainly the erosional deposits from the Rocky Mountains. In addition, the northern portions display the large impacts of the continental glaciers, and in western Montana, both continental glacial and the long reach of alpine glacial features.

The western side of the Rocky Mountains border several physiographic provinces. The northern Rockies are adjacent to the Columbia Plateau, an area dominated by volcanic materials of the Miocene-Pliocene periods (25–2 million years ago). Some of the lava flows extend over 100 miles (160 kilometers) and experienced folding and faulting creating ridges and steep hillsides. To the west of the middle Rocky Mountains is the great expanse of the Basin and Range Province, a large area occupying over 297,800 square miles (771,300 square kilometers) of recently faulted mountains and valleys. This province consists of a series of parallel mountain ranges with wide valleys of low relief. The southern Rocky Mountains in Colorado blend into the Colorado Plateau—a long, high area above 4,920 feet (1,500 meters) of mainly horizontal sedimentary rock eroded into steep-walled valleys, exposing folded and faulted rock formations. Scattered throughout the area are igneous structures, including large shield and conic volcano mountains, lava-capped mesas and tables, and lava flows.

The mountains, plateaus, valleys, and plains in this region display the radical topographic variations of the area. Colorado has the highest average elevation among the coterminous states of over 6,800 feet (2,070 meters). Colorado also has 59 peaks that soar over 14,000 feet (4,268 meters), also known as the "14'ers." Wyoming also has a very high average elevation of 6,700 feet (2,040 meters), yet does not have the multitude of high peaks similar to Colorado. Both Montana and Idaho have peaks that are slightly over 12,500 feet (3,811 meters), yet they also have low lands that are below 1,800 feet (549 meters). Overall, there are more than 20 major mountain ranges in the Mountain West, along with many isolated mountains. To the east and west of the Rocky Mountains are the flat plains and plateaus that generally slope away from the high peaks.

The elevation changes, differences between windward and leeward sides of mountains, the rain shadow effect, and the large latitudinal differences between the northern and southern portions of the four states provide diversity in climatic conditions. The northern portions of Idaho and Montana experience the most diversity in temperature and precipitation. Parts of Idaho receive over 60 inches (1,500 millimeters) of precipitation while adjacent valleys may receive less than five inches (125 millimeters) with temperatures ranging from 48 degrees C to negative 51 degrees C. All of the states experience high temperature differences between mountain passes and lowlands along with large ranges in precipitation, both rainfall and snowfall. The eastern portions of Colorado, Wyoming, and Montana display the westerly longitudinal progression of drier conditions in the Great Plains. The orographic effect of the Rocky Mountains produces higher precipitation on the western slopes—the windward side—and drier conditions on the eastern slopes—the leeward side.

The precipitation regime of the Rocky Mountains produces the headwaters of six major drainage systems: the Missouri, Arkansas, Rio Grande, Snake, Bear, and Colorado Rivers. The Missouri and Arkansas Rivers are some the largest contributors to the Mississippi River. From the southern portion of the Rocky Mountains, the Rio Grande drains southward into the Gulf of Mexico. The flow of the Rio Grande is interrupted by a number of reservoirs and over-allocation to municipalities, agriculture, and industries. From the western slope of the Rockies, the Colorado, Bear, and Snake Rivers drain across the Colorado Plateau, the Basin and Range, and the Columbia Plateau provinces. The Colorado River has its beginnings in northern Colorado and western Wyoming, traversing more than 1,429 miles (2,300 kilometers) to the Gulf of California in Mexico. The Colorado River, like the Rio Grande, feeds into a number of reservoirs created by large dams, the most notable of which is the

Hoover Dam producing Lake Mead. Similarly, the Snake River has a number of dams and reservoirs along its route to the Columbia River regulating its maximum and minimum flows. Finally, the Bear River is only a small and short river compared to the other five rivers, traveling only 347 miles (560 kilometers). It is also different from the other rivers because of the fact that it drains into a closed drainage basin, the Great Salt Lake, with no outlet to the ocean or sea.

The vegetation patterns correspond to the elevation and precipitation complexes of the Rocky Mountains, the Great Plains, the Basin and Range, and Plateau provinces. An increase in elevation creates cooler temperatures along with slopes away from direct solar radiation, while precipitation will generally be higher on the windward sides of mountains and lower on the leeward side. There are five vegetation zones through this region: Prairies, foothills, montane, sub alpine, and alpine. East of the Rocky Mountains, the Great Plains are dominated by mixed-grass prairies in the northern portions (Montana and Wyoming) and short grass prairies in the south extending into Colorado. The mixed grass prairie includes little bluestem, needle grasses, wheat grasses, sand-reeds, and gramas. The short grass prairie also has buffalo grass, ring grass, needle-and-thread, June grass, and galleta. The foothills zone is a transition from the prairies to the montane and can have a mix of sagebrushes and scattered woodlands of ponderosa pine, limber pine, juniper, pinion, Gambel oaks, and shrubs. The lower and warmer montane zone is dominated by Douglas firs. In the higher and cooler montane zone, lodge pole pines and dispersed aspen stands are found. The sub-alpine zone varies between spruce fir, white spruce, Englemann spruce, and white pine, depending on micro-climatic conditions. The alpine region transforms trees into shrub-like krummholz with wind, growing-day length, and soil conditions. In addition, grasses, sedges, sagebrushes, mosses, and lichens along with hundreds of flowering plants add to the vegetation diversity in this highest elevation zone, in conditions similar to the Arctic.

Adding to the complexity of the vegetation pattern are two major factors: The micro and local variations in topography, climate, soils, and geology and the drainage patterns with their corresponding riparian and river ecosystems. Changes in solar radiation, small patches of soil nutrients, and exposed bedrock generate mixes of vegetation in short distances. Access to moisture in the floodplain allows plants to extend their regime into the drier portions of the plains, the higher elevations, and the southern slopes of mountains. The major drainage systems flowing out of the Rocky Mountains extend the riparian species of broad-leaf cottonwoods, alders, and willows far into the adjacent plains and plateaus for hundreds of miles.

The combination of the physiography, climatic conditions, soils, fauna, and vegetation create broad areas of similar characteristics called ecoregions. The four-state mountain area is part of the Dry Domain and has elements of the Great Plains, southern Rocky Mountain Steppe, middle Rocky Mountain Steppe, northern Rocky Mountain Steppe, and Intermountain Semi-Desert and Desert. These elements are the basic components that compose the major habitats of the area and explain the considerable number of mammals, birds, and amphibians found throughout the area. The ecozones, coupled with the U.S. Fish and Wildlife Service's Gap Analysis program—a series of statewide terrestrial vertebrate inventories using GIS and remote sensing techniques to model species distribution and species richness—provide regional details of fauna through the area. The number of terrestrial vertebrates found range from a low of 375 in Idaho to almost 600 in Colorado. The majority of these are bird species (60–70 percent) with mammals (24–28 percent) the next largest category. Amphibians and reptiles are found throughout the region and account for 10–20 percent of the total species. Fish species, though not part of the Gap Analysis, are critical to the region's aquatic ecosystem. There are approximately 30–50 fish species; however, this number will vary based on the dominance of native and non-native varieties.

POPULATION

The Mountain West is one of the fastest growing areas in the United States. Between 2000 and 2005 the population of the United States grew by 5.3 percent while Colorado and Idaho statewide grew by over 8.5 percent, and portions of Montana and

Wyoming grew at rates approaching this number. Typical of the west, populations are centered in urban areas, with extremely low densities found in between the concentrations.

Colorado has the largest population (4.67 million) in the region with the majority along the eastern slope, the Front Range, in Denver (554,636), Colorado Springs (360,879), and Aurora (276,393). Idaho's population (1.43 million) is more dispersed across the state, but it is still in urban areas with Boise in the west-central portion the largest (185,787) and the other cities located in the central portions of the state: Nampa (51,867), Pocatello (51,466), and Idaho Falls (50,730).

The highest density of large cities in Montana (935,670) are along the eastern slopes of its western mountains; Missoula (57,053), Great Falls (56,690), and Butte–Silver Bow (34,606). Montana's largest city, Billings (89,847), is located in the west-central plains. Wyoming has the smallest population (509,294) with only Cheyenne (53,011) and Casper (49,644) as population centers. However, the next tier of cities is dispersed across the state with no concentrations except along the historic railroad lines. The population migration into the Mountain West is predominately to the urban areas; however, rural second homes are scattered in the more recreation- and amenity-oriented landscapes.

ECONOMY

Historically, mining, agriculture, forestry, and ranching were the focus of economic activities in the Mountain West. However, as the population shifted to urban areas in the mid-20th century, city-centered economic activities began to increase in importance. The U.S. Bureau of Economic Analysis identifies 10 major domestic production activities: Agriculture, forestry, fishing, and hunting; mining; utilities; construction; durable goods manufacturing; nondurable goods; wholesale trade; transportation; information; and fire. Of these activities, three categories can be considered non-urban: Agriculture, forestry, fishing, and hunting; transportation; and mining. As a percent of the total gross domestic production, agriculture, forestry, fishing and hunting are a major production activity in Montana and Idaho (eight to nine percent), while mining is dominant in Wyoming (47 percent) and important in Colorado and Montana (eight to nine percent). Transportation is also significant in Wyoming and Montana (nine percent). In all four states, recreation is a very important component of the economy, though it is not considered a production activity but rather a service industry. These activities are important because of the amount of land they require and their role in the domestic economy. Crop and grazing lands dominate the landscape in all four states, with forested areas the next largest category.

PUBLIC AND PRIVATE LANDS

The Mountain West is part of the transition area between the dominance of public and private land ownership. To the east, the majority of the lands are in private ownership, while to the west and south more of the land is in public ownership. This is an important factor because as more lands become public, it decreases the potential for private enterprise, but increases protection of natural resources. Idaho has the highest percent of public lands (50 percent), mainly in the northern half of the state. Wyoming (42 percent), Colorado (37 percent), and Montana's public lands are located in the western portions of each state. Each of the four states has approximately the same amount of public lands, between 38–43,700 square miles (98–113,000 square kilometers), however, because of their size differences, the percentages change. The public lands are managed by several federal agencies, mainly the U.S. Forest Service, the U.S. Bureau of Land Management, the U.S. National Park Service, and the U.S. Fish and Wildlife Service.

There are 50 national forests, 34 national parks, national historic sites, national trails and national monuments, and five national recreation areas distributed between the four states. Lands managed by the Bureau of Land Management (BLM) are generally distributed in the plains and plateaus between the mountains, sometimes referred to as the "checker-board" area, for the pattern of every other land section (one square mile).

The diversity of the landscape, variety of fauna and flora, and the importance of water resources make the Mountain West one of the most vital areas to the United States. The physical amenities and natural resources of the Mountain West will continue to attract people for residency, employment, or recreation. However, the intensity of activities has the potential to have large impacts on the environment. The conservation management of federal lands, the responsibility of private enterprise to sustain the environment, and the participation of local citizens to monitor their impacts can mitigate these impacts. The types of interactions between the environment and the population are critical to sustain this area for future generations.

SEE ALSO: Mountains; National Parks; Prairie; Rivers; Rocky Mountains; Rural Gentrification; Tourism.

BIBLIOGRAPHY. R. Bailey, *Ecoregions of the United States* (U.S. Department of Agriculture, U.S. Forest Service, 1980); J.S. Baron, ed., *Rocky Mountain Futures: An Ecological Perspective* (Island Press, 2002); D. Blood, *Rocky Mountain Wildlife* (Hancock House Publishers, 1976); C. Hunt, *Physiography of the United States* (W.H. Freeman and Co., 1967); L. Kershaw, A. MacKinnon, and J. Pojar, *Plants of the Rocky Mountains* (Lone Pine Publishing, 1998); D.H. Knight, *Mountains and Plains: The Ecology of Wyoming Landscapes* (Yale University Press, 1994); M.J. Mac, P.A. Opler, C.E. Puckett Haecker, and P. D. Doran, *Status and Trends of the Nation's Biological Resources* (U.S. Department of the Interior, U.S. Geological Survey, 1998); W.D. Thornbury, *Regional Geomorphology of the United States* (John Wiley & Sons, Inc., 1965).

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United States, Northeast

THE NORTHEASTERN UNITED States is often referred to as New England and includes the states of Maine, Massachusetts, New Hampshire, and Vermont. Most of the area is part of the northern end of the Appalachian Mountains where winters are cold and snowy. The states that occupy the region were settled by the Puritans and their descendants. Other immigrant groups have also come in the 19th and 20th centuries from Ireland, Portugal, Italy, and French-speaking Canada

Maine is in the northeast corner of the United States and is the largest of the New England states. Its city of Eastport is the most easterly of all American cities. Along with New Hampshire and Massachusetts, Maine is bound by the Atlantic Ocean on its eastern side. On the west, it is bounded by New Hampshire and by the Canadian province of Quebec. The Canadian province of New Brunswick bounds it on the northeastern side.

Maine's coast is in the first of three land regions, which are the Coastal Lowlands, the Eastern New England Upland, and the White Mountain Region. The Coastal Lowlands extend from the Atlantic coast between 10 and 40 miles inland and form a strip along Maine's Atlantic shoreline. It is part of a larger region of land that stretches along the entire New England coast.

The Coastal Lowlands area does not rise much above sea level. It has broad sandy beaches that give way to salt marshes. During earlier ice ages, it was depressed from much greater heights by the great weight of glaciers. The southern part of Maine's coast has numerous sandy beaches. Old Orchard Beach is a hard packed sandy beach that is 11 miles (18 kilometers) long. It is one of the longest of all sandy beaches on the Atlantic coast of the United States. The coast is a lowland area in which farming of cranberries, blueberries, beef cattle, and poultry is done. The northern part of the Coastal Lowlands is rocky and dominated by high cliffs. Deposits of sand, gravel, granite, and limestone are mined for construction and other uses.

Maine is best known for its rocky northern coast. Along the Maine coast are over 400 islands that are from two to 25 square miles (five to 65 square kilometers) in size. There are also thousands of smaller islands. The largest is Mount Desert, which is about 100 square miles (260 square kilometers). There are numerous ports with deep water where ships harbor along Maine's 3,000-mile long coastline. Fishing for lobster and other deep sea fishing are major industries.

The Eastern New England Upland area occupies the middle part of Maine. It is a belt between 20 and 50 miles (32 to 80 kilometers) wide and is part of an uplifted shelf that extends from Connecticut to Canada. The northern area covers Maine's entire border with New Brunswick except for the thin Coastal Lowlands strip. Some areas of this region are several thousand feet above sea level. Dairy and beef cattle are raised in the area. The Aroostook Plateau in the northeast has deep, fertile soil; excellent for farming, it has made Maine famous as a potato producing state. Forestry is important in the region as it is in other parts of Maine. Its mountains look green all year long because of the vast number of trees covering nearly 90 percent of the state. The Eastern New England Upland area has a great number of lakes south of the Aroostook Plateau. In the center of the Upland area, mountains cut across, as do swift-moving steams fed by melting snows.

The White Mountain Region occupies western Maine. It extends into New Hampshire and Vermont. In the north, the region is only about five miles (eight kilometers) wide. In the south, it is 30 miles (48 kilometers) wide. Logging is a major occupation in the area. Maine's tallest mountains and hundreds of lakes occupy the area's valleys. Mount Katahdin, rising to 5,268 feet (1,606 meters), is the highest mountain in Maine. In addition, 97 other mountains exceed 3,000 feet (910 meters). Among the region's wildlife are moose, beavers, foxes, lynxes, martens, minks, raccoons, black bears, deer, and over 300 kinds of birds. The climate in the region of the White Mountains is cool to cold because of Arctic or coastal sea winds. Snow covers the region in winter making skiing a popular sport in Maine, Vermont, and New Hampshire.

Vermont is about 160 miles long and 80 miles wide. Vermont covers 9,615 square miles (24,900 square kilometers). Its land regions are mostly mountainous. Northeast Highlands are part of an area shared with Maine and New Hampshire. The area is covered by mountains composed of granite, which rise from 2,700 to 3,300 feet (823 to 1,010 meters) above the sea level of the Atlantic coastline. Gore Mountain, at 3,330 feet (1,015 meters), is the tallest. The Northeast Highlands area is cut with many fast-flowing mountain streams.

The Western New England Upland region covers most of the eastern part of Vermont. The area extends into Western Massachusetts and is also called the Vermont Piedmont. Part of the area is composed of broad farmlands with streams that flow into the Connecticut River Valley. Farming in the valley produces apples, strawberries, and other crops. The lowlands of the Western New England Upland contain numerous lakes in the northern area. The region rises to the west in the western hills, which connect with granite outcroppings. These turn into granite hills along the boundary with the Green Mountains.

The Green Mountains region is a spine covering central Vermont. The highest peak, Mount Mansfield, is 4,393 feet high (1,339 meters) and a number of other peaks are nearly as tall. Because of the beauty and the winter snows, the region is the center of Vermont's tourist industry. It is also an area that is logged for timber and mined for a variety of minerals. In the north, the Green Mountains decline to become lower mountain ranges. In southern Vermont between the Green Mountains and the Taconic Mountains is the Vermont Valley. The valley is narrow with small rivers and river valleys that stretch for miles north from Massachusetts into central Vermont. The Baton Kill and Waloomsac rivers flow through the Vermont Valley.

The Taconic Mountains cover a narrow strip in southwestern Vermont. Equinox Mountain (3,816 feet), Dorset Peak (3,770 feet), Little Equinox Mountain (3,320 feet), Mother Myrick Mountain (3,290 feet), and Bear Mountain (3,260 feet) are found in the Taconic Mountains of Vermont from which flow swift streams into areas with beautiful lakes. The Champlain Valley borders Lake Champlain in northwestern Vermont. The area is sometimes called the Vermont Lowland—a fertile area that is farmed extensively with dairy operations. It also has numerous apple orchards surrounded by corn, hay, oats, and wheat fields. Burlington, Vermont's largest city, is located in the region.

New Hampshire is about 190 miles long and 70 miles wide. Canada forms its northern border and Massachusetts is on its southern border. In the east, New Hampshire has a short coastline on the Atlantic Ocean. Maine lies to the east and the Vermont state line marks its western boundary. New Hampshire covers 9,351 square miles (24,100 square kilometers). There are three land areas in New Hampshire.

The coastal lowlands are in the extreme southeastern corner of the state and are part of the larger

New England Coastal Lowlands. The area extends inland from about 15 to 20 miles (24 to 32 kilometers). The coastal area has a number sandy beaches that are used for recreation. Great Bay on the coast is a stopover for migratory birds, especially geese and ducks. The rivers of the area have been a source of water power in the past.

The two remaining regions are the Eastern New England Upland and the White Mountains, which are divided by the Merrimack River that rises in the White Mountains and flows across the upland area and empties into the sea near Boston, Massachusetts. The Upland region covers most of the southern, western, and eastern parts of the state. The Connecticut River Valley forms its western boundary. The Hills and Lakes area surrounds the Merrimack River on the west, east, and northern sides. The White Mountain Region is in the northern part of the state. It is a rugged mountain range, heavily forested with spruce and fir and yellow birch. Mount Washington (6,288 feet) is the tallest in New England and is famous for extreme weather. In 1934, the Mount Washington Observatory recorded winds at 231 miles per hour.

Massachusetts is 190 miles long and 50 miles wide at its most distant points and covers 8,284 square miles (21,456 square kilometers), excluding nearly 1,000 square miles of coastal water areas. New Hampshire and Vermont border Massachusetts in the north. It is bordered in the south by Connecticut and Rhode Island. The Atlantic Ocean forms the east coast and New York forms the western border. The coastline is 192 miles (309 kilometers) long.

Massachusetts has six land areas. In the east is the Coastal Lowlands region. It makes up the eastern third of the state. This area includes the long sandy peninsula of Cape Cod, Nantucket Island, Martha's Vineyard, the Elizabeth Islands, and other smaller islands. The region is a popular summer resort and has several excellent harbors including Boston. Swampy areas are found along the coast. At the end of the last ice age, glacial deposits were left to dot the area. The middle of Massachusetts is covered by the Eastern New England Upland extending from Maine to New Jersey. The Massachusetts portion is about 50 miles wide. Moving westward, the area rises to 1,000 feet in height (300 meters) and then gradually slopes westward to the Connecticut River Valley. The Connecticut Valley, drained by the Connecticut River, is long and narrow. It is about 20 miles (32 kilometers) wide and has rich soil and mild temperatures that make it productive farmland. The Western New England Upland is the major area west of the Connecticut River Valley. It is about 20 to 30 miles (32 to 48 kilometers) across from the Connecticut Valley to the Berkshire Valley. The Berkshire Hills area is an extension of the Green Mountains of Vermont. The Berkshire Hills are over 2,000 feet (610 meters) in height. The northern part of the Upland region near Vermont has the highest mountains in Massachusetts, such as Mount Greylock, at 3,487 feet (1,064 meters) above sea level. The narrow Berkshire Valley lies between the Berkshire Hills and the Taconic Mountains; its green pastures make it a major dairy area. The Taconic Mountains of Massachusetts are the sixth landform. They were formed during the late Ordovician Period (440 million years ago).

SEE ALSO: Atlantic Ocean; Beaches; Coastal Zone; Fisheries; Lakes; Mountains; Potatoes; Rivers; Tourism.

BIBLIOGRAPHY. Rennay Craats, *Guide to New Hampshire* (Weigl Publishers, Inc., 2001); Gene Daniell, ed., *White Mountain Guide* (Appalachian Mountain Club Books, 2003); Green Mountain Club, *Long Trail Guide: Hiking Vermont's High Ridge* (Green Mountain Club, Inc., 2003); John O. Hayden, *50 Hikes in Vermont: Walks, Hikes, and Overnights in the Green Mountain State* (The Countryman Press, 2003); Christopher J. Lenney, *Sightseeking: Clues to the Landscape History of New England* (University Press of New England, 2003); Terrell S. Lester et al., *Maine: The Seasons* (Knopf Publishing Group, 2001); John H. Long, ed., *Connecticut, Maine, Massachusetts, Rhode Island: Atlas of Historical County Boundaries* (Scribner, 1995); Paul M. Searls, *Two Vermonts: Geography and Identity, 1865–1910* (University of New Hampshire Press, 2006); Tom Seymour, *Foraging New England: Finding, Identifying, and Preparing Edible Wild Foods and Medicinal Plants from Maine to Connecticut* (Falcon Press Publishing, 2002); Christina Tree and Diane E. Foulds, *Vermont: An Explorer's Guide* (The Countryman Press, 2003).

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United States, Pacific Northwest

THE PACIFIC NORTHWEST is a region of varied landforms and differing climatic conditions consisting of two states: Oregon and Washington. As of 2005, Oregon is 98,386 square miles and ranks as the 9th largest state; it has an estimated population of 3,641,056 and is the 27th most populated state. Also as of 2005, Washington is 71,303 square miles and ranks as the 18th largest state; it has an estimated population of 6,287,759 and is the 15th most populated state. Both states are located on the west coast of North America within a latitudinal band containing a humid coastal climate. Precipitation amounts are particularly high along the coasts of both states and especially on the windward slopes of the Coastal Range and the Cascade Mountains. High pressure over the eastern Pacific Ocean blocks the moist air from moving farther south. This guarantees maximum precipitation along the coastal areas of Oregon and Washington. On some occasions, the amount of rainfall can be extraordinarily excessive and flooding can be a serious problem. In November 2006, areas of western Washington received over 15 inches of rainfall, an amount that brought severe flooding to homes and businesses. Televised news accounts showed automobiles and even houses caught up in fast moving rivers. Earthquakes are not infrequent, and the massive eruption of Mount St. Helens in the 1980s is a reminder of the dynamic geological nature of the region.

To the east of the prominent north-south trending mountain ranges, precipitation diminishes significantly. The coastal areas of the two states receive between 60 and 80 inches of precipitation annually while areas inland range from 10 to 20 inches annually. In fact, both states contain areas of true desert in their eastern areas. Vegetation in the region includes Douglas fir, redwoods, spruce, red cedar, and hemlock within the alpine coniferous forest. Grasslands are found within the steppe east of the mountains.

The Pacific Northwest was identified by Joel Garreau in his 1981 book *The Nine Nations of North America* as lying within two regions: Ecotopia, a borrowing from a 1975 book of the same name by Ernest Callenbach, and the Empty Quarter, an expanse of the interior stretching from the border with New Mexico north through the arid and mountainous western United States and into Canada and Alaska. The Empty Quarter is characterized by having the lowest population densities of any area of comparable size on the continent. The term *Ecotopia* is derived from Callenbach's combination of the two words *ecological* and *utopia*. The term characterizes well the attitudes of the people in the region and identifies their love of nature and overwhelming support of environmental awareness and protection. The coastal area has also been called "Cascadia" after the Cascade Mountains and because of the multitude of rivers flowing out of the highlands into the Pacific Ocean.

The fast flowing and voluminous rivers in the region are valuable sources of power for the generation of electricity. Within the Columbia Basin, hydroelectric power is used in the processing of aluminum, a metal used extensively in the manufacture of airplanes. With several major operations of the Boeing aircraft company being located in the Puget Sound region, it comes as no surprise that this world class manufacturer of airplanes is the most important customer for aluminum produced locally. Accessibility to substantial amounts of aluminum within the Pacific Northwest is one reason why Boeing remains within this region despite its significant number of rainy days each year, a climatic condition not ideal for operating aircraft.

The Pacific Northwest was visited by Western explorers and settlers much later than other regions in North America. In 1778, Captain James Cook explored along the Pacific Coast in search of the long-sought Northwest Passage. The historic Lewis and Clark expedition of 1806 was the first to enter the region by land. A number of American Indian groups were encountered by early explorers in the region. Among them were the Klamath, Nez Perce, Bannock, and Chinook. By the 1840s, settlers were arriving by way of the Oregon Trail, an activity that waited until a boundary dispute with the United Kingdom could be resolved. Railroad construction in the 1880s brought a much-needed surface connection to points east for the shipment of the region's first important products: Lumber and wheat.

Industrial production in the Pacific Northwest received a powerful impetus with the opening of the

Bonneville Dam in 1943. Power generation from this structure allowed for the expansion of existing industries and development of new ones. Water control also assisted in the expansion of the agricultural sector in the region. The variety of agricultural products grown in the region rivals the variability of the landforms. Washington alone ranks highly in an abundance of food products. Prominent in its product inventory are hops, spearmint oil, lentils, peas, cherries, plums (and prunes), onions, cranberries, strawberries, grapes, carrots, potatoes, apricots, asparagus, and apples.

Agriculture in Oregon's fertile Willamette Valley is equally productive. Cattle raising, dairy operations, apples, peppermint, and potatoes are just a few of the important agricultural products in the state. Both states are important in lumber production but controversies over the years about harvesting, clear cutting, and alleged mismanagement of the resource have clouded the industry. Salmon fishing has long been an economic mainstay in the Pacific Northwest. The country's third major wheat growing area is on the Columbia Plateau. The area is referred to as the "Palouse" and both spring and winter wheat is grown there.

Lumber operations have been a constant economic activity in the region. Emerging from this industry in recent years is a burgeoning furniture manufacturing complex. The wood products industry employs over 50,000 workers, many of them in the booming furniture-manufacturing sector. Perhaps the greatest single economic endeavor has been the emergence of Microsoft under the leadership of Bill Gates, an unparalleled software producing operation that has made Gates the richest man in the world. But Gates is not alone in acquiring a massive fortune. The Puget Sound area in Washington is reportedly the home of more billionaires than any other place in the world. The accumulation of wealth from fast growing computer enterprises has created something of a rich man, poor man society in which the gap between the haves and have-nots is increasing.

A prominent urban corridor, or conurbation, has grown over the years in the intermountain valleys from Eugene, Oregon north to Seattle and beyond to Vancouver, British Columbia. This corridor is home to nearly eight million people in Oregon and Washington. Its annual economic output exceeds $200 million and represents a wide range of industrial and service activities. The corridor has become an important center for electronics and computer related activities, which is a reflection of the emerging information age seen in many regions of the United States. The region is also a favored retirement location for people seeking an association with both true wilderness and the dynamic of a stimulating and ecologically aware urban populace.

Seattle is the region's largest city, a claim it has held since the late 19th century when the region became an important supplier of lumber and wheat to the rest of the country. Initially, Seattle was a logging center but it quickly gained in prominence as a regional growth center once it was included in the national railroad system. The rise of Boeing has guaranteed Seattle a measure of urban prominence since the 1920s. Portland, Oregon has access to the interior by way of the Columbia River Valley. As such, it has long been an important shipping point for food products to the interior and to overseas locations. Both Seattle and Portland have populations in excess of one million. In many ways the Pacific Northwest is more closely tied to other Pacific Rim countries than to points east in the United States and Canada, an attribute shared with California and British Columbia. Trade with Japan, China, and countries in southeast Asia continues to increase every year.

SEE ALSO: Desert; Hydropower; Lewis and Clark Expedition; Mountains; Northern Spotted Owl; Pacific Ocean; Salmon; Timber Industry.

BIBLIOGRAPHY. Ernest Callenbach, *Ecotopia* (Bantam Books, 1975); David Peterson Del Mar, *Oregon's Promise: An Interpretive History* (Oregon State University Press, 2003); Jane Claire Dirks-Edmunds, *Not Just Trees: The Legacy of a Douglas-fir Forest* (Washington State University Press, 1999); John C. Hudson, *Across This Land: A Regional Geography of the United States and Canada* (Johns Hopkins University Press, 2002); Philip L. Jackson and A. Jon Kimerling, eds., *Atlas of the Pacific Northwest*, 9th ed. (Oregon State University Press, 2003); Hill Williams, *The Restless Northwest: A Geological Story* (Washington State University Press, 2002).

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United States, Southeast

THE SOUTHEASTERN STATES of Georgia, South Carolina, North Carolina, and Virginia border the Atlantic Ocean on their eastern shores. Georgia is the southernmost state in the region and borders Florida. Virginia is the northernmost and borders Maryland to its north and east.

The general geography of these states comprises three parts. Each has a coastal plain that begins at the Atlantic Ocean and which extends west to a second area—a plateau region called the Piedmont. The third region is the Appalachian Mountains, which run from Canada to Georgia.

Each of these states is traversed by rivers that flow from the mountains to their Atlantic coast. The rivers were the highways used by the pioneers after the beginning of settlements as they moved westward to eventually across the mountains. In Virginia, the rivers all flow into the Chesapeake Bay. From north to south, the rivers are the Potomac, the Rappahannock, the York, and the James. These rivers all have important tributaries upstream.

The Chesapeake Bay is a vast estuary surrounded by Virginia and Maryland. It begins with the entrance of the Susquehanna River into its northernmost reaches. The Susquehanna's watershed feeding into the Chesapeake includes parts of New York, Pennsylvania, Maryland, the District of Columbia, and West Virginia. The length of the Chesapeake is 455 miles (304 kilometers) from the Susquehanna River's entrance south to the Atlantic Ocean. Geologists believe that the bay was formed at the end of the Eocene era when it was hit by a major bolide at the lower end of the Susquehanna about 35 million years ago. The Chesapeake is relatively shallow with brackish water. The word *Chesapeake* is an Algonquin word for shellfish, which abound in the bay along with oysters, crabs, and numerous species of fish. Most of the bay is surrounded by Virginia. The James, York, Rappahannock, and Potomac Rivers form peninsulas extending into the bay. The Northern Neck is the peninsula formed by the Potomac and the Rappahannock Rivers. The York and the Rappahannock form the Middle Peninsula. The James and the York Rivers form The Peninsula. The James is the longest river in Virginia with a length of 340 miles. The climate of the Chesapeake Bay is humid and subtropical. It has hot, humid summers and mild, rainy winters. However, severe winters do occasionally occur in which the more brackish parts of the tributary rivers freeze over solid enough for lightweight automobiles to drive across. The Virginia eastern side of the Chesapeake Bay is called the Eastern Shore. It forms a fourth peninsula with its eastern side on the Atlantic Ocean and its western side on the Bay.

Hampton Roads Harbor is located at the southern end of the Chesapeake Bay and is one of the world's best natural harbors. South of it along the Virginia–North Carolina border is the Dismal Swamp. The swamp is a large wetlands area with a rich variety of wildlife such as Virginia deer, rabbits, raccoons, foxes, bobcats, bears, and numerous species of birds, snakes, frogs, and turtles. A portion of the swamp has been preserved in far southeastern Virginia and northeastern North Carolina as the Great Dismal Swamp National Wildlife Refuge. Attempts to drain, log, and farm the Dismal Swamp were made in colonial times, but for the most part it is still in primitive condition. In its center is Lake Drummond. Its soils are so complicated by organic materials that crops from its soils have produced unusual results, such as mottled colors in cotton.

The Atlantic Coastal Plain in all of the southeast states extends inland until it reaches the Fall Line. Ships can navigate the rivers from the ocean to the Fall Line, where rocky rapids make anything but limited journeys by canoe almost impossible. The Atlantic Coastal Plain widens from north to south because the Appalachian Mountains run from northeast to southwest. It is broadest in Georgia where it crosses into Florida, and as it moves westward across south Georgia, it becomes the Gulf Coastal Plain that extends into Texas as far south as the Rio Grande River and westward to Del Rio. In the southeast, the Atlantic Coastal Plain was at the time of the first English settlements covered with forests that were a mixture of pines and a variety of deciduous trees. These were, and still are, harvested for use in paper pulp production and furniture making. The soil is usually sandy loam because the sand was deposited when the area was under the Atlantic Ocean. In South Carolina and in some places in Georgia, there are sand hills that are the ancient sand dunes of the ocean. The Atlantic Coastal Plain is farmed extensively making use of modern chemical fertilizers. Bright-leaf tobacco, peanuts, cotton, corn, sweet potatoes, and, in recent decades, soybeans have become common crops. Large numbers of hogs are also raised.

In North Carolina, the eastern part of the state juts into the Atlantic Ocean. A spear point of barrier islands called the Outer Banks protects the coastline. They have three capes: Cape Hatteras, Cape Lookout, and Cape Fear. The beaches on the Outer Banks are popular tourist destinations and are the site of frequent storms that have wrecked many ships. Between the Outer Banks and the mainland are a number of islands and vast lagoons. Albemarle Sound and Pamlico Sound are the largest of the brackish water lagoons. They are fed by the Chowan, Roanoke, Neuse, and Tar Rivers. The mainland coast is a low swampy tidewater area.

The land rises between Wilmington at the head of the Cape Fear estuary and Georgetown, South Carolina. In South Carolina, the long bay from the North Carolina state line to beyond Myrtle Beach forms an extensive beach resort area. Between Georgetown and Charlestown there are barrier islands such as Paley's Island and swampy areas that were, until the advent of mechanized rice farming in Texas and Louisiana, major rice growing areas.

The coast of Georgia is home to a number of barrier islands including Sea Island and Cumberland, which is a natural preserve. Inland, the Atlantic Coastal Plain in Georgia is lightly populated. The region is farmed and forested with loblolly pines, which are logged for pulpwood and, in some areas, worked to gather pine rosin.

Just north of the Florida state line lies the Okefenokee Swamp, which has been a national wildlife refuge since 1936. It covers an area of 438,000 acres, which is about 38 miles long by 25 miles wide. The Okefenokee Swamp occupies a vast peat bog that lies in a saucer-shaped depression. Until 7,000 years ago, the depression was part of the ocean floor. The Suwannee River (280 miles long) rises in the swamp, flows west out of Georgia to cross Florida, and empties into the Gulf of Mexico near Cedar Key. The Okefenokee teems with wildlife and is famous for it numerous alligators. The areas to the west and south are very lightly populated and heavily forested.

The Burning of Atlanta

When the American Civil War broke out, Atlanta was a major railway junction and the 12th largest city in the Confederacy. Its cotton warehouses were quickly put to use by Confederate quartermasters to store war materiel for the Confederate armies, and the Atlanta Rolling Mill was used to make iron-plating, including for the CSS *Virginia*. The Confederates had planned to fortify Atlanta, but it was extremely difficult. Lemuel Grant, a local businessman, did built redoubts on some of the approaches to the city. The interlinked earthworks and trenches could not stop a determined Union attack.

In 1864, the Union forces did attack Atlanta, and on September 1, the Confederate General John Bell Hood, after holding out for four months, was forced to evacuate the city. Before he did so, he gave orders for public buildings to be destroyed. General William Sherman of the Union forces then captured the city. He occupied it for two months, and then, as he left, he ordered out the civilian population and gave his men instructions to burn the city down. As he later described it, "Behind us lay Atlanta, smouldering and in ruins, the black smoke rising high in the air, and hanging like a pall over the ruined city." He spared only the churches and hospitals.

The burning of Atlanta, made famous around the world by the book and film *Gone with the Wind*, was not just a random act of revenge against a city that had provided so much support for the Confederacy. It also came soon after Lincoln had won the 1864 presidential election, with Lincoln facing a Democratic platform that was urging for a truce to end the war.

The Atlantic Coastal Plain changes into the Gulf Coastal Plain as it moves westward. It ends in Georgia at the Chattahoochee River, which is the boundary between Georgia and Alabama for the southern half of the state. The Chattahoochee changes its name to the Apalachicola River when it enters

Florida. In all of the southeastern states, the Atlantic Coastal Plain extends west and southwestward and gradually rises until it meets the Fall Line.

The Fall Line marks the beginning of the Piedmont Plateau. The region varies in elevation but is generally from 200 feet to 1,000 feet above sea level. In the western areas, some individual hills rise to over 2,000 feet in height. Along the Fall Line are a number of cities that grew up to take advantage of the waterpower at the rapids. Among the important cities on the Fall Line are Richmond, Petersburg, Raleigh, Columbia, Augusta, Macon, and Columbus. The Piedmont Plateau has two major sub-regions. The Outer Piedmont is the lower-level section while the Inner Piedmont is the higher portion that is close to the Appalachian Mountains. The soils of the Piedmont are often thick red clay. The red clay is high in iron content and permanently stains white garments. It is fertile, especially if organic material is applied as a soil conditioning mulch. The red soil is like that found in Africa from which this part of North America split off millions of years ago.

The Piedmont was settled by Scotch-Irish pioneers before the American Revolution. The population has changed a lot due to immigration from other population stocks, including African Americans. Cotton, corn, livestock, and some tobacco varieties have remained staple crops. However, most of the people now work in cities or factories, as farming has become more a matter of contract operations, such as chicken production. Plantations were developed on the Atlantic Coastal Plain but rarely were there large farms in the Piedmont.

The Piedmont Plateau is fairly level, but desiccated by rivers and streams. Numerous rivers that flow across it include the Broad, the Catawba, the Yadkin in North Carolina, which is called the Pee Dee River in coastal South Carolina, and the Savannah, which divides Georgia and South Carolina. The Chattahoochee River rises in Habersham County, Georgia, and crosses the plateau to supply Atlanta with water and then flows almost due south to the Gulf of Mexico. The dam at Buford, Georgia, that impounds Lake Lanier is like that of other dams and lakes on the rivers of the Piedmont region: It supplies water, generates electrical power, and provides water sports recreation.

The rocks in much of the inner Piedmont are usually igneous. A unique example of the igneous rock is Stone Mountain in Georgia, which is a granite monolith or dome. It rises above the surrounding Piedmont Plateau to a height of 1,683 feet (512 meters) above sea level. Running north of Atlanta through South Carolina and North Carolina is a belt of igneous rocks that are usually granite from subterranean volcanic action millions of years ago, including the granite at Elberton, Georgia, which is quarried extensively.

The transition from the Piedmont plateau to the Appalachian Mountains is an abrupt shift to the Blue Ridge Mountains, which run from Georgia to Pennsylvania. They form the eastern front of the Appalachians and are usually composed of metamorphic rocks, some of which are igneous and some sedimentary. They are among the oldest mountains in the country. The Blue Ridge Mountains are heavily forested in deciduous trees, and pines of various types also grow in abundance. Bears, wild cats, and other animals inhabit its cool woods.

Beyond the Blue Ridge Mountains is the Ridge and Valley Region. Long ridges, usually of metamorphic or sedimentary rock, run from northern Alabama to New York. Between the ridges are valleys that are usually flat and fertile. The rock may be sandstone or limestone. Because of the folding of the ridges, metamorphism is common. Marble is found at Tate, Georgia, and other minerals such as coal are found in the sedimentary areas.

Many of the Southern Appalachians are over 5,000 feet high. Because the temperature is cooler, they have attracted visitors seeking relief from the summer heat in the Atlantic Coastal Plains or the Piedmont. The higher elevations have flora that is similar to southern Canada.

SEE ALSO: Appalachian Mountains; Atlantic Ocean; Coastal Zone; Dunes; Estuaries; Oceans; Rivers.

BIBLIOGRAPHY. Peter Alden et al., *National Audubon Society Field Guide to the Southeastern States: Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee* (Knopf Publishing Group, 1989); Wilber H. Duncan and Marion B. Duncan, *Trees of the Southeastern United States* (University of Georgia Press, 2000); Keith Frye, *Roadside Geol-*

ogy of Virginia (Mountain Press Publishing, 1986); Scott Weidensaul, *Mountains of the Heart: A Natural History of the Appalachians* (Fulcrum Publishing, 1994); Sarah Bird Wright, *Islands of the South and Southeastern United States* (Peachtree Publishers, 1989).

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United States, Southwest

THE SOUTHWEST IS an arid region of high surface relief and relatively low population density. The four states within the region are Arizona, Nevada, New Mexico, and Utah. As of 2005, Arizona is 114,006 square miles and ranks as the 6th largest state; it has an estimated population of 5,939,292 and is the 18th most populated state. Nevada is 110,567 square miles and ranks as the 7th largest state; it has an estimated population of 2,414,807 and is the 35th most populated state. New Mexico is 121,593 square miles and ranks as the 5th largest state; it has an estimated population of 1,928,384 and is the 36th most populated state. Finally, Utah is 84,904 square miles and ranks as the 13th largest state; it has an estimated population of 2,469,585 and is the 34th most populated state. As the numbers indicate, all four states are relatively large in area and rank low in population. Each of these states has its own unique physical and cultural characteristics and all of them share certain attributes as well. The four-state region is part of the larger area characterized as the Empty Quarter by journalist Joel Garreau in his 1981 book *The Nine Nations of North America* because of its low population densities.

The region is representative of the widespread dry climates of the western United States. Specifically, each of the states has extensive areas of desert, steppe, and undifferentiated highlands. Seasonal temperature regimes range from cool to cold winters and mild to cool summers and much of the variation is attributable to changes in altitude. Precipitation is decidedly on the low side with some areas receiving less than 10 inches per year and others averaging between 10 and 20 inches per year. Vegetation found in this four-state region includes broadleaf deciduous and a variety of coniferous species including ponderosa pine, piñon, and juniper. The latter two tend to grow within the same location resulting in extensive areas of piñon and juniper forests. Unique within the region is the saguaro cactus found in Arizona and northern Mexico. The saguaro cactus grows upward of 12 feet or more and has curving branches, white flowers, and an edible red fruit. The soils in the region are primarily aridisols reflective of the dry climate and mountain soils found within its many uplands and mountainous areas. The region is marked by decidedly rugged and angular mountainous terrain. This characteristic is due to the relative geologic youth of mountains in the west, which have yet to become eroded and rounded like the Appalachian complex in the east.

Culturally, the region is quite diverse. Anglo, Latino, and Native American peoples have coexisted for years within this four-state region. The Native American cohort was, of course, the first inhabitant and its tenure in the region dates back over 10,000 years. Latino presence dates from the early years of Spanish exploration in the 17th century. The Anglo contingent arrived during the western expansion in the mid-19th century.

Perhaps the earliest formal international land route in North American history was the Camino Real (the Royal Road), which began in Mexico City and followed a generally northward course connecting the capitals of the Spanish colonial territory. The colonial centers and inclusive dates of occupation in New Mexico included San Juan Pueblo (1598–1600) and San Gabriel (1600–09), both places located within a few miles of each other and approximately 50 miles north of Santa Fe, the Spanish colonial capital of longest duration (1609–1821). When Mexico achieved independence, the Camino Real was no longer considered a royal route but was nonetheless used extensively for years to come. The Camino Real entered the region at Ciudad Juárez and El Paso and then followed the rift valley northward through current day Las Cruces, Fort Selden, Socorro, Isleta Pueblo, Albuquerque, Santa Fe, San Juan Pueblo, and San Gabriel. The route followed closely the valley of the Rio Grande River and other land routes of the period. In the modern era, Interstate 25 follows essentially the same route as far as

Santa Fe before turning to the east and then north to Raton before crossing into Colorado.

In the colonial era, Santa Fe was a favored location because of two specific site characteristics: First, the settlement was on the Santa Fe River and close to the Rio Grande, insuring access to reliable water sources; second, with the Sangre de Cristo Mountains to the north and east and the Jemez Mountains 30 miles to the west, it was easily defended from attacks by Native Americans hostile to the Spanish.

Currently, the Native American groups reside primarily on reservations and pueblos within the four-state region. The largest single group is the Navajo, whose homeland is centered in the Four Corners area, the place where four southwestern states meet: New Mexico, Colorado, Utah, and Arizona. Within the Navajo area in northern Arizona is an enclave of Hopi. In addition, there are a number of Apache tribes in New Mexico and Arizona. Utes in Colorado and Papago in southern Arizona are also Native Americans, adding to the cultural diversity within the region. Utah is the homeland of the Mormon religion—the Church of Jesus Christ of Latter-day Saints—and Salt Lake City is the primary metropolitan center in the state.

Economic activity within the region has similarities and some decided differences. In Nevada, where the federal government still owns nearly 90 percent of the land, the forms of agriculture found in the Midwest and other regions to the east did not develop. The Homestead Act in the 19th century, which provided 160-acre parcels of land to prospective farmers, did not fit the vast expanses of arid land within Nevada. Nonetheless, land adjacent to adequate water sources was selected for agricultural pursuits. Agricultural activity within the Phoenix area grew slowly until the advent of the refrigerated railroad car, which allowed for the shipment of fresh and frozen food products nationwide. Concurrent with this important technological innovation was the realization that the Phoenix area was an ideal retirement area and a haven for those suffering from respiratory ailments. Within a few short decades, Phoenix grew dramatically in population. This metropolitan area is also the center for a thriving electronics industry and other high value added manufacturing activities.

Economic activity in Arizona was based on the so-called Five C's: Cotton, copper, cattle, citrus, and climate, with the latter referring to the reputedly ideal weather situation encouraging tourism. Cotton production gradually migrated west out of the old Cotton Belt in the south following the onslaught of the boll weevil early in the 20th century. The warm and sunny environs, especially in Texas and Arizona, were ideal for cotton growing as long as adequate water was available. With irrigation water diverted to this activity and other agricultural products, cotton growing flourished. Copper mining is an important activity as well. In addition to mining the copper ore, the concentrating and smelting of the raw product also takes place close to the mine sites because only a small percentage of the ore has copper within it and it cannot be economically shipped great distances. Cattle is important to the Arizona economy, especially in recent decades during which the building of feed lots near large urban markets occurred concurrently with a significant shift away from open grazing on federal lands. Citrus growing, especially orange groves, grew in prominence in Arizona as the activity gave way to urban development in southern California. Tourism continues to be an important industry in Arizona and throughout the four-state region.

The natural wonders of the Colorado Plateau, a vast area of geologic uplift that saw the rise of Pike's Peak and associated mountains in the state, continue to draw tourists from around the world. The Grand Canyon, Zion, Bryce, Capital Reef, and the Canyonlands region near Moab, Utah, exhibit dramatic eroded sandstone and shale landforms found nowhere else in the world. Also unique are the flourishing clusters of hotels and gambling establishments in Las Vegas, Lake Tahoe, and Reno, which attract hundreds of thousands of tourists annually. Early in its history Nevada became important in mining. Near the end of the 19th century, the famous Comstock Lode played out and the Nevada economy was decimated. By 1910, however, other mining operations began and the future of the state's economy was no longer in danger.

Nevada currently is the center of a controversy focused on the proposed permanent storage of spent radioactive fuels from government projects and over 120 nuclear power plants around the country. Yucca

Mountain, a remote site 100 miles northwest of Las Vegas, was identified in the 1970s by the Environmental Protection Agency as the favored place for the underground storage of the spent nuclear fuel. The proposal has met with considerable objections by environmental groups and the State of Nevada from the onset. Representatives of the state objected strenuously to a Nevada site for disposal because the state has no nuclear plants within its borders. In addition, experts are now suggesting that the whole question of burying nuclear wastes be reexamined to determine if more efficient ways can be found to dispose of this dangerous nuclear by-product. Nevada is also the home of the famous Hoover Dam, a gigantic structure on the lower Colorado River that provides both river control and hydroelectric power within the region and beyond. Hoover Dam is one of a number of major water control structures installed on rivers in the southwest. In recent years, proposals have been made by environmentalists and other scientists that the era of great dams was no longer valid and that plans be made to eliminate the majority of them in the western United States.

The border with Mexico in Arizona and New Mexico has become the center of an international controversy surrounding the illegal immigration of primarily Latinos into the United States. Estimates suggest that as many as one million illegal aliens annually have entered the United States over the last three decades. There is a genuine sociological push-pull process in operation in this movement: The pull is, of course, the perceived economic opportunities within the highly productive and wealthy United States, and the push is the high unemployment and lack of sufficient numbers of jobs within Mexico. The issue has defied mutually agreeable resolution through the years and remains a sore point in U.S. relations with the affected Latin American countries, as well as in domestic politics. There is a tragic aspect to the situation along the border: over the years, perhaps thousands of people attempting to enter the United States have died due to exposure in the inhospitable desert environments. In addition, attempts to smuggle people across the border in packed semi-trailers have resulted in many deaths. The existence of an illegal cross border drug trade only exacerbates an already serious set of problems plaguing the United States and Mexico.

A number of Mexican migrants have moved to the expanding dairy production region of eastern New Mexico. The region has grown dramatically with the purchase of extensive and relatively inexpensive areas of land in the region by Californians interested in establishing dairy operations. In 2005 New Mexico ranked as the fourth largest dairy state in the country. The optimism of the state's dairy industry is best exemplified by its stated goal to surpass Wisconsin and become the leading dairy state in the United States. New Mexico also has extensive grazing opportunities for cattle and sheep. There are even a few llama raising operations in the state.

A variety of agricultural products are grown in sunny New Mexico. Hay predominates and is an essential ingredient in the successful dairy and cattle raising industries. Pecans are grown in the southern part of the state and chiles, both red and green, are found in abundance in New Mexico. In fact, the official state question is "Red or green?" referring, of course, to which chili pepper a customer prefers when ordering a restaurant dish.

Fresh water availability is a constant concern within the region and in contiguous western and Midwestern states. From the mid-1990s to the present, a serious drought has gripped the region. One of the immediate consequences of the drought was the weakening of the piñon and other coniferous trees followed by an invasion of the pine beetle. The insect is able to penetrate the bark of a weakened tree and set up a colony. The response of the tree is literally to shut down its activity. Within four weeks of a pine beetle invasion, the needles on a mature piñon will be brown and the tree dead. It is estimated that virtually all the piñon in Arizona were lost and a good share of the New Mexico stand was similarly affected. Another outcome of the drought impacted the annual and legally required delivery of water from New Mexico to Texas. In order to ensure that the correct amount of water was available, the New Mexico state government purchased agricultural land along the Pecos and took it out of production, allowing for the required delivery of water to Texas.

SEE ALSO: Cattle; Cotton; Desert; Mexico; Mountains; Native Americans; Steppe.

BIBLIOGRAPHY. Clay Anderson, *Arizona Grand Canyon* (Hunter Publishers, Inc., 2001); John C. Hudson, *Across this Land: A Regional Geography of the United States and Canada* (Johns Hopkins University Press, 2002); Donald W. Meinig, *Southwest: Three Peoples in Geographical Change, 1600–1970* (University of New Mexico Press, 1988); John A. Murray, *Cactus Country: An Illustrated Guide* (National Book Network, 1997); National Park Service, *El Camino Real de Tierra Adentro: National Historic Trail* (U.S. Department of the Interior, 2002).

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United States, Texas

TEXAS IS THE largest of the continental 48 American states. It lies at the western end of the Gulf of Mexico and the Southern Gulf Coastal Plain. It is also at the southern end of the North American Great Plains. The state is 266,807 square miles (691,030 square kilometers) and it extends over 800 miles from the Texas state line with Louisiana near Beaumont to El Paso in the west, which is close to New Mexico. It extends 737 miles (1,186 kilometers) from its northern extreme near Dalhart in the panhandle to its southernmost point near Brownsville on the Rio Grande River, which separates it from Mexico.

The topography of Texas can be compared to four steps. Beginning at sea level at the Gulf of Mexico the land slowly rises until it meets the second step at the Edwards plateau, which holds the Texas Hill Country. The third step is the Stockton plateau and the High Plains. The fourth step is at El Capitan (8,751 feet or 2,667 meters), which is part of the Guadalupe Mountains and the Rocky Mountains in El Paso.

There are five land regions in Texas. The Gulf Coastal Plain includes the coast, which stretches 367 miles (591 kilometers) from Louisiana to Mexico. It is a region of marshes, coastal wetlands, bays, tidal flats, marshes, dunes, beaches, coastal prairies, and barrier islands. Texas's barrier islands protect the mainland from tidal surges during the hurricanes that come every summer or so. These barrier islands, lagoons, and bay shores were the home of the Karankawa Indians at the time of the arrival of the Spanish and later European explorers. There are 17 barrier islands, five of which are major islands. These islands include Galveston, Padre, Mustang, and Matagorda. Much of Padre and Matagorda are still pristine preserves. The Aransas National Wildlife Refuge, which includes part of Matagorda, is the winter home of the endangered Whooping Crane. The largest barrier island is Padre and the largest bay is Galveston.

The Gulf Coastal Plain extends northward up the Sabine River to near Shreveport. In its lower reaches the Sabine River is a petroleum-rich area of swamps and bayous separating Texas and Louisiana. The Big Thicket, an area rich in biodiversity, extends from Beaumont (site of the 1902 Spindletop oil gusher) northward. The northernmost part of the Gulf Coastal Plain is forested with pines, oaks, and other trees common to its more eastern parts. At Kilgore the great East Texas Oil Field began pumping in the 1930s. The southern part of the plain extends south to Mexico and west to about Del Rio. The southern part is less forested and more open. In South Texas the Gulf Coastal Plains extend from Corpus Christi to Brownsville and then west to the Edwards Plateau, the southern end of which is at Del Rio. The area is one of huge ranches including the famous King Ranch. Javelina (*Peccary angulatus*) or collared peccary are often hunted in the region. Along the Rio Grande from Laredo to Brownsville orchards of oranges and grapefruits are an important part of the economy.

The Gulf Coastal Plain joins the Prairie Plains that extend from Red River in the north to San Antonio. The two plains merge in the Cross Timbers, which is a long narrow strip of forest that extends from Oklahoma deep into central Texas. The trees are smaller post oaks, blackjacks, and other less valuable trees. This area is also rich in petroleum resources in the Austin Chalk Formation, around Luling, and elsewhere. The Prairie Plains end in central Texas at the Balcones Escarpment centered at Austin. The Balcones Escarpment is the eastern edge of the Edwards Plateau, a desiccated region covered by cedars and shrubby plants. Like much of western Texas it appears desolate; however, the high mineral content of the thin, rocky soils and the food value of shrubs and grasses support cat-

Big Bend National Park in Texas is occasionally visited by jaguars at the northern end of their range.

tle, mule deer, and other forms of life such as black ground squirrels and road runners on ranches and in wild areas. Rainfall amounts decline to desert levels in the Trans-Pecos area into which the Chihuahuan Desert extends. There, the thorny plants increase and trees are replaced by shrubs. Ranchers in the area turn to the prickly pear cactus to support their cattle in times of drought. The spines are burned off with flame throwers, allowing cattle to eat the succulents for food and moisture.

The Prairie Plains turn into the Rolling Plains west of Fort Worth. The area is hilly with increasing shrubby plants and numerous cattle ranches. The Great Plains join the Rolling Plains in the Panhandle and they extend to the Rio Grande River. The southern end covers the Stockton Plateau, which is west of the Pecos River and extends to the east to about Del Rio. The Panhandle and the Rolling Plains are often referred to as the cap rock region because the rock is impermeable. The central area of the Great Plains includes the Monahans sand hills, a large dune area west of Odessa. It was described by Spanish explorers who also explored the Llano Estacado, a dry treeless area of the High Plains extending about 250 miles by 150 miles.

The Permian Basin is a large area of oil-rich sedimentary rock. For most of its geologic history Texas was under the ocean, and in the Permian geologic era the Permian Basin was surrounded by a vast coral reef. It became a trap for enormous quantities of oil and gas. The western part of the reef is now the Guadalupe Mountains, most of which lie in New Mexico and include the Carlsbad Caverns. However, the southern part of the Guadalupe Mountains extends into Texas and rises to 8,749 feet (2,667 meters) on El Capitan at the southern end. The land drops dramatically from El Capitan to salt flats at its base. The peak was used as a landmark by stage coaches of the Butterfield Overland Mail in pioneer days.

The region of far southwestern Texas is an extension of the Basin and Range Region of the Rocky Mountains. It includes the Fort Davis Mountains where in the upper elevations antelope mingle with cattle on the ranch lands. Other mountains are the Glass Mountains, the Santiago Mountains, and the Tierra Vieja Mountains. The southern portion of the area is rugged, isolated, and virtually uninhabited.

Along the Rio Grande River the area where the river turns north is called the Big Bend, much of which is now a National Park. The park is usually filled with visitors during the mild days of Christmas and New Years. The Big Bend region, high in elevation, is occasionally visited by jaguars at the northern end of their range and by mountain lions. The course of the Rio Grande River often passes through canyons of spectacular beauty.

El Paso is the largest city in southwest Texas. The area is arid and abounds with barrel cacti and other cacti. To the north of the city are the Hueco Tanks. The tanks are large natural rock formations that act as basins for trapping rain water. They supplied water to Native Americans and to travelers on stagecoaches, and were the site of one of the last Native American battles.

SEE ALSO: Cattle; Drilling (Oil and Gas); Livestock; Rio Grande River; Rocky Mountains; United States, Southwest (Arizona, Nevada, New Mexico, Utah).

BIBLIOGRAPHY. Wayne H. McAlister, *Matagorda Island: A Naturalist's Guide* (University of Texas Press, 1993); Laurence Parent, *Big Bend National Park* (University of Texas Press, 2006); Darwin R. Spearing, *Roadside Geology of Texas* (Mountain Press Publishing Company, 1991); D. Gentry Steele, *Land of the Desert Sun: Texas' Big Bend County* (Texas A&M Press, 1999); Joe C. Truett and Daniel W. Lay, *Land of Bears and Honey: A Natural History of East Texas* (University of Texas Press, 1994).

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Universal Soil Loss Equation (USLE)

THE UNIVERSAL SOIL Loss Equation (USLE) is one of the most widely used empirical models for estimating long-term average soil loss. Wischmeier and Smith introduced this equation in 1978; the U.S. Soil Conservation Service first utilized USLE on a large scale. Soil erosion has for a long time been a major concern, particularly because of its negative impacts on agriculture and sedimentation of reservoirs. A range of natural and anthropogenic factors influence soil erosion processes, which occur in all landscape types and under a range of land use systems. USLE was intended for cropping systems, but is also applicable to nonagricultural conditions (such as construction sites). USLE was developed to predict annual soil loss rates from a particular field or single slope, where it is used to compare soil losses from a specific cropping and management system to "tolerable soil loss" rates. Moreover, USLE is used to evaluate the effectiveness of alternative cropping systems and management practices in reducing soil loss, and determining optimal levels of cropping and maximal tolerable slope.

The USLE consists of six factors reflecting effects of precipitation patterns, topography, vegetation, land management, and soil characteristics. Specifically, USLE computes expected surface erosion on a particular slope as:

$$A = R \times K \times LS \times C \times P$$

A represents the potential long-term average annual soil loss in tons per acre per year; *R* is the rainfall and runoff factor (erosivity); *K* is the soil erodibility factor; *LS* is the slope length-gradient factor; *C* is the crop/vegetation and management factor; and *P* is the support practice factor.

USLE is used worldwide and has come under increasing criticism. However, every model makes assumptions that limit its usefulness to certain conditions. First, USLE is intended to estimate sheet and rill erosion only. It is not calibrated to account for soil loss from gully and channel erosion, or wind erosion. It does not identify areas susceptible to landslides. Second, USLE was designed to estimate average annual soil loss from a particular field. Its predictive capability is best at evaluating soil loss at that scale and less applicable to others. Particularly in areas of high spatial and temporal variability of input parameters, uncertainty associated with results may be high. Third, USLE does not identify areas of sediment deposition. Fourth, USLE requires judgment in applying values for the variables. Differences in judgment will account for differences in the assessment of field conditions, making the comparison of estimates difficult. Fifth, USLE was designed for use in the Midwestern United States, but has been widely used and misused throughout the world.

Revisions of USLE, which more accurately predict soil loss, have been implemented since the 1990s. The revised USLE (RUSLE) was released in the early 1990s and afterwards underwent several revisions. These revised models take advantage of new research about soil erosion processes and relationships between the variables, and of the capability of computer technology and geographic information systems. In spite of its limitations, which are well known, USLE remains a widely accepted model. USLE is easy to apply for assessing relative erosion potentials under different site conditions and land management practices. However, it is a best available estimate of annual average soil loss, rather than an absolute value.

SEE ALSO: Soil Erosion; Soil Science; Soils.

BIBLIOGRAPHY. K.G. Renard et al., "RUSLE: Revised Universal Soil Loss Equation," *Journal of Soil and Water Conservation* (v.46, 1991); K.G. Renard et al., "Predicting Soil Erosion by Water. A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE)," in *Agriculture Handbook No. 703* (U.S. Department of Agriculture, Agricultural Research Service, 1997); T.J. Toy, G.R. Foster, and K.G. Renard, *Soil Erosion: Processes, Prediction, Measurement and Control* (Wiley & Sons, 2003); United Nations Environment Programme (UNEP), "Guidelines for Sediment Control Practices in the Insular Caribbean," *CEP Technical Report No. 32* (UNEP, 1994); W.H. Wischmeier and D.D. Smith, "Predicting Rainfall Erosion Losses: A Guide to Conservation Planning," in *Agriculture Handbook 537* (U.S. Department of Agriculture, Agricultural Research Service, 1978).

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Ural Mountains

THE URAL MOUNTAINS extend for approximately 1,000 miles in a generally north-south orientation in Russia from the Kirgiz Steppe in Kazakhstan to the Kara Sea on the Arctic Ocean. Novaya Zemlya, an island in the Arctic Ocean, is an extension of the Urals. This mountain range is geologically quite old and dates from the Carboniferous period. The Urals formed when the Siberian plate impacted on the more massive Laurasian Plate. Because of their age the mountains are worn down and reduced through erosion. The average height of the range is 3,000–4,000 feet and the highest peak is Mount Narodnaya at 6,214 feet. The Urals mark the unofficial but traditional boundary between Europe and Siberia.

The Middle Urals are densely forested and rich in mineral wealth. The famous Urals Industrial Region was developed in the Middle Urals region and is based on mining and industry. The region is comprised of the Chelyabinsk, Sverdlovsk, Kurgan, Orenburg and Perm oblasts. The Middle Urals region has extensive deposits of iron, copper, chromium, bauxite, lead, zinc, gold, platinum, potassium, magnesium, asbestos, and other important minerals. There are major oil fields in the region but no coalfields. Industries within the region reflect its mineral wealth: Metallurgical, chemical, and heavy industries are dominant. The Urals Industrial Region developed rapidly during World War II with the movement of industrial capability from the Russian Plain in the west to prevent it from attack by German forces. Industry and mining give way to pasture lands in the Southern Urals.

Ekaterinaberg, an industrialized city of over 1.3 million people, is the self-proclaimed capital of the Urals. The city has experienced a variety of environmental contamination problems resulting from years of accumulated pollution from the multitude of industries both within the city and the surrounding region. There is a high degree of water pollution from heavy metals and deposits of tailings from the many mines. The problem of thermal pollution is also found in streams and lakes near the Beloyarskaya nuclear power plant, which is 15 miles from Ekaterinaberg.

Scientists in the region are well aware of the dangers of environmental degradation in the Urals Industrial Region. The Ural Environmental Union, a composite of government officials, environmental activists, and scientists has taken the lead in gathering information on pollution problems and in developing programs to rectify the situation. Another organization, the Institute of Industrial Ecology, is leading a program to set environmental priorities for the Urals. The program is called "The Assessment of Priorities for Middle Urals' Environmental Pollution Protection." Its initial focus area is the Chelyabinsk and Sverdlovsk oblasts. The plan calls for a series of environmental studies at local levels with the results subsequently extrapolated to the region. The project includes development of methods for establishing priorities for future environmentally related projects and to ensure sound economic growth as well.

International collaboration is an important part of the effort and experts from the United States will play a role in implementing pollution protection safeguards learned in addressing comparable problems. Eradicating environmental degradation in the

Urals and establishing effective programs to avoid serious levels of pollution in the future will not be an easy task. Decades of environmental disruption and the accumulation of a wide variety of pollutants presents an enormous challenge. Also, there is the need to maintain high levels of industrial activity in the region while environmental remediation is underway.

SEE ALSO: Environmentalism; Industry; Mining; Mountains; Nuclear Power; Pollution, Water; Russia (and Soviet Union).

BIBLIOGRAPHY. Edward A. Keller, *Introduction to Environmental Geology*, 3rd ed. (Prentice Hall, 2004); John J.W. Rogers and P. Geoffrey Feiss, *People and the Earth* (Cambridge University Press, 1998); Les Rountree, Martin Lewis, Marie Price, and William Wycoff, *Diversity and Globalization: World Regions, Environment, Development*, 3rd ed. (Prentice Hall, 2005); Denis D.J. Shaw, *Russia in the Modern World* (Blackwell, 1999).

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Uranium

URANIUM IS A metallic-white element, number 92 in the periodic table, with the symbol U. It is found in the earth in the form of minerals such as pitchblende, carnotite, and urainite. Attention is focused on uranium because of its central role in the nuclear energy industry. Martin Heinrich Klaproth discovered uranium in 1789, naming it after the recently identified planet Uranus. However, it was not isolated until 1841. It is the heaviest naturally occurring element and it exists in 16 different isotopes, which have different configurations of nuclear particles. Naturally occurring uranium consists of a mixture of three of these isotopes, with more than 99 percent being uranium-238. Uranium is radioactive, which means that it emits particles and ultimately deteriorates into lead over thousands of years. The time taken for half of the atoms of uranium in a sample to become lead is called the half-life.

Henri Becquerel discovered the property of radioactivity in 1896. In 1938, Otto Hahn and Fritz Strassmann determined that the slow bombardment of uranium by neutrons could lead to the breakdown of atoms and the emission of additional neutrons, which leads to the chain reaction known as nuclear fission. This atomic technology was rapidly adapted for military purposes and in 1945 the United States exploded two nuclear devices on cities in Japan. As well as furnishing a variety of missiles and weapons, nuclear power was also used to generate electricity and to transport submarines.

Uranium represents approximately two parts in a million of the earth and the uranium-235 isotope is needed for the nuclear fission process. Consequently, although uranium represents a much more productive source of energy than fossil fuels, securing a steady source of the material is expensive and problematic. Uranium is used as the basis for the production of the heavier transuranium products that are used for fission activities. The radioactivity represents a severe health problem for people in the proximity of the metal and the possibility that it can be used as a weapon of unparalleled power means that considerable care must be taken in its sale and transportation.

Speculation surrounds the fate of the uranium used in the former Soviet Union, much of which is believed to be in an insecure situation. In the former Soviet Union, at Chernobyl in the Ukraine, the world's worst nuclear plant accident occurred and generations of Ukrainians are being poisoned by the still virulent radiation. The danger of further incidents, with the problem of disposing of waste products that remain toxic for thousands of years, continues to bedevil the use of uranium in electricity generation. However, the present rate of global environmental degradation and climate change means that it is likely to remain under consideration for the foreseeable future. Currently, it is estimated that the demand for low-cost uranium supplies for energy production will exceed supply over the next few decades unless significant new deposits are found. This includes secondary sources of uranium, which use recycled uranium in different forms.

SEE ALSO: Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); Nuclear Weapons.

BIBLIOGRAPHY. Greenpeace, www.greenpeace.org (cited July 2006); International Atomic Energy Agency, www.iaea.org (cited July 2006); Broder J. Merkel and Andrea Hasche-Berger, eds., *Uranium in the Environment: Mining Impact and Consequences* (Springer, 2005).

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Urban Ecology

URBAN ECOLOGY IS the study of the urban ecosystem as an ecological unit that is part of the larger global ecosystem; it is also known as the ecology of cities and towns. Urban ecology examines the relationships between the urban and natural systems and interactions among the biotic components—including humans. It also involves the study of the urban ecosystem's impact on other ecosystems, seeking to understand relationships with the rural system, particularly transfers of matter and energy and the complementary functions the surrounding space provides. The relationship with the global system derives from the contribution of the city to global environmental change and the use of renewable and nonrenewable natural resources.

As an interdisciplinary field of study, there is a debate among fields regarding an identifiable specific approach. Ecology understands urban ecology as a subfield of the discipline that studies the ecological relations in the unique human-modified environment, adopting a traditional approach and applying conventional theories, or with the perspective of integrating the human system and humans as another species. From this point of view, we can examine the budget of matter and energy flowing through the urban ecosystem and observe a unit that almost wholly depends on external sources of system inputs—food, fuel, water, and building materials—a heterotrophic ecosystem that does have parallel on earth. The outputs—solid waste, wastewater, combustion gases, and heat—are the results of industrial respiration, which is a metabolic process of what resembles a large living organism. The system inputs have varied distant origins while the outputs have varied destinations, thus the city depends on areas much larger than its own surface. This is the ecological footprint, the equivalent area of land required to support the provision of inputs and process the outputs. It measures the dependence of the city on other ecosystems and its sustainability; the more area required the more unsustainable the city.

Sociology and anthropology understand urban ecology as a division of human ecology, the study of how humans relate to their environment. The concept has a sociological origin in the Chicago School of Sociology of the 1920s. Robert E. Park and Ernest W. Burguess conceived the human ecology approach to explain the urban development and spatial segregation within the city of Chicago as the result of the intervention of social and economic forces. Cities were regarded in their theory as environments governed by competition and accommodation forces, inspired by ecology and the ecological factors intervening in a natural ecosystem. From this point of view, groups compete for a scarce resource—the land—and this struggle leads to the division of the urban space into areas with homogeneous social and economic characteristics and to the appropriation of the most valuable areas by the higher rent groups. Naturalist Edward O. Wilson developed the notion of biophilia to define the nongenetic emotional affiliation of human beings to nature and other life forms for having lived within a biological world. This helps to understand the preference for living close to nature, moving to the suburbs, valuing natural landscapes, and ultimately, supporting conservation of ecosystems and species and desiring to manage them efficiently. Biophilia can be promoted by education and experience with wildlife or discouraged by living within a completely industrial environment.

Political studies approach urban ecology by highlighting the role of institutions and identifying economic and social processes as forces implicated in environmental changes at various spatial scales, focusing on man as an agent of change. The field develops into political ecology. Urban ecology becomes a policy to increase the sustainability of the urban system by minimizing the impact on natural systems, promoting restoration plans of degraded habitats and conservation of those areas with a natural habitat. Urban ecology is seen as the conceptual basis of the process of sustainable urban development, a policy to build green cities or ecocities. The goal is to achieve healthier and more liveable cities, maintaining biodiversity and more efficiently managing space and resources, so that the community has not only architectural, social, and economic assets but also environmental ones.

THE URBAN ECOSYSTEM

The urban ecosystem is the result of human alteration of the natural system and is an environment intensely modified by social and economic development. The components of the urban habitat—climate, soils, hydrology, and biodiversity—are different from the surrounding nonurban areas. However, differences in the urban ecosystem are observed in line with the model of urbanization. Sprawl—the spatially-extended urban expansion over rural land—produces a city model based on high rates of energy consumption and associated disadvantages: Increased travel times and transport costs, pollution, traffic congestion, and broad transformation of the countryside.

The model has a major advantage over the dense city model: The conservation of large undeveloped land areas interspersed with the urban fabric, which locally retain former environmental attributes. These spaces are extremely varied. Green spaces such as natural parks, urban river corridors, formal gardens, recreational areas, sports parks, and street trees are important environmental assets for urban communities as they provide both recreational opportunities and ecosystem services, supporting local species and maintaining air quality. Some are remnants of past landscapes while others have been planted.

The course of urbanization produces a fragmentation of natural habitats, that is, wetland, grassland, woodland, and agricultural land turning into interstitial open spaces of semi-natural vegetation or farm land surrounded by urban, industrial, commercial, or residential land uses. Other areas with significant green space but dedicated to other uses are airports, cemeteries, golf courses, scientific and technological parks, and university campuses. Water courses, water bodies, lakes, and reservoirs are aquatic ecosystems that may or may not be attached to vegetated areas. Other areas offer a much lower environmental quality with low to medium concentrations of waste or pollution and highly variable physical, chemical, and biological soil characteristics: Derelict land, vacant lots, and brownfields—former industrial or commercial lands. Still other areas are highly degraded by dumps or densely crossed by infrastructures, yet they attract and keep some wildlife species.

THE CITYSCAPE

The mixture of built forms with the residual rural landscape yields a differentiated landscape known as a cityscape. The variety originates from combining land use categories, densities of population, and types of vegetated areas: Paved industrial, residential, commercial, grassy residential, dispersed residential, forested residential, agricultural, green areas, and vacant sites. The extensive network of roads, railroads, distribution pipelines, power lines, and dikes act as barriers that create habitat fragmentation by obstructing normal animal movement, increasing mortality, and isolating habitats and populations, threatening species with extinction. Essentially, this struggle for survival takes place in suburban areas, for city centers have already gone through this phenomenon.

There are a number of alterations and pressures acting upon species and humans in the built environment. The urban climate—the result of the modifications produced by the built structures and the combustion of fossil fuels—is defined by the heat island effect, which is an increase in temperature of up to nine degrees F (five degrees C), an increase in precipitation between five and 10 percent, a reduced total solar radiation, a higher precipitation runoff, a lower precipitation infiltration rate caused by the broad extent of pavement and other impervious surfaces, and a varied regime of wind speeds according to street orientation with respect to predominant wind directions.

AIR, WATER, AND LIGHT POLLUTION

Air pollution is caused by emissions derived from the burning of fossil fuels and industrial processes used by heavy industry, urban traffic, and household heating systems. Concentrations of complex atmospheric pollutants, gases, and suspended particulate matter create a toxic atmosphere. The deposition of those airborne pollutants, by either wet or dry processes, produces an acidification and nitrification of soils and water bodies. The application of fertilizers to home lawns and urban gardens at similar rates to agriculture adds large quantities of nitrogen and phosphorous to the water bodies. The leading causes of reduced water quality are nonpoint source stormwater, or polluted runoff; sewer overflows; and nontreated wastewater point discharges flowing into water courses. They increase the loadings of nitrogen and phosphorous nutrients, raise temperatures, reduce visibility, and decrease dissolved oxygen levels, producing a decline in wildlife, hypoxia, and, eventually, harmful algal blooms. Artificial night lighting, a form of pollution produced by the illumination of buildings, commercial signage, and streetlights, reaches miles around cities, and has the biological effect of disturbing nocturnal species. Light pollution goes in all directions and interferes with feeding, predation, reproduction, and other activities of populations.

URBAN WILDLIFE

Disturbance is responded to with the settlement of tolerant and adapted species that represent earlier stages of ecological succession in the urban environment. The high frequency of disturbance often causes retrogression, thus these species are tolerant to stress. Species richness—the number, evenness, and relative abundance of species—sharply declines in the urban environment from the human disruption and habitat destruction, while total populations increase, creating a decline in ecological diversity. Specialist species are replaced by fewer synanthropic generalist species, some of them invasive, and benefiting from the more favorable climate, food abundance, and habitat. It has been observed how some wild avian, mammalian, or amphibian species adjust to the new urban environment by occupying emerging and growing ecological niches, a response termed synurbanization. These species are adapted to reduced territories, nonmigratory patterns, frequent changes in habitat and diet, and daily contact with people, for they possess an ecological, demographic, and behavioral plasticity differentiated from the rural populations. This response is progressively increasing diversity in urban wildlife.

MANAGEMENT

A range of measures and approaches have been conceived to implement an urban ecology policy. Habitat management includes landscape and watershed restoration of native forests, riparian woodland, and urban intertidal wetlands. Methods applied are revegetation with native species, stabilization of banks and slopes by reducing runoff, cleanup, and remediation. These measures bring back the functions of earlier habitats in densely settled regions, including water filtration and improvement of water quality by removing pollutants, flood control, and providing green space for recreation. Other measures are linking fragmented urban habitats isolated from each other with a corridor network to strengthen their ecological value, expanding forested areas, facilitating safe wildlife crossing and free movement, and preventing road kill by means of underpasses and overpasses. The creation of new habitat with bioengineering techniques to mitigate the destruction of another has not been demonstrated to be completely successful since it can fail to compensate for the loss because some properties have vanished due to the rarity or complexity of the initial ecosystem.

Urban management measures include regulation of development intensity and patterns using improved land use control and zoning, sewage and stormwater runoff treatment, landfill restoration, and land remediation by removal of contaminants in soil, groundwater, and sediments as well as implementation of transportation policies such as slower speed limits, efficient public transportation, car sharing, park and ride programs, and encouragement of change in fuel consumption.

Economic inequity and segregation across urban neighborhoods has environmental and social implications. Land values are higher next to designed or preserved green spaces, while affordable housing is limited to areas close to infrastructures, industrial areas, commercial areas, and impoverished areas with poorer recreational assets. The socioeconomic status of a family is a limiting factor to accessing housing in middle-class neighborhoods. The exposure to poor ecological conditions in urban middle and low income neighborhoods may decrease the ability to assess the significance of biodiversity, and, thus, decrease support for diversity.

SEE ALSO: Anthropology; Cities; Ecology; Ecosystem; Eutrophication; Human Ecology; Political Ecology; Pollution, Air; Pollution, Water; Sociology; Urban Gardening and Agriculture; Urban Growth Control; Urban Parks Movement; Urban Sprawl; Urbanization.

BIBLIOGRAPHY. Marina Alberti, John M. Marzluff, Eric Shulenberger, Gordon Bradley, Clare Ryan, and Craig Zumbrunnen, "Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems," *BioScience* (v.53/12, 2003); Jürgen Breuste, Hildegard Feldmann, and Ogarit Uhlmann, eds., *Urban Ecology* (Springer-Verlag, 1998); Oliver L. Gilbert, *The Ecology of Urban Habitats* (Chapman and Hall, 1989); Gordon McGranahan and David Satterthwaite, "The Environmental Dimensions of Sustainable Development for Cities," *Geography* (v.87/3, 2002); Rutherford H. Platt, Rowan A. Rowntree, and Pamela C. Muick, eds., *The Ecological City: Preserving and Restoring Urban Biodiversity* (University of Massachusetts Press, 1994); Herbert Sukopp, Makoto Numata, and A. Huber, eds., *Urban Ecology as the Basis of Urban Planning* (SPB Academic Publishing, 1995).

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Urban Gardening and Agriculture

WITH HALF THE world's population now living in urban areas and most of the world's best cropland already under cultivation, urban gardening and agriculture is rapidly becoming an important source of food for city dwellers. Researcher Margarida Correia notes, "urban agriculture marks a return to early cities, where food production was part and parcel of daily life."

Urban agriculture has the following general characteristics: It is located within or on the fringe of a town, city, or metropolis; grows, raises, processes, and distributes a diversity of food and non-food products; uses and reuses human and natural resources, products, and services largely found in and around that urban area; and in turn, supplies human and material resources, products, and services largely to that urban area. However, urban agriculture is more than just a way to produce food in cities. In terms of the three elements of sustainable development: Environment, economy, and society, urban gardens and agriculture provide a number of significant functions.

From an environmental perspective, urban gardens can make an integral contribution to the amount of green space in cities. Increased green space can assist in reducing airborne pollutants, thereby improving air quality. Urban gardens also create suitable habitat for a number of bird species. Common urban gardening techniques, such as regular crop rotation and crop-mix, discourage pest problems and reduce the need for pesticide use, leading to both health and environmental benefits. Related to this, locally-grown produce does not have to be transported long distances, therefore requiring fewer preservatives. Moreover, gardens absorb rainwater and stormwater, which reduces urban sewer loads. Communities participating in urban gardening initiatives also harvest rainwater and recycle grey-water from their homes for use in gardens. Urban organic waste can also be composted and used in gardens. Rooftop gardens in particular have been noted for their insulating effect, keeping buildings cooler in summer and warmer in winter.

Economically, urban agriculture has proven to be financially beneficial. Community-sourced food products lower family food expenses, especially in cities where most fresh produce is imported, and therefore costly. In addition, some community gardens sell a portion of their produce at local farmers' markets with the proceeds providing funds for related projects.

In many cases, urban gardens are community-driven initiatives. Neighborhoods or other social units collaborate in the maintenance, growing, and harvesting of these gardens, all of which provide excellent vehicles for community integration and pride. Other community benefits also emerge from these initiatives, such as youth programs, local school activities, and job training for local residents and youth. Some gardens donate produce to local food banks, addressing access to fresh food in less advantaged communities. As experience with urban agriculture expands and diversifies, communities are integrating other social programs, such as prisoner rehabilitation.

Interrelated to all of these factors is the issue of food security. Cuba is frequently cited as an excellent example of how urban gardening and agriculture can be harnessed to provide food for urban and suburban populations. The collapse of the Soviet Union in the late 1980s drastically reduced agricultural inputs sent to Cuba, and in the immediately following years the national caloric intake of Cubans declined by one-third. In response, the number of urban gardens in Cuba has surged to about 8,000 nationwide and statistics indicate that urban agriculture produced 58 percent of the country's vegetables—over 1.7 million tons—in 2000.

Urban gardens have been planted in a diverse range of urban spaces: Patios and balconies, abandoned plots of land, rooftops, schoolyards, and more. Urban gardening initiatives have occasionally been fraught with land-use planning or zoning issues, such as in New York City in the 1990s, when over 100 vacated lots containing community gardens were due to be auctioned off by the city council. Over 60 of these were bought by a local organization and are now protected. In developed countries, the leaders in urban gardening initiatives are Germany and Switzerland. Esslingen in Germany has a bylaw requiring flat and sloping roofs—up to 15 degrees—to be vegetated. In Switzerland, a new law stipulates that all new buildings must relocate the green space taken up by the building's footprint to their rooftops; even existing buildings—some centuries old—are required to vegetate 20 percent of their roof surfaces.

SEE ALSO: Community Gardens; Cuba; Farmers' Markets; Gardens; Germany; Landscape Architecture; Switzerland; Urban Ecology; Vertical Ecology.

BIBLIOGRAPHY. Miguel A. Altieri et al., "The Greening of the 'Barrios': Urban Agriculture for Food Security in Cuba," *Agriculture and Human Values* (v.16/2, 1999); Margarida Correia, "Harvest in the City," *Earth Island Journal* (v.20/3, 2005); International Development Research Centre, www.idrc.ca (cited September 2006); Sonja Killoran-McKibbon, "Cuba's Urban Agriculture: Food Security and Urban Sustainability," *Women and Environments International Magazine* (no.70/71, 2006); L. Mougeot, "The Role of Urban and Periurban Agriculture in Urban Food Security and Poverty Alleviation," presentation given at United Nations Development Programme and Food and Agriculture Organization's "Food for the Cities: Parallel Event at Istanbul+5" (June 2001); Goya Ngan, *Green Roof Policies: Tools for Encouraging Sustainable Design* (Canadian Society of Landscape Architects, 2004); Oxfam International, "Havana's Green Revolution," www.oxfam.org (cited September 2006); Raquel Pinderhughes, "From the Ground Up: The Role of Urban Gardens and Farms in Low-Income Communities," *Environmental Assets and the Poor* (Russell Sage Foundation, 2000); World Resources Institute, "Inexhaustible Appetites: Testing the Limits of Agroecosystems," (July 2001), earthtrends.wri.org (cited September 2006).

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Urban Growth Control

THE TERM *urban growth control* is used to describe a broad set of growth management strategies intended to combat urban sprawl and its social and environmental consequences. For growth control advocates, it is generally the spatial expansion or "growth" of cities that necessitates "control," not the size of its population. Urban growth control may therefore be characterized as a set of land use planning policies meant to limit the suburbanization of metropolitan areas.

The urban growth control movement in the United States is a key element of "smart growth" policies and the Livability Agenda promoted by both Bill Clinton and Al Gore. These agendas are generally interested in producing cities that are compact and dense while at the same time livable, convenient, and pedestrian-friendly. As of 2005, 28 states had institutionalized growth management programs. However, in many cases the most rigorous growth control legislation is administered through county and municipal governments.

The rapid horizontal expansion of cities to suburban and exurban areas is a major cause of concern for the urban growth control movement. Urban sprawl is characterized by a variety of distinct land use patterns. First, large-scale municipal and commercial developments such as wide streets, broad parking lots, large retail stores, and expansive office parks all consume large land areas. Second, low-density housing developments add urbanized land disproportionately to increased population. Third, homogenous housing and commercial development often result in low structural diversity and uniform building designs. And fourth, segregated, single-use zoning results in commercial, residential, and business zones that are separated by large distances.

There are many effects of urban sprawl. Urban growth control advocates argue that suburban sprawl diverts financial resources away from valuable urban infrastructure by funding new and upgraded road and highway projects; consumes open space with ecological value such as forests and wetlands; subdivides and impinges upon productive agricultural regions; produces a culture of single-occupant vehicle use as residents of suburban and exurban areas become increasingly dependent on automobiles to move between single-use areas and to and from the urban core; creates longer commutes, which in turn raises air pollution levels as well as driver fatality rates; and increasingly segregates the citizenry of metropolitan areas along class, cultural, and racial lines, most notably captured in the movement of white middle-class populations to suburban areas, a phenomenon called White Flight.

Opponents contend that urban growth leads to less traffic because the driving population is spread over a larger area, which in turn leads to lower pollution levels. They argue that urban growth control will lead to higher real estate prices inside the growth boundary, placing a burden on low- and middle-income households, and a loss of freedom by citizens to choose where they live and work.

A variety of growth management policy tool options are available to urban planners attempting to control sprawl. Traditional policy tools include zoning ordinances and land use regulations. Another common policy option necessitates the establishment of certain public facilities such as water, sewage, and electricity as a precondition to suburban development. Still another option consists of infill and redevelopment strategies in the urban core—especially high density housing options, mixed use development, and viable downtown transportation alternatives.

Urban sprawl's large parking lots and stores lead to dependency on cars to move between single-use areas.

Urban growth boundaries (UGBs), also referred to as urban and rural "limit lines," present another zoning policy option for controlling sprawl. The establishment of urban growth boundaries is an intentional effort to control urban sprawl by assigning the area inside the boundary for high-density settlement and the area outside for low-density development. Areas outside of the UGB are often referred to as greenbelts. Low-density development outside the UGB can be a misleading term. While the overall density is low, many growth management plans mandate smaller, dense settlement clusters surrounded by agricultural and/or open space outside the UGB.

Urban growth boundaries are not without controversy. In limiting growth outside of the growth boundary in favor of open space, critics argue that politicians are effectively telling landowners in these areas what they can and cannot do with their property. Legislation promoting UGBs is oftentimes contested by suburban and rural citizens who argue that their private property loses value under restrictive land use policies. Citing the Fifth Amendment of the U.S. Constitution, these groups argue they should be duly compensated for land "takings." Others, including many urban residents, counter by citing public trust doctrines that stipulate that the ecosystem services provided by preserved spaces are in fact common property to be valued and used by everyone.

SEE ALSO: Land Use Policy and Planning; Public Trust Doctrine; Suburbs; Takings; Urban Sprawl; Urbanization.

BIBLIOGRAPHY. American Planning Association, www.planning.org (cited April 2006); Andres Duany, Elizabeth Plater-Zyberk, Jeff Speck, *Suburban Nation: The Rise of Sprawl and the Decline of the American Dream* (North Point Press, 2001); Dolores Hayden, *Building Suburbia: Green Fields and Urban Growth, 1820–2000* (Vintage, 2004); Jane Jacobs, *The Death and Life of Great American Cities* (Vintage, 1994); Sustainable Communities Network, www.smartgrowth.org (cited April 2006).

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Urbanization

URBANIZATION, OR THE process by which cities grow, is one of the most important geographic phenomena in the world today. This is because the proportion of the world's population living in urban settlements is growing at a rapid rate, and many of the most significant economic, social, cultural, political, and environmental processes are increasingly occurring within and between the growing numbers of cities in the world today.

According to the United Nations (UN), by 2003, there were already 372 cities of a million or more people, 39 cities with over five million residents, and 16 cities over 10 million. Projections for the future suggest that, in 30 years, about 60 percent of the world's population will live in cities, though what defines a "city" and "urban" is subject to debate, because different countries use very different definitions. Still, even the most conservative estimates suggest that the world's urban population will grow from 2.86 billion in 2000 to 4.98 billion by 2030. Future projections suggest that, by 2030, there will be 500 cities with more than 1 million residents, 50 cities with over five million residents, and 20 cities over 10 million. Thus, we are living in an increasingly urbanized world with larger and larger urban populations.

GLOBAL TRENDS

While all parts of the world will become increasingly urbanized, there is a striking difference in the trends and projections on a regional basis. In certain parts of the world, like in Africa, Asia, and the Middle East, urban growth is taking place at a dramatic pace. In these regions, many of the largest cities are growing at annual rates between 4 and 7 percent, which means that they will double in size in only 10 to 18 years. For the most part, urban growth in these regions is a consequence of internal migration by massive numbers of rural residents seeking a better life in urban areas, as agricultural development problems persist, and cities become the engines of economic growth.

In other parts of the world, particularly in the largest cities of North America, Europe, and Latin America, there are strong indications that metropolitan growth rates have been slowing down. Of course, many of the countries in these regions already have high levels of urbanization; according to their own national definitions, between 75 and 90 percent of the population live in urban areas, so rates of urban growth are likely to be slower.

Even so, there is evidence to suggest that the largest cities in these regions are beginning to grow less rapidly, and in some cases, to lose their populations to mid- and small-sized cities. One case in point: Almost all the cities in Latin America with a million or more inhabitants, despite continued increases in the absolute number of residents, have had much slower population growth rates in the past two decades, including Mexico City, Buenos Aires, São Paulo and Río de Janeiro. So despite the fact that cities like São Paulo and Mexico City are still among the largest cities in the world, mid- and small-sized cities have begun to grow very rapidly, gaining population both from large urban centers and from rural areas. The same process is being repeated in North America and Europe as well.

Four main factors have prompted the slowing down of growth in many of the world's largest cities. First of all, governments have begun to employ deliberate decentralization policies because the unequal allocation of people and resources in large cities produces serious problems and regional unbalance. Second, many industrial plants have moved out of larger cities into smaller cities either by policy or to take advantage of cheaper land and labor. Third, improvements in telecommunication and transportation technologies have further increased the dispersion of manufacturing factories and residences away from principal cities. Finally, there is an overall trend toward suburbanization and population deconcentration, where low-density, ex-urban settlements, with their own shopping malls, factories, office parks, and entertainment facilities, predominate. Thus, the vast majority of new urban growth in North America, Europe, and Latin America has begun to, and will continue to occur in mid- and small-sized cities.

While Mexico City is still among the largest cities in the world, its population growth rate has begun to slow.

SOCIAL POLARIZATION

According to the UN, no matter where urban growth occurs, the economic contributions of cities are, and will continue to be, critical. Urban-based economic activities account for more than 50 percent of Gross Domestic Product (GDP) in all countries and up to 80 percent in more urbanized countries in Latin America, or more in Europe. Thus, cities and towns are not only the loci of production, but they are also the loci of the most important impacts of globalization and, hence, will be the places of change and expectations for the future.

Yet, ironically, today's cities are marked by social polarization, which may unwittingly place the economic and social futures of cities at risk. Social inequality is an integral and inevitable part of everyday life. In fact, in most cities today, this social inequality is actually on the rise. Many scholars argue that these trends are not merely incidental, but are inscribed as part of the global economy where the prosperity of the elite rests on the exploitation of the poor.

One manifestation of this social polarization is the fact that today's cities are characterized by great inequalities in income distribution, with the richest 10 percent of the population often earning 30–40 percent of the total income, and the poorest 50 percent earning less than 25 percent of the total income. With few exceptions, between 1960 and 2000, the majority of countries experienced a continued concentration of income within their populations. While absolute incomes for all groups have grown, according to the UN, the population in the top quintile has grown much faster than those in the bottom two quintiles.

This rising inequality in income has in turn created markedly different housing situations for the rich and the poor in cities. While many of the richest residents separate themselves in gated communities, the poorest residents live in homogeneously poor public housing or informal housing communities. A long-term housing crisis has emerged in many cities of the world, which means many of the poorest families settle land illegally and build their own homes informally, especially on the fringes of major urban centers. A vast majority of these families hold no legal title, and many live in housing that is considered substandard or even unfit for settlement.

While land title regularization programs and access to more efficient formal markets have improved conditions for some, for many, the only option for affordable housing remains the informal sector. Thus, access to low-cost, quality land and housing is a major concern for most cities across the globe, where population growth and rapid urbanization predominate.

ENVIRONMENTAL DISTRESS

Most cities are also undergoing severe environmental distress. This distress is caused by a lack of resources, inadequate attention, and inefficient management practices. As a result, a variety of environmental problems exist in cities today. These include problems involving:

- Public land management: The constant reduction of green areas, which causes an excessive impermeability of soil and an increase in critical areas of flooding. The illegal occupation of watersheds is also causing groundwater contamination.
- Public transportation planning: Inadequate public transportation alternatives, including the expansion of subway networks and bus lines, means that the percentage of car users continues to rise, which leads to air, noise, and water pollution.
- Air quality: The lack of strict practical and short-term measures and policies, along with enforcement of environmental standards, causes overall high levels of industrial air pollution. A highly motorized and congested transport system also results in high levels of particulate air pollution.
- Sewerage: The delay in the completion of sewage master plans means that a significant percentage of residents are not connected to the sewer system. Thus, only a small percentage of sewage receives some sort of treatment in wastewater treatment plants.
- Water: Even though most residents have access to piped water, most water sources and waterways within cities are contaminated. Because of pollution problems coupled with growing demand, maintaining reliable supply is a problem, especially for those populations that live in areas prone to flooding.
- Solid waste: The thousands of tons of solid waste created every day by millions of residents means that conventional and formal methods for disposal are cost-prohibitive. This has led to open burning of undisposed waste, as well as soil, groundwater, and surface water contamination through run-off and leaking.

In all cases, environmental degradation is associated with ill-health effects, for both adults and children. In many cities today, residents suffer from respiratory ailments, vehicular deaths (from poor transport planning), and industrial accidents (from inadequate occupational safety standards). In the most impoverished pockets, where poor water quality, overcrowding, substandard housing, and underventilation prevail, adults and children also suffer and die from infectious diseases including diarrhea, tuberculosis, cerebrospinal meningitis, schistosomiasis, and skin infections. Because so many residents in today's cities are poor, the result is a highly "unlivable" environment.

TOWARD "LIVABLE" CITIES

Given that urbanization is inevitable, there is a dire need to come up with ways to make cities more "livable." Of course, "livable" means different things to different people, but most would agree that "livability" can be defined as an equitable urban environment that assures jobs close enough to decent housing with wages commensurate with rents. "Livability" also means having access to the services that make for healthful surroundings and personal satisfaction and happiness. Importantly, "livability" depends on people having an effective say in the control and management of their urban environment. Thus governance, or the ways in which governmental and nongovernmental organizations (NGOs) work together, as well as the ways in which political power is equitably distributed in cities, becomes essential to creating "livable" cities.

In the end, it is an open question whether the economic advantages that can be found in the city result in improved quality of living for most residents, who are not a part of the elite population. Even though many cities have become centers for economic growth and wealth generation, most evidence suggests that a handful of people at the top of the social hierarchy reap most of the benefits. Few cities in the world today provide decent livelihoods and healthy habitats for a majority of ordinary people. On the contrary, income inequality is rapidly growing and environmental resources are being degraded on a great scale. Consequently, the changing form, economic base, environmental condition, and social structure of cities will continue to be of immense importance.

SEE ALSO: Automobiles; Cities; Heat Island Effect; New Urbanism; Pollution, Air; Pollution, Water; Poverty; Public Land Management; Sewage and Sewer Systems; Suburbs; Sustainable Cities; Transportation; Waste, Solid; Wastewater; Water Demand.

BIBLIOGRAPHY. Gary Bridge and Sophie Watson, eds., *The Blackwell City Reader* (Blackwell Publishers, 2002); Peter Evans, ed., *Livable Cities? Urban Struggles for Livelihood and Sustainability* (University of California Press, 2002); Peter Marcuse and Ronald van Kempen, eds., *Globalizing Cities: A New Spatial Order?* (Blackwell Publishers, 2000); Saskia Sassen, *Cities in a World Economy,* 2nd ed. (Pine Forge/Sage, 2000); Allen Scott, ed., *Global City-Regions* (Oxford University Press, 2002); John Short and Kim Yong Hyon, *Globalization and the City* (Addison Wesley Longman, 1999); United Nations Human Settlements Programme (UN-Habitat), *The State of the World's Cities, 2004/5* (UN-Habitat, 2005).

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Urban Parks Movement

PUBLIC URBAN PARKS are a product of a reform effort that emerged in the mid-19th century to ameliorate the living conditions of working people. In the United States, the best known park advocate was Frederick Law Olmsted, who, with his partner Calvert Vaux, conceived of and promoted the construction of Central Park in New York City (1858) and the Emerald Necklace in Boston (1878–80), as well as some of the most notable parks in other large cities in the United States. Never easy to fund, the case for parks was always pitted against the potential for profit from the undeveloped real estate, and the possibility that parks would attract lower classes into more affluent areas. Related conflicts continue to this day.

Over the course of the 20th century, the case for constructing urban parks has ebbed and flowed, evolving with changes in the affluence and demographic composition of neighborhoods. At the beginning of the century, interest in providing access to nature in densely urbanized areas began to shift toward an outdoor recreation model, wherein recreation facilities were developed to encourage fitness, team sports, and activities aimed at the acculturation of immigrant communities. Natural or naturalistic spaces were then less important, and were encroached upon by tennis courts, baseball fields, recreation halls, and other facilities. At the same time, there was an increasing interest in the preservation of nature and wilderness far from the urban centers. This movement is well known as the conservation movement, largely formulated under Theodore Roosevelt's administration (1901–09).

THE LATE 20TH CENTURY

As the country became more affluent after World War II and the federal government underwrote suburbanization, the groundwork was laid for the emergence of the environmental movement, including greater concern about ecological processes and the need to preserve wilderness and open spaces—including at the suburban fringe. Conservation approaches of the Roosevelt Progressive Era that espoused the use and long-term sustainable management of natural resources were replaced by a

Urban parks have come full circle from relieving crowded living conditions to remedying environmental problems.

politics of preservation for ecological values and for leisure. It is also during the late 1960s and into the 1970s that new models were experimented with, such as conservation easements, greenways, community gardens, and land trusts in and near urban areas. Large-scale national recreation areas adjacent to cities were also created from the newly established Land and Conservation Fund (1964) to offer natural settings for outdoor recreation for urban dwellers. There was a general shift in appreciation toward more natural settings that offered contact with local indigenous ecosystems such as the Santa Monica National Recreation Area, dominated by coastal chaparral and oak woodlands.

What constituted a park became harder to define, and the umbrella under which such as concept could be categorized broadened. Meanwhile, older cities were being depopulated by the middle class, and investments were being made in parks in suburbs, combining large open spaces with recreation facilities; in urban fringe open spaces; and in the preservation of remote "wild" lands. Urban parks, including such well-known ones as New York City's Central Park, suffered from lack of funds as many large cities went through fiscal crises in the 1970s.

With the rise of the environmental movement, there was an increasing recognition that natural processes, especially at the urban fringe, needed to be protected. Ian McHarg's *Design With Nature* (1970) was one such important intellectual milestone. McHarg pointed out that development could be designed to minimize environmental impacts if natural environmental processes were understood and considered in siting subdivisions. He pioneered the use of overlay maps showing streams and sensitive riparian corridors, for example, and where development could take place that would have the least ecological impact. While McHarg's analysis was influential intellectually, it remained at the margin of planning practice. Yet, it was important because it supported challenges to sprawl, and contributed to emerging efforts to preserve ecologically important (and other) open spaces in suburbanizing environments.

Large-scale subdivisions at the urban fringe, especially those catering to the middle class and upper middle class, felt obliged to provide open spaces and parks as part of the amenity package. They followed a formulaic offering of lawns, playing fields, meandering bicycle paths, and recreation facilities. In deteriorating urban cores, another phenomenon was developing: the rediscovery of urban gardens for food self-sufficiency on vacant and abandoned parcels. Neither of these different trajectories corresponded—understandably—to the early mission of urban parks to provide relief from insalubrious and crowded living conditions and an aesthetic respite from the industrial city. With urban diversity came an increasingly disparate set of approaches to public open spaces addressing the multiplicity of urban settings—the older, poorer urban core, the more affluent residential neighborhoods, older established suburbs, and expansion on the urban fringe.

THE 21ST CENTURY

By the turn of the 21st century, the variety of approaches to public open spaces has grown considerably, and encompasses diverse ideologies about nature, the role of public spaces, and the place (and type) of recreation in an urbanized context. The rise of new urbanism and return to the urban core of large cities have revived interest in urban parks as places for relief from city pressures, a place for nature, and other functions such as stormwater mitigation. The new sciences of conservation and restoration biology have also been a factor in reassessing the function and location of urban parks, leading to tension about what kinds of new parks should be created, and where, and the functions of older parks. For example, in Chicago, efforts have been made to renaturalize portions of the extensive park system, removing and replacing non-native trees. In California, this has led to the extirpation of non-native eucalyptus. In both cases, these efforts have encountered opposition.

For these reasons, urban parks are harder to define today. With the preservation and inclusion of undeveloped natural spaces in cities, restored waterways, the creation of bioswales in interstitial and often overlooked places, innovative re-engineered streetscapes for storm water management, and street calming approaches that involve widening sidewalks and expanding the pedestrian sphere into linear street parks, the traditional idea of urban parks is no longer sufficient.

Going into the 21st century, urban parks will encompass a range of services and uses. Non-built urban land—both on the urban fringe and in cities themselves—may increasingly be recruited to mitigate the environmental impacts of urbanization and climate change, as well as serving recreation and aesthetic purposes. Wild, vestigial remnants of urban land—"feral" spaces—may also increasingly be recruited into the park portfolio as urban land becomes more scarce for traditional park creation. At the same time, as population and urbanized lands in some areas continue to increase, cities, counties, and other governmental organizations will be expected to expand park and open space venues in the newly urbanizing areas.

None of these changes occur easily and the challenges involve the creation of new models for stewardship and funding. As municipal budgets have declined due to the restructuring of fiscal revenues, parks and recreation departments have suffered across the country. One new possibility for funding may be the valuation of open space ecosystem services, whether for storm water regulation or air pollution mitigation. Research demonstrates that natural services contribute benefits to cities that have monetary value. The very notion of the urban park, starting from a strategy to relieve human inhabitants of polluted, crowded, and unsanitary cities, may come full circle as a new approach to helping to remediate the newer problems of global climate change, toxic hotspots, and water shortages through renaturalizing the urban environment.

SEE ALSO: Central Park; Garden Cities; Landscape Architecture; New Urbanism; Olmsted, Frederick Law; Urban Ecology; Urban Gardening and Agriculture; Urbanization; Urban Planning.

BIBLIOGRAPHY. Troy A. Erdman, "Landscape Architecture: Design and Problem Solving," *Tech Directions* (v.61/2, 2001); Ian McHarg, *Design With Nature* (John Wiley & Sons Inc., 1992 [1970]); Witold Rybczynski, *A Clearing in the Distance: Frederick Law Olmsted and America in the Nineteenth Century* (Scribner, 2000).

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Urban Planning

URBAN PLANNING IS generally an interactive process that produces land use plans that provide guidance to the implementation of urban development. The process includes the following: (1) the conceptualization of a place that is under development pressure, (2) the consideration of whether the alternative types of growth patterns are feasible, (3) the specification of a set of systems related to development, and (4) the recommendation of a set of standards intended to result in a functional and/or aesthetically pleasing urban pattern. The planning process often involves a large time frame, sometimes decades. The space under consideration may range from an undeveloped parcel of land up to an entire metropolitan area covering thousands of square miles.

While it is difficult to define and quantify precise numbers, in the early 21st century it can be stated that the majority of earth's residents are urban, not rural. Urban residents live in central cities and their related suburbs. Their construction is the result of many levels of planning, including the individual or family who plans to build a house on a residential lot using a blueprint. Urban planning refers to a larger scale, which considers the overall spatial pattern of urban areas, and the anticipation of how a population of individuals will socially interact.

Jane Jacobs promoted high-density, pedestrian-friendly urban neighborhoods.

There are a number of elements involved in urban planning, which are sometimes but not always coordinated. For example, transportation urban planning seeks to add roads to accommodate more traffic or improve traffic flow. Alternatively, a light rail line might be designed so that rail cars can attract riders, which can reduce the level of road traffic. Subdivision planners will take a parcel of land and design the location of houses, buildings, and roads. Public service planners might forecast the need for and the location of new schools, firehouses, and police stations. Overall, a land use plan might be devised where different types of permitted land uses are identified as a set of zones on a map.

While planning of new cities has been occurring for thousands of years, contemporary urban planning was influenced by several individuals. First, Ebenezer Howard (1850–1928) promoted his idea of "Garden Cities," which were designed to reduce the negative social and environmental impacts of emerging industrial cities in places like England and the northeastern United States. Garden cities sought to combine the city with the country at a density lower than the observed cities at that time, but higher than the rural areas engaged in primary resource production such as agriculture. While no development matches the garden city blueprint, thousands of places worldwide have garden city design elements and essentially suburban population densities.

A few decades later, Frank Lloyd Wright (1867–1959) promoted his idea of a "Broadacre City." This plan incorporated the decentralization processes inherent in emerging transportation and communications technologies, and proposed a decentralized urban form where each residential lot was about an acre in size. Commercial land uses occur in small clusters, and the system is tied together with a large network of highways and arterial roads. While no development matches the broadacre city blueprint, thousands of places around the world have broadacre city design elements and essentially exurban population densities.

ROBERT MOSES AND JANE JACOBS

The interaction between transportation and urban development played out notably in a series of disputes between Robert Moses (1888–1981), a New York City planner who promoted large-scale highway construction and high-rise public housing projects, and Jane Jacobs (1916–2006), a writer and observer of

Robert Moses's vision for New York City included more highway construction in Manhattan.

urban processes. Jacobs observed that high-density, irregular urban neighborhoods with a high level of pedestrian activity and interaction were diverse and innovative places. She critiqued the sterility of large public works projects, which encouraged urban exodus into sprawling suburbs and fragmented exurbs. Jacobs was on the winning side of preventing highway construction in Manhattan in the early 1960s. Some of Jacobs's ideas have found their way into new urbanism, with its elements of mixed land use and pedestrian-friendly neighborhoods.

Current and future urban planning may be focused on three areas: Core central cities through selected redevelopment or gentrification of decayed neighborhoods, sprawling suburbs through the rezoning of developments to have mixed uses with closer proximity of work and residence, and fragmented exurbs through the clustering of lots and the retention of common area open space. Examples of all three development types can be found in numerous locations around the earth, and viewed from space using satellite photography.

SEE ALSO: Garden Cities; Landscape Architecture; Land Use Policy and Planning; New Urbanism; Sustainable Cities; Urban Sprawl; Wright, Frank Lloyd.

BIBLIOGRAPHY. Peter Calthorpe and William Fulton, *The Regional City: Planning for the End of Sprawl* (Island Press, 2001); Jane Jacobs, *The Death and Life of Great American Cities* (Random House, 1961); David Rusk, *Inside Game, Outside Game: Winning Strategies for Saving Urban America* (Brookings Institution Press, 1999); Stephen V. Ward, ed., *The Garden City: Past, Present and Future* (E & FN Spon, 1992); Frank Lloyd Wright, "Broadacre City: A New Community Plan," in R. Legates, ed., *The City Reader* (Routledge, 1996).

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Urban Sprawl

THE TERM *urban sprawl* is is used widely and inconsistently and is usually associated with negative connotations of urban expansion. The definition means, variously, unplanned loss of agricultural and other land to sub(urbanization) where there is minimal or no coordination of service and infrastructure provision, through to planned urban expansion that provides appropriate services and infrastructure but converts land to urban uses. The term could be more accurately expressed as *suburban sprawl*. As Richard Peiser notes, the term *sprawl* is used to mean different things, including "the gluttonous use of land, uninterrupted monotonous development, leapfrog discontinuous development and inefficient use of land." In terms of sustainability, each of these problems labeled *sprawl* invokes different solutions in order to make cities more sustainable.

HISTORICAL CONTEXT

The use of the term *urban sprawl* has increased as people have become more concerned about the environmental and social impacts of urban expansion and are advocating that cities become more sustainable. This is not to say that urban expansion is new. For example, relative to English cities, some American and Australian cities were spread over large areas in the 19th century. Whereas today the expansion of cities is often seen by governments, planners, and many ordinary people as a problem, the spread of the city was understood as being beneficial for health, sunlight, and to reduce the risk of disease. Spreading the city out was one way of overcoming the damp, unhealthy, overcrowded conditions of older European cities. It was also considered part of the moral health of citizens to garden and demonstrate pride in maintaining their dwelling and yard. This way of thinking was also important in England, where one of the common elements of many planned towns in the 19th and early 20th centuries (including Saltaire, Bourneville, Port Sunlight, Letchworth, and Welwyn Garden City) was the provision of space, gardens, and access to sunlight. Importantly, the reduction in urban densities was often accompanied by clear urban boundaries to prevent the city "spilling over" onto other land uses.

TRANSPORTATION

The spread of cities is closely related to the means of transport, and influenced by factors such as topography, population growth, and industrial development. When walking was the only available and affordable means of transport, the urban density was very high. Improvements in transport enabled people to commute over longer distances. The expansion of cities such as Melbourne in the 19th century and Los Angeles in the early 20th century was due largely to the provision and affordability of train and/or tram/streetcar transport. The transport infrastructure in many cities was developed as a way of selling land for residential use. The later arrival of the automobile accelerated this process because it enabled infilling between rail lines and the outward growth of the city beyond the rail lines.

Los Angeles, which was once promoted as the vision of a healthy, wealthy, and uncrowded lifestyle, became associated with terms such as *automobile dependence*. Los Angeles has become a metaphor for sprawl—the specter of freeway cloverleaf interchanges is raised in many cities as a warning of what could occur if a city was permitted to "sprawl." Los Angeles is certainly spread out. It extends 131 miles (212 kilometers) along its east-west axis and covers 2,814 square miles (7,287 square kilometers) of land. Whether this spreading of an urban area is seen as positive or, as is implied through the use of the term *sprawl,* negative, depends on how an individual assesses the economic, sociocultural, and environmental costs and benefits of this form of urban development.

The spread of suburbia brings economic costs and benefits. In some cases, landholders on the fringe of the city sell their land after years of farming because this is their only means of supporting themselves in retirement. Various U.S. states now have programs to retain agricultural land and prevent its conversion to urban uses. The economic benefits also accrue to automobile manufacturers and associated industries and to construction and white goods industries. The economic costs of urban expansion include the loss of agricultural productivity, the costs to provide infrastructure and services for residents in outer suburban locations, the potential for transport congestion as commuting is predominantly automobile-based, and the potential loss of productivity if commuting times are longer.

The sociocultural benefits of urban expansion include the possibility of larger houses and more entertaining space, safe space for children to play, and the provision of space for other activities such as gardening. It is also less likely that residents from different socioeconomic classes would mix, which is seen as desirable by many people when selecting accommodation. On the negative side are aspects including the loss of community, the experience of social isolation (particularly for women), and the loss of identity as previously separate towns are "gobbled up" by urban sprawl. The process of urban expansion is also seen as self-perpetuating, in that low-density development means many modes of public transport are not viable and therefore people without access to private transport become further trapped and isolated in these dispersed locations where there are often insufficient or inappropriate amenities.

ENVIRONMENTAL IMPACTS

The environmental aspects of urban expansion are now perceived as mostly negative. This is because environmental regulation and technology, in the form of pollution abatement devices, noise insulation, and so on, have reduced the negative impacts of many urban and industrial activities. Previously, the spatial separation of perceived incompatible activities was considered crucial. Now, spatial separation is often perceived as "sprawl," which is a significant factor to consider in relation to sustainable cities because it has an impact on issues such as water, transport, and biodiversity and because it is one of the most visible aspects of the relationship between cities and other physical environments.

There has been significant debate in recent years about the desirability of various urban forms. At its simplest, the debate has been characterized as a compact-versus-dispersed-city debate. The dispersed city has higher environmental costs in biodiversity loss, its contribution to climate change, the provision of more infrastructure, and so on but is generally better for local air quality because pollution can often be dispersed by winds. The claim many advocates of centralized or compact urban forms make about the more efficient use of infrastructure is often disputed, because the infrastructure in many existing urban areas is dated or in poor condition.

The outward expansion of cities readily enables the provision of new infrastructure.

Recent attempts to reduce urban sprawl include Smart Growth and some new urbanist developments. These initiatives do not entirely reduce sprawl and have been criticized as adding to the problem or creating other problems. It is important to ask: What is the problem to be solved? It is apparent that over the past 50 years there has been a significant move from perceiving crowding and high urban densities as a problem to the understanding that the outward growth of cities is a problem. The use of the term *sprawl* is often very loose, but it draws attention to important issues that will occupy urban planners and policy makers for many years as the world's population grows and the need for sustainability is increasingly recognized.

SEE ALSO: Cities; New Urbanism; Suburbs; Sustainability; Sustainable Cities; Transportation; Urban Growth Control; Urbanization; Urban Planning.

BIBLIOGRAPHY. Lionel Frost, *The New Urban Frontier: Urbanisation and City Building in Australasia and the American West* (UNSW Press, 1991); George Gonzalez, "Urban Sprawl, Global Warming and the Limits of Ecological Modernisation," *Environmental Politics* (v.14/3, 2005); Phil McManus, *Vortex Cities to Sustainable Cities: Australia's Urban Challenge* (UNSW Press, 2005); Peter Newman and Jeffrey Kenworthy, *Sustainability and Cities: Overcoming Automobile Dependence* (Island Press, 1999); Richard Peiser, "Decomposing Urban Sprawl," *Town Planning Review* (v.72/3, 2005); Bernard Salt, "LA Likeness Lingers in La-La Land," *Australian* (July 28, 2005); Michael Southworth, "New Urbanism and the American Metropolis," *Built Environment* (v.29/3, 2003); Karen Till, "New Urbanism and Nature: Green Marketing and the Neotraditional Community," *Urban Geography* (v.22/3, 2001); Harriet Tregoning, Julian Agyeman, and Christine Shenot, "Sprawl, Smart Growth and Sustainability," *Local Environment* (v.7/4, 2002).

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Uruguay

LOCATED IN THE southern part of the continent of South America, Uruguay has a land area

The Paper Mill Protests

In 2003, ENCE, a Spanish company, received permission from the government of Uruguay to build a cellulose processing plant on the Uruguay River at Fray Bentos. Two years later, a Finnish multinational company, Metsa Botnia, was also given approval to build a similar plant. As the Uruguay River is shared by both Argentina and Uruguay, and Argentines were worried about possible pollution of the river, protests began. Argentines argued that the use of the river was governed by a bilateral treaty, and the Uruguayan government would have to seek permission from the Argentine authorities, which they had not done. The Uruguayans denied that there would be any environmental damage to the river.

On April 30, 2005, some 40,000 Argentine activists from the town of Gualeguaychu, north of Buenos Aires, blocked the Libertador General San Martín Bridge connecting the town to Fray Bentos as a protest. Soon Argentine politicians became involved and on December 23, the bridge was again blocked, this time along with another nearby bridge. The Uruguayan chancellor Reinaldo Gargano criticized Argentina for violating the regulations of Mercosur—the regional trade grouping—which allowed for free circulation of goods.

In early 2006, the situation escalated with the involvement of international environmental groups such as Greenpeace. The border was again blockaded by the Argentines, in particular against the Finnish mill. Protests increased during the year and finally ENCE announced that it would relocate its works elsewhere. With Uruguay trying to protect one of the largest foreign investments in the country, the dispute continues.

of 68,039 square miles (176,220 square kilometers) and an estimated population in 2006 of 3.4 million, most of them concentrated in Montevideo, the capital. Uruguay is a flat and fertile plain interrupted only by small elevations in the south and east that do not exceed 1,640 feet (500 meters). The coast is low and sandy, and the climate mild with occasional strong winds. The dense fluvial network, dominated by the Uruguay River, and adequate precipitation explain why around 70 percent of the country is constituted by natural pastures grazed by the livestock introduced by the Spaniards in the 17th century,

Many of the environmental problems of Uruguay, a predominantly agrarian country and increasingly also a tourist destination, have been traditionally related to transboundary pollution from neighboring Brazil, especially the acid rain produced by the coal power plant of Candiota, which affects approximately one-fifth of the country. Soil erosion by wind has also been a traditional concern for ranchers (especially in the Department of Canelones), but recently it has begun to affect the expanding agricultural areas planted with soya beans on the highly erosion-prone soils of the eastern side. In 2003, only 0.4 percent of the total land area of Uruguay enjoyed some degree of environmental protection.

Water pollution by food processing industries (chiefly meat and meat products) is also significant. Critical areas in this respect are the Santa Lucia Basin (providing around 60 percent of the urban water supply of the country) and the urban basins near Montevideo. The capital suffers from air pollution originated by the oil refinery and the thermal power plants located in the vicinity. However, Uruguay obtains most of its energy from hydropower produced in the big dams of Rio Negro and Salto Grande (shared with Argentina) on the Uruguay River. In periods of drought, coal and oil power plants supply the energy needed.

During the 1990s, the expansion of forest land, advised by the World Bank and encouraged by the state with the objective of attracting foreign companies and developing the pulp and paper sector, was one of the key environmental issues in Uruguay. Rapid growth species such as eucalyptus have been introduced and benefits provided to foreign investors in the form of economic subsidies for plantations on specially designated areas. In turn, this has created wood and cellulose surpluses for export and possible carbon sinks for climate change policies.

However, the momentum gained by forestry faces opposition as well, especially from Argentina. In 2006 the proposal to build two paper and cellulose factories on the Uruguay River raised strong opposition by the neighboring country (a large proportion of the border between Argentina and Uruguay is formed by the Uruguay River). These factories represent the highest investment in Uruguay's history (about $1.8 billion) and are planned to produce more than 1.5 million tons per year of paper and cellulose. On the other side of the river, Argentine citizens argue that the pollution caused by these factories would ruin their agricultural and tourist activities. Argentina threatened to take this case to the international court of The Hague.

SEE ALSO: Acid Rain; Argentina; Brazil; Hydropower; Plantation Forestry; Pollution, Air; Pollution, Water; Pulp and Paper Industry; Soil Erosion; Tourism.

BIBLIOGRAPHY. Central Intelligence Agency, "Uruguay," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); United Nations Development Programme, "Human Development Report: Uruguay," hdr.undp.org (cited April 2006); World Bank, "Uruguay," *Little Green Data Book*, lnweb18.worldbank.org (cited April 2006).

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Use Value versus Exchange Value

USE AND EXCHANGE value are two different measures of the value of resources, goods, or services for humans. *Use value* refers to the actual use of something; for example, fruits and vegetables have a use value in providing nutrition for people. *Exchange value* refers to the price on the marketplace; for example, a commercial farmer grows crops for their exchange value. Anything that does not exist in commodity form has no exchange value, even if it has use value. This may be because property rights and/or markets do not exist, either because they are difficult or impossible to establish (e.g., clean air to breathe, many kinds of knowledge), or because there has been little or no interest in a given society to develop them (e.g., many societies did not provide for market exchange of land until they were colonized). Also, people lacking means of exchange (i.e., the poor) may place a high use value on basic necessities but be unable to pay for them. Therefore, the highest exchange value can be realized from selling a commodity to rich people, even if they have little need for it. Thus, exchange value is not an accurate measure of use value.

Mainstream economics usually assumes that exchange value *is* the best available measure of use value, however. This has both environmental and social implications. Environmentally, economic "efficiency" leads to treating noncommodified components of nature as if they had zero value, including clean air and water, scenic beauty, biodiversity, the "existence value" of species, and human health. The destruction of such values is ignored by indicators of economic welfare and economic growth (e.g., Gross National Product). Economic growth policies that ignore these adverse effects promote environmental destruction. Cost-benefit analysis attempts to overcome this problem, but only by arbitrarily defining exchange values of things for which no markets exist.

In social terms, the assumption that exchange values are a good measure of use values helps to justify an allocation of resources that favors the wealthy. The concept of Pareto efficiency claims that the most efficient allocation of resources exists when any change in allocation would lead to the loss of economic welfare of at least some individuals. This ignores that, if some amount of money were transferred from rich to poor people, the latter would surely gain more use value than the former would lose. Hence, arguments for economic efficiency tend to justify an unequal distribution of resources, such as highly unequal land ownership favoring large export-oriented plantations that typically apply large amounts of agrochemicals, at the expense of small peasants trying to eke out a living on the marginal land not occupied by the plantations. A large portion of peasant production is subsistence-oriented, meaning that it is devoted to use and not exchange value, and hence tends to be regarded as "unproductive."

The distinction between use and exchange value also has a gender dimension, in that women working in the household, or in subsistence-oriented agriculture, are often classified as unproductive because they do not generate exchange value. The greater difficulties they may face as a result of environmental degradation (e.g., long treks to collect fuelwood) are therefore also underestimated in economic calculations.

In fact, even in the wealthiest countries, a very large portion of production occurs within households (e.g., cooking) or within contexts of mutual aid and gift exchange (e.g., the free exchange of knowledge among scholars). Hence, as particularly pointed out by J.K. Gibson-Graham, a focus on the money economy (and thus exchange value) alone ignores a huge portion of the real economy, severely restricting any attempts to effect positive change.

In principle, the most severe discrepancies between use and exchange values could be overcome if: (1) most things of use value were made into commodities, and (2) income distribution were made more equal. However, it is hardly desirable to make everything into a commodity, and a larger degree of equity in income is hard to achieve. Furthermore, even use value is a utilitarian concept; people may wish to preserve spiritual or other values in nature that cannot be reduced to use value (because nature is not there just to serve humans). Hence, nonmarket mechanisms, including actions by government as well as civil society, are needed to preserve many environmental resources that have little or no exchange value.

SEE ALSO: Cost-Benefit Analysis; Economics; Historical Materialism; Markets; Marx, Karl; Resources; Subsistence.

BIBLIOGRAPHY. Herman E. Daly and Joshua Farley, *Ecological Economics: Principles and Applications* (Island Press, 2004); Paul Ekins and Manfred Max-Neef, eds., *Real-Life Economics: Understanding Wealth Creation* (Routledge, 1992); J.K. Gibson-Graham, *The End*

of Capitalism (as We Knew It): A Feminist Critique of Political Economy (Blackwell, 1996); E.F. Schumacher, *Small Is Beautiful: Economics as If People Mattered* (Blond and Briggs, 1973).

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U.S. Geological Survey

THE U.S. GEOLOGICAL Survey was established on March 3, 1879, during the last minutes before the close of the final session of the 45th Congress, when President Rutherford B. Hayes signed the bill appropriating money for the Survey. The inclusive bill included a brief section establishing the new agency, the U.S. Geological Survey. Under the Department of the Interior, it was created to oversee the "classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain." The legislation to create the Survey developed from an 1878 report of the National Academy of Sciences, which had been requested by Congress to provide a plan for surveying the American Western Territories.

By 1867, America's emerging industries were making huge demands on its natural resources, so the Commissioner of the General Land Office, J. Wilson, declared that the development of geological characteristics and mineral wealth was of the highest concern to the American people, and Congress authorized western explorations in which geology would be the principal objective. These General Land Office surveys were to include a study of the geology and natural resources along the 40th parallel route of the Transcontinental Railroad under the auspices of the Corps of Engineers and a geological survey of the natural resources of the new state of Nebraska. Clarence King, the first director of the U.S. Geological Survey, would later say:

> 1867 marks, in the history of national geological work, a turning point, when the science ceased to be dragged in the dust of rapid exploration and took a commanding position in the professional work of the country.

The Geological Survey was fashioned to unify and centralize the work undertaken by these important field surveys across the American West. From 1868 to 1870, the King and Hayden Surveys received funding for exploration in Wyoming and Colorado, and in 1869 the bureau was placed directly under the Secretary of the Interior. In 1870, Hayden presented to Congress a plan for the geological and geographical exploration of the Territories of the United States. With Congressional authorization, the Hayden Survey became the Geological and Geographical Survey of the Territories.

By 1870, two more surveys had taken place—Professor of Geology John Wesley Powell with a party of nine men left Green River, Wyoming, in three small boats to explore the unknown canyons of the American southwest under private sponsorship. Between 1867 and 1868, he had explored the Rocky Mountains in Colorado and eastern Utah and decided to explore these unknown canyon lands in boats. In a legendary and troubled trip down the Green and Colorado Rivers, Powell and five remaining members completed the journey through the Grand Canyon on August 13, 1869. In 1870, Professor Powell received an appropriation of $10,000 from Congress to make a second trip down the Colorado, being required only to report his results to the Smithsonian Institution. On June 10, 1872, Congress appropriated another $20,000 for completion of the survey.

In 1869 and 1871, expeditions were led by Lieutenant George Wheeler, an Army Engineer who explored California, Nevada, and Arizona. He surveyed the American West from south and east of White Pine, Nevada, to the Colorado River to create maps of wagon roads and military sites. Two years later, he was sent to explore the land south of the Central Pacific Railroad in eastern Nevada and Arizona. The extensive maps and information from these four surveys represent the foundation for the establishment of the Geological Survey.

The responsibilities of the bureau include exploratory surveys of geologic structure, the preparation of geological and topographical maps; the examination, classification and evaluation of natural resources; water studies to provide irrigation and water power; the organization of public lands; and the investigation of natural hazards, all related to the publication of papers, bulletins, and maps based upon these surveys. In 1962 the Survey was authorized to conduct surveys on private lands. The Survey also serves the United States by:

> providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

SEE ALSO: Army Corps of Engineers; Geology; Hydropower; Irrigation; Minerals; Mining.

BIBLIOGRAPHY. Mary C. Rabbitt, "The United States Geological Survey: 1879–1989," *U.S. Geological Survey Circular 1050*, www.usgs.gov (cited January 2007); U.S. Department of The Interior, *A Brief History of the U.S. Geological Survey* (U.S. Department of The Interior, 1974); U.S. Geological Survey Committee of Review, David Jack Cowen, and National Research Council, *Weaving a National Map: A Review of the U.S. Geological Survey Concept of the National Map* (National Academy Press, April 2003).

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Usufruct Rights

THE LEGAL TERM *usufruct right* is derived from ancient Roman law and means the temporary right to use to the property of another as long as the nature of the property is unchanged. In terms of natural resources, when a landholder gives or sells the usufruct rights to another person, that person may use the resources on the land in various ways, including planting and harvesting crops, grazing livestock, and collecting forest products. *Usufruct rights* refer to levels of control a person has over property, while not owning the property. In addition to usufruct, or use rights, other levels of control a person might have over property include the right of exclusion (the right to prevent other people from using the resource) and the right of alienation (the right to sell and give away the resources). A person with usufruct rights to natural resources may also have the right to exclude other people from using the resources, and may (but not always) have the right to sell the use of the resource.

Property rights define relationships between people and mediate their use of property in terms of "who can (and cannot)" "do what" and under "what circumstance" to the specific property. As such, property rights are usually considered social relationships between people with respect to a thing, but not between people and a thing. Consequently multiple aspects of social and cultural institutions influence the configuration of property rights, including usufruct rights.

The usufruct rights to lobster fisheries in northeastern Nova Scotia provide an excellent example illustrating the social nature of property rights. Describing the system of property rights that characterize the valuable lobster fisheries in St. George's Bay, Nova Scotia, John Wagner and Anthony David found the term *kindness* was used to refer to usufruct rights. This term could be traced back to 18th century when a large number of Scottish people immigrated to Nova Scotia. A *kindness* was considered as the right of occupation and use of the land, but not the right of ownership. Transferred to the fishing industry, the right to harvest lobsters in certain parts of the bay was also based on *kindness*. In today's generation these rights are referred to as "gentlemen's agreements." As a form of usufruct right to resources, *kindness* is best understood as a cultural system in which resources users are motivated to perpetuate and sustain the system of access to resources (effectively their economic livelihoods) through social and cultural institutions that sustain family and community values. This property system provides a well-defined set of rules that ultimately constitute an essential component of an effective management system.

Usufruct rights are often associated with customary law and common pool resources, which were common in preindustrialized America and Europe and are still active forms of law and resource control in many developing nations. Oftentimes, usufruct rights to hunt, forage, and plant crops on commonly held property are seen as an insecure and an economically inefficient form of tenure. Market-driven arguments posit that when resources are managed under a usufruct system, it obstructs investment aimed at improving the long-term quality or value of the land. As a result nation states around the world have sought to privatize land ownership. The most classic case of privatizing land while removing all use rights took place between the 12th and 19th century with the enclosure of the English commons. The motivating force was one of commoditization of land and its resources. As the English landowners brought together their scattered parcels of land and privatized the ownership of the land, former ways of subsistence living that used the commons for grazing, hunting, and collection of fuel were abolished. From a state perspective, privatizing land is a critical part of establishing state legitimacy in that it creates a census of people and their holdings, generates a class of taxpayers, and is believed to introduce land security. However, this process of land settlement also erases all usufruct rights, and as a result a class of landless people has emerged around the world.

In many parts of the world farmers still rely on usufruct rights and other customary forms of resource tenure for their subsistence livelihood. Contemporary empirical studies increasingly demonstrate that, in both industrialized and developing countries, common pool resources and usufruct rights associated with them have been and continue to be a successful way to manage natural resources.

SEE ALSO: Enclosure; Land Tenure; Private Property; Property Rights; Resources; Subsistence.

BIBLIOGRAPHY. Amity Doolittle, *Property and Politics in Sabah, Malaysia: Native Struggles over Land Rights* (University of Washington, 2005); Bonnie J. McCay and J.M. Acheson, eds., *The Question of the Commons: The Culture and Ecology of Communal Resources* (University of Arizona Press, 1990); Robert McNetting, "Unequal Commoners and Uncommon Equity: Property and Community among Smallholder Farmers," *Ecologist* (v.27/1, 1997); John Wagner and Anthony Davis, "Property as a Social Relations: Rights of 'Kindness' and the Social Organization of Lobster Fishing among Northeastern Nova Scotian Scottish Gaels," *Human Organization* (v.63/3, 2004).

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Uzbekistan

ECOLOGY AND UZBEKI national identity are intimately tied together. The forced cultivation of cotton—a cash crop that requires large amounts of water—and the diversion of the Aral Sea's two main feeder rivers, the Amu Darya and the Syr Darya, by Soviet authorities made the resulting Aral Sea environmental disaster a major, if not predominant, national concern. The Aral Sea, which is divided in half by Kazakhstan in the north and Uzbekistan in the south, was at one time the fourth-largest body of landlocked water in the world. In addition to providing a steady supply of water in a relatively arid region, the Aral supported a productive and important fishing industry. Perhaps even more important for Uzbeki national identity, the Aral Sea has had an important historical significance for the Uzbekis.

Now, however, cities like Moynaq that were on the banks of the Aral in the 1960s are some 100 miles away from the shrinking sea. Since the 1960s and large-scale, seemingly deliberate Soviet diversion of water away from Central Asia, the Aral Sea has lost around 60 percent of its volume. With accelerating demands from agriculture and industry the water level drops some 11 inches a year. If current trends continue, there will be nothing left of the mighty Aral but a vast salt desert.

Aggravating the Uzbeki sense of national ecological betrayal even further was the final shelving by Soviet authorities in the 1985 of the Sibaral Project, a project that promised to divert Siberian rivers back into the Aral.

Some of the first independent Uzbeki intellectuals and dissidents against Soviet rule used the Aral Sea as a symbol of Soviet exploitation. Sagdulla Karamatov wrote the novel *The Last Sand Dune* in 1983 as a veiled protest against Soviet policies. The writer Mamadil Makhmudov in *Today and Tomorrow* called the Aral environmental crisis the result of "limitless demands, unjustice and unfairness" by central Soviet authorities and modern Russia. The poet Zulfia Mominiva in *I'm Grateful for Your Lessons* used the name of the Aral—*ar* means dignity, *al* means to take away—to protest the destruction of Central Asian identity and dignity for the sake of northern, centralized power. The drying of the

Aral Sea was like the drying of the Uzbeki spirit under Soviet oppression. The demands for quotas of cotton and the exploitation of Uzbeki labor along with Uzbeki water caused further popular divisions with central rule and continued Russian attempts to dominate the Central Asian region.

Despite popular dissidence and national anguish, the Aral Sea continues to evaporate. The current climate of largely totalitarian rule by President Karimov has not led to any significant changes in the Aral Sea crisis. Nor does it seem likely that a weakened Russia would be willing to divert its water supplies to the independent state of Uzbekistan. In addition, Uzbekistan faces the potential for new environmental crises with the expansion of the oil and gas sector and the prospect of unsustainable industrial and urban development.

SEE ALSO: Aral Sea; Cotton; Kazakstan; Lakes; Ob-Irtysh River; Russian (and Soviet Union); Water Demand.

BIBLIOGRAPHY. Tom Bissell, *Chasing the Sea* (Pantheon Books, 2003); Peter Craumer, *Rural and Agricultural Development in Uzbekistan* (The Royal Institute of International Affairs, 1995); Arun Elhance, "Conflict and Cooperation Over Water in the Aral Sea Basin," *Studies in Conflict and Terrorism* (v.20, 1997); Rusi Nasar, "Reflections on the Aral Sea Tragedy in the National Literature of Turkestan," *Central Asian Survey* (v.8/1, 1989); Anita Sengupta, *The Formation of the Uzbek Nation-State* (Lexington Books, 2003).

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Vaccination

VACCINATIONS ARE USED to prevent infectious diseases. A weakened form of the infectious pathogen is used to stimulate the body's immune system to manufacture antibodies enabling the body to defend itself against the infectious pathogen. Vaccinations work because the immune system in the bodies of animals, birds, or humans is able to utilize the immunogen that is introduced to make antibodies. The antibodies destroy or neutralize the infectious agent whether it is a virus, bacteria, fungi, or some other pathogen. There are four types of vaccines. Those that contain bacteria or viruses that have been altered are called live attenuated vaccines. Vaccines that contain only parts of the infectious bacteria or virus are component vaccines. Killed vaccines use bacteria or viruses that have been killed. Toxid vaccines use toxins that the pathogen makes to neutralize it.

Vaccinations may be given orally or with a hypodermic needle. Oral vaccines may be used because they are cheaper, and do not have the risk of an injury or infection from injection. The polio, rotavirus, brucellosis, and cholera vaccines have been successfully administered orally. Many vaccines given to children, especially those under two years of age, have been given orally.

Vaccination with hypodermic needles is also widespread. Alexander Wood and Charles Gabriel Pravaz invented this form in 1853; prior to that time a cut was made in the skin for inoculation. The vaccine shots may be administered in the muscles that surround the stomach. Rabies vaccination is administered in this manner. Other vaccinations are administered in the shoulder muscles of the arms, or in the hips. Whether a vaccination is administered orally or with a hypodermic needle generally depends upon where the vaccination can be most productive in triggering the immune system to work. Many vaccines are not absorbed well if given in the stomach. Others are more effective if given orally rather than hypodermically.

The development of vaccines began in the late 1700s after it was noticed that milkmaids who developed cowpox were immune to smallpox. The practice of inoculating people with infectious material from a mild, but active, case of smallpox was developed before the advent of vaccinations. Edward Jenner, who coined the term *vaccine* from the Latin word for cow—*vacca*—introduced the safer method of inoculation with cowpox, which eventually led to banning smallpox vaccinations by the middle of the 19th century.

Opposition to vaccinations has occurred in many times and places. The mandating of compulsory vaccinations by governments has added to the controversies. During the Colonial era, the Boston printer James Franklin used his newspaper to attack inoculations by distorting the number of deaths in the Inoculation Controversy. More recent controversies have arisen in response to a number of vaccines. The manufacture of vaccines seems to inevitably involve the use of materials to which a few individuals are extremely sensitive. Deaths or medical injuries have occurred, but while tragic for those individuals who die or are injured, the vast majority of people benefit because they do not die from the disease or suffer harm from its effects. In recent decades, the use of mercury in vaccinations may have contributed to the rise of autism. Other materials used to manufacture vaccines have had negative effects.

Vaccinations may be given to immunize against a disease, but others are given to minimize a disease already contracted. Louis Pasteur's first vaccination was administered to a child who had been injured by a rabid dog. The weakened form of the rabies virus he administered triggered the immune response to work more rapidly than the original infection. Therapeutic vaccines against the HIV/AIDS virus, non-Hodgkin's Lymphoma, and other diseases have had some success.

SEE ALSO: Antibiotics; Disease; Pasteur, Louis; Smallpox.

BIBLIOGRAPHY. James Keith and Keith Colgrove, *State of Immunity: The Politics of Vaccination in Twentieth-Century America* (University of California Press, 2006); David Kirby, *Evidence of Harm: Mercury in Vaccines and the Autism Epidemic—A Medical Controversy* (St. Martin's Press, 2006); Richard Neustaedter, *The Vaccine Guide: Risks and Benefits for Children and Adults* (North Atlantic Books, 2002); Peter Parham, *The Immune System* (Taylor & Francis, Inc., 2004); Stanley A. Plotkin and Walter A. Orenstein, *Vaccines* (Elsevier Health Sciences, 2003).

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Values, Environmental

VALUES REPRESENT AN individual's judgment about what is valuable or important based on his or her principles or standards. Environmental values, ethics, and worldviews are human social-psychological constructs informed by people's inner experiences and their personal reasoning about nature. Environmental ethics are the moral judgments and attitudes that guide people in the way they behave toward nature. By comparison, value systems and worldviews are the reference frameworks through which people interpret their experiences and make them meaningful. The terms *environmental ethics* and *environmental values* are often used interchangeably. While environmental values are said to be formed early on in life, a person's worldviews are based on his or her broader social and political experiences and are, therefore, formed later in life. Worldviews relate to people's beliefs about the reality of the world, how the world behaves, their notions of justice, and what they think is right and wrong. Collectively, the values, ethics, and worldviews held by groups of individuals shape social identity and culture.

The origin of the concept of values expressed as an environmental ethic can be traced to Aldo Leopold's book *A Sand County Almanac and Sketches Here and There*. Although published shortly after his death in 1949, the book received greater popularity when re-released in 1970. The 1970 edition also included several influential essays by Leopold such as "The Land Ethic" in which he proposed that the causes of the ecological crisis were philosophical. Leopold also discussed an evolution in ethics from a focus on relationships between individuals, to relationships between individuals and society, to relationships between individuals, society, and the environment. Leopold expressed this environmental ethic as: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

Two other landmark papers published in the journal *Science* in the late 1960s also fostered the debate on environmental ethics: Lynn White's "The Historical Roots of our Ecologic Crisis" (1967), and Garrett Hardin's "The Tragedy of the Commons" (1968).

Environmental worldview theory emerged in the late 1970s and was underpinned by social scientists Riley Dunlap and Kent Van Liere's New Environmental Paradigm (NEP) scale, published in 1978. The NEP was developed in response to the anti-environmental worldview referred to by Dennis Pirages and Paul Ehrlich in 1974 as society's Dominant Social Paradigm (DSP). The NEP continues to be used extensively in research on environmental worldviews and is considered to be one of the more popular scales for measuring environmental beliefs and charting public attitudes toward the natural environment. In the early 1990s, social scientists Paul Stern and Thomas Dietz were among the first to propose a value-basis theory for environmental concern. These conceptual links have since been expanded to incorporate considerations of attitudes and beliefs.

Social scientists have demonstrated that environmental norms, values, and attitudes are correlated with environmental behaviors. These research findings support the premise that developing an understanding of people's values can help to understand the strength of their commitment to environmental issues and also predict when their environmental attitudes will be translated into environmentally relevant behaviors. Environmental value scales represent the most common form of measurement used to predict people's activities, consumer behavior, and/or economic sacrifice made to protect the environment. Environmental value scales can be broadly categorized into the following three forms: (1) values based on self-interest; (2) values based on concern for others; and (3) values based on concern for ecosystems.

Self-interest values are represented by egocentric and egoistic values. These values support the extraction and use of nature by individuals to enhance their own lives and the lives of their families. While they promote the protection of environmental aspects that provide personal benefits, they oppose the protection of environmental aspects that result in high personal costs. Garrett Hardin's theory of the "Tragedy of the Commons," where farmers' actions are governed by their self-interest, is underpinned by an egocentric ethic.

Values based on one's concern for others are represented by homocentric, anthropocentric, and social-altruistic values. These values support nature for its role in maintaining or enhancing the quality of life for humans including, for example, its role in providing clean air, water, and fossil fuels. As human-centered value orientations, these values promote social justice and maximizing the social good for all people. They support the view that people's attitudes toward nature or environmental policies should be judged on the basis of how human beings are affected by them. As such, they consider the well-being of other living creatures to be of lesser, if any, importance.

Values based on one's concern for ecosystems or the biosphere include biocentric, biospheric, and ecocentric values. These values assign intrinsic worth to all aspects of the environment (inanimate and animate) and they consider the survival of all living and nonliving things as components of healthy ecosystems to be of primary importance. Ecocentric value orientations value nature (in the form of ecological wholes such as species, ecosystems, and the biosphere) for its existence, aesthetics, and spiritual value, regardless of its ability to satisfy human needs. Ecocentrics identify with a connectedness between themselves and nature, as exemplified by Aldo Leopold's land ethic in his book *A Sand County Almanac*. Similar to environmental value scales, environmental worldviews range from those that are more anthropocentric (humans ruling over and manipulating nature) to those that are more ecocentric (humans connecting with and coexisting equally with nature).

Anthropocentric worldviews include the technocentric, mechanistic, cornucopian, and the accommodationist or managerialist worldviews. The technocentric worldview is considered the dominant worldview in Western organizations and is the assumed underlying position for conventional scientific method. It considers the world to be objectively knowable through the study and measurement of its parts, and that technological advances can overcome environmental problems. Similarly, the cornucopian worldview sees humans, through their ingenuity and technology, using nature to provide indefinitely for their needs and wants. The accommodationist or managerialist worldview sees using improvements in environmental legislation and environmental or ecological management practices as the way to accommodate or manage human impacts on nature.

Ecocentric worldview orientations include the ecocentric, communalist or ecosocialist, and gaianist or utopian worldviews. People who contend that the natural world consists of ecosystems that should be managed as such typically hold the ecocentric worldview. It sees the world and organizations and communities in it as being organized into interdependent systems. The communalist or ecosocialist worldview shows concern for ecologically sustainable development and distributive social justice. It also sees small-scale technologies directing environmental management and production, and providing the economic resources for all people to sustain an equitable standard of living. The gaianist or utopian worldview is an extreme ecocentric worldview that considers the land and all living things to be equal and which promotes the rights of nature. This is reflected in the deep ecology movement initiated by Norwegian philosopher Arne Naess in 1973, and later expanded by other writers including George Sessions, Bill Devall, and Warwick Fox.

Just as people's environmental ethics, values, and worldviews influence their environmental behavior; they also inform their reasoning on what environmental sustainability means and how sustainable development can be achieved. Two of the first documents to popularize the notion of sustainable development, the World Commission on Environment and Development's (1987) report "Our Common Future" and the United Nations' (1992) "Agenda 21" promote an anthropocentric ethic, in the form of intergenerational anthropocentrism, or ecologically sustainable economic development, as the preferred global ethic for achieving sustainable development.

Education for sustainable development is a key process in fostering the environmental ethic promoted by such international conferences and charters. Education for sustainable development builds upon environmental education, which first gained international recognition at the UN Conference on the Human Environment in Stockholm in 1972. It also draws from other associated disciplines including values education to move beyond a focus on environmental concerns to utilize an interdisciplinary approach encompassing human, social, and economic factors. While such education is traditionally concentrated within schools and associated institutions aimed at children and young people, educationalist Darlene Clover states that it is also important to provide such learning opportunities for all ages, including adults. Clover highlights the value of providing community-based education that is experiential and develops people's relationships with each other, their community, and the natural environment. John Fien expanded the notion of experiential learning through education for the environment, whereby education becomes a social change process based on translating knowledge into action.

Educating people so that they may hold ethics and values consistent with ecologically sustainable development can involve a variety of techniques including formal and informal approaches and public awareness raising and advocacy. By using a combination of teaching approaches, it is anticipated that participants will be better equipped to develop a life-long approach to learning and the ability to adjust their ethics and values so that they may remain appropriate in changing contexts.

SEE ALSO: Environmentalism; Ethics; Land Ethic; Religion; Social Ecology.

BIBLIOGRAPHY. Darlene Clover, *The Greening of Education* (UNESCO, 1997); John Fien, *Education for the Environment: Critical Curriculum Theorising and Environmental Education* (Deakin University, 1993); Garrett Hardin, "The Tragedy of the Commons," *Science* (v.162, 1968); Linda Kalof and Terre Satterfield, eds., *Environmental Values* (Earthscan, 2005); Aldo Leopold, *A Sand County Almanac and Sketches Here and There* (Oxford University Press, 1949); Carolyn Merchant, *Radical Ecology: The Search for a Livable World* (Routledge, 1992); Timothy O'Riordan, *Environmentalism* (Pion, 1981); Dennis Pirages and Paul Ehrlich, *Ark II: Social Responses to Environmental Imperatives* (Freeman, 1974); Mikael Stenmark, *Environmental Ethics and Policy-Making* (Ashgate Publishing, 2002); UNESCO-UNEP, *The Tbilisi Declaration* (UNESCO-UNEP, 1978); Lynn White, "The Historical Roots of Our Ecologic Crisis," *Science* (v.155, 1967).

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Variability (Natural, Patterns of, Climatological)

WEATHER IS CONSTANTLY changing. Climate, in contrast, is a record of the variations in weather over long periods of time. For example, the climate of the Ice Age, which, in terms of geologic ages was a mere few thousand years ago, was extremely cold; since then the global climate has warmed considerably. However, the long-term trends in the climate, whether of localities, continents, or even of the globe, vary in discernable patterns. One factor that has affected the variability of the climate has been continental drift. Over millions of years, continents moved from warmer regions to colder regions and vice versa. However, of interest to climatologists are variable patterns that are more intermediate.

From the 1940s until the early 1970s, the climate in North America was cooling; since then the climate has been warming. Today, many scientists fear that global warming is occurring because of human activities such as the burning of fossil fuels, especially coal, natural gas, and petroleum. The problem with this assessment is that over the last 10,000 years there have been periods of warming and cooling in North America. In addition, studies of the growth rings of trees have shown variations in the patterns of growth that indicated periods that were wetter and periods that were dryer. The general conclusion climatologists and other scientists have made is that there are variations in the patterns of rainfall, temperature, winds, and other meteorological phenomena. These variations have a number of causes.

The oceans covering over 70 percent of Earth's surface are a major influence on the earth's climate; they affect the weather constantly. As the sun strikes the surface of the oceans and sea—especially in the equatorial regions—it warms them, causing evaporation. The resulting cloud covers are driven by the winds onto land masses where they interact with the colder air masses of the polar regions, causing rain and snow. The oceans also act as heat traps by absorbing vast amounts of heat, which is then slowly released and, in the case of the warm currents such as the Gulf Stream, transported to colder regions.

Many climatologists, meteorologists, and other scientists believe that changes in the oceans can create long-term patterns in the weather. Changes in evaporation rates can affect the salinity of the oceans. Even small changes can produce significant variations in the patterns of the climate.

Oceans affect the weather constantly; clouds driven onto colder land masses can cause rain and snow.

It is essentially the way in which heat is distributed and redistributed in changing patterns that causes variability in the climate. Studies of the way in which the oceans absorb and then spread the heat from the sun via ocean currents, hurricanes, typhoons, and by moisture patterns are pointing to a better way of understanding climatic variations.

Because there are naturally occurring global patterns of warming and cooling, many scientists are of the opinion that the term *global warming* is misleading. The better term to use to reflect variation in global climate is *global climate change*. This term has been suggested as a means for including the naturally occurring changes that are due to more than just the release of vast amounts of carbon dioxide into the atmosphere since the beginning of the Industrial Revolution in the late 1700s.

Of interest to scientists are variations in the rainfall patterns occurring in the African Sahel where the rainfall varies widely. For some periods it is too wet and at other times extended droughts affect the lives of millions living on the margins of the Sahara Desert. The ultimate goal is to not only aid the people of the area, but to understand the types of patterns that can destroy civilizations.

SEE ALSO: Climate; El Niño–Southern Oscillation (ENSO); Global Warming; North Atlantic Oscillation (NAO); Weather.

BIBLIOGRAPHY. John D. Cox, *Climate Crash: Abrupt Climate Change and What It Means for Our Future* (National Academies Press, 2005); Brian M. Fagan, *Little Ice Age: How Climate Made History (1300–1850)* (Basic Books, 2001); Brian M. Fagan, *Long Summer: How Climate Changed Civilization* (Basic Books, 2005); Tim Flannery, *The Weather Makers: How Man Is Changing the Climate and What It Means for Life on Earth* (Grove/Atlantic, Inc, 2006); Eugene Linden, *The Winds of Change: Climate, Weather, and the Destruction of Civilizations* (Simon & Schuster Trade, 2006).

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Vegetarianism

VEGETARIANISM, IN ITS broadest definition, is a dietary pattern where meat, fish, and poultry are excluded. Frequently, vegetarians will exclude dietary products that include animal by-products and derivatives; however, *vegetarian* is a broad term that can have varied definitions and meanings. Some self-defined vegetarians may include animal products ranging from eggs and dairy, to seafood, and even occasional meat. Vegetarian dietary patterns are found throughout the world today and are influenced by a myriad of factors ranging from religious beliefs, economic influence, meat availability, environmental beliefs, and ideological beliefs.

In less-developed nations, large populations have primarily vegetarian diets due to economic factors, not choice.

Broadly speaking, vegetarians can be broken into four primary groups: lacto ova vegetarians, lacto vegetarians, vegans, and fruitarians. Lacto ova vegetarians do not consume meat, fish, and poultry, but do eat eggs and dairy products. Lacto vegetarians do not consume meat, fish, poultry, and eggs, but do eat dairy products. Vegans do not consume any meat, fish, poultry, dairy, eggs, or other animal-made food products, such as honey. Vegans, as well as many vegetarians, are also likely to avoid animal products in their clothing (wool, leather, and silk, for example), grooming, and cosmetic products, and other products. Fruitarian diets are vegan, but specific in that only fruits and vegetables that are defined as fruits are consumed.

In many parts of the world, particularly in less-developed nations and areas that do not lend themselves to meat production, large populations may consume a diet that is primarily vegetarian in nature not by "choice" per se, but because of circumstance. In agriculturally-based environments where horticultural production is limited these resources are more beneficial for human consumption than animal consumption, thusly limiting the capacity to develop strong animal-based agriculture and limiting meat available for human consumption. In such populations, whose diets are primarily vegetarian with occasional meat eating, meat consumption is frequently aligned with holidays and special events.

In the industrialized developed world, meat consumption is quite high. The United States leads the world in meat consumption (red meat, poultry, and fish) with an average annual consumption of 195 pounds per person. Within the United States research suggests that 2.5–5 percent of the population identify as vegetarian and that the numbers of vegetarians are on the rise. While in many parts of the world vegetarian dietary habits may be shaped by environmental and economic factors limiting the availability of meat, vegetarians in the United States often make an active choice in their dietary patterns. While various factors influence this choice—the healthful benefits of a diet low in animal products, ethical beliefs about animals, and religious beliefs—the most influential belief affiliated with American vegetarians is the belief that vegetarianism is beneficial for the environment.

As the developed world continues to increase meat consumption, there has been a parallel growth in the production of meat. Today, significant portions of the world have been transformed to enable cattle raising. In Central America, over approximately the last 50 years, a quarter of the rainforest loss has been to beef production. In addition to the rainforest loss, this beef production also impacts the environment further, as it is shipped to its primary consumer markets in the United States and Europe via the consumption of fossil fuels in transport and the output of toxic exhausts. Cattle farming has, as a practice, immediate environmental impacts.

In the United States, cattle farms consume approximately one-half of the annual water used, while simultaneously being a major source of water pollution via the tons of organic farm waste. Additionally, the intensive farming of beef production in the United States also consumes high levels of fossil fuels (with coinciding emissions) via the transportation of grains and food for the animals, the removal of animal waste, the transportation of animals, their slaughtering, and the transportation of meat.

Worldwide, the nation with the highest percentage of intentional vegetarians is likely India, with only 30 percent of the population consuming meat regularly, 20 percent being strict vegetarians, and the remaining 50 percent being occasional meat eaters. Many Indians who adhere to a strict vegetarian diet do so in part because of religious beliefs. In addition to religious beliefs, one's economic situation may prohibit the purchase and consumption of meat for many. Socio-environmentally, for those with little economic means, cattle may be more useful as a source of labor, dairy, and dung (that may be used as a fire source) than as meat.

SEE ALSO: Cattle; Food; Livestock; Meat; Religion.

BIBLIOGRAPHY. Alan Beardsworth and Teresa Keil, "The Vegetarian Option: Varieties, Conversions, Motives, and Careers," *Sociological Review* (v.40, 1992); Linda Kalof, Thomas Dietz, Paul C. Stern, and Gergory A. Guagnano, "Social Psychological and Structural Influences on Vegetarian Beliefs," *Rural Sociology* (v.64, 1999); Michael Pollan, *The Omnivore's Dilemma: A Natural History of Four Meals* (Penguin Press, 2006); F.J. Simoons, *Eat Not This Flesh: Food Avoidances from Prehistory to the Present* (University of Wisconsin Press, 1994); United States Department of Agriculture (USDA), "Agriculture Fact Book 2001–2002," www.usda.gov (cited June 2006); USDA, "Country Profile: Passage to India," www.fas.usda.gov (cited June 2006).

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Venezuela

LOCATED IN THE northeastern part of the South American continent, Venezuela has a land area of 353,839 square miles (916,445 square kilometers) and an estimated population of 25.7 million people in 2006. The country can be divided into four main physiographical units: the old Guyana Massif in the southeast with maximum elevations of 9,843 feet (3,000 meters); the Andes to the west (maximum elevations around 16,404 feet [5,000 meters]); the coastal ranges in the north formed by two mountain chains separated by a tectonic plain, and the large flat plains of the Llanos drained by the Orinoco river and its tributaries in the south. The Orinoco is one of the largest rivers of South America, running 1,333 miles (2,150 kilometers) and forming a delta of more than 9,653 square miles (25,000 square kilometers). The variety of natural conditions produces a high biodiversity with ecosystems ranging from the coastal mangroves of the Atlantic to the rich savanna formations of the Llanos to the xerophitic communities of the arid north. Venezuela is one of the top 20 countries of the world in plant and animal diversity.

Venezuela remains an oil-dependent nation, and many of the environmental problems of the country derive from this condition. From 1929 to 1970, Venezuela was the largest world exporter of oil and still holds enormous reserves of oil and natural gas in the Orinoco Delta. Oil spills have contaminated large parts of the Maracaibo Lake, killing fish and forcing the closure of some coastal resorts, and Lake Valencia is seriously affected by the discharge of untreated wastes. Air pollution is common in cities such as Caracas, Maracaibo, and Valencia. In these and other urban areas, 30 percent of the population lacked wastewater facilities in 2000. In rural areas, population without water sanitation exceeds 50 percent, although only one-tenth of the total population of Venezuela is rural.

Venezuela has the highest percentage of protected land of any Latin American nation. In 2003 it was estimated that more than 70 percent of the country enjoyed some environmental protection. Eleven natural sites (including Ramsar Sites and a Reserve of the Biosphere) cover more than 2.5 million acres (one million hectares). A particularly emblematic protected area is the Imataca Forest Reserve (bordering Guyana) for its natural and cultural diversity (it is the home of at least five indigenous groups) Despite this, the country is losing its rain forests at a fast pace (more than 2.5 million hectares disappeared between 1990 and 1995, or twice the average rate for tropical South America). Moreover, there is increasing evidence of soil degradation in the pastures of the Llanos due to overgrazing by cattle.

In December 1999, Venezuela suffered the worst environmental catastrophe of its history and one of the worst episodes of this kind of Latin America. Heavy rains coupled with landslides on the hills in the state of Vargas (near the Caribbean) killed approximately 30,000 people and left more than 500,000 homeless. The city of La Guaira, where informal settlement on steep slopes was and remains widespread, took the hardest toll (25,000 dead or missing). Uncontrolled urbanization may also be behind the closing in February 2006 of the main highway (and economic backbone of Venezuela with a circulation of more than 50,000 vehicles a day) between Caracas and La Guaira. The highway was closed because of the high risk of failure of several bridges whose pillars have been undermined by wastewater coming from the numerous slums surrounding this communication network.

SEE ALSO: Biodiversity; Deforestation; Ecosystems; Hazards; Natural Gas; Oil Spills; Overgrazing; Petroleum; Pollution, Air; Pollution, Water; Rain Forests; Sewage and Sewer Systems; Urbanization; Wastewater.

BIBLIOGRAPHY. Central Intelligence Agency, "Venezuela," *World Factbook,* www.cia.gov (cited April 2006); Steven L. Hilty, *Birds of Venezuela,* 2nd ed. (Princeton University Press, 2003); United Nations Development Programme, "Human Development Report: Venezuela," hdr.undp.org (cited April 2006); World Bank, "Venezuela," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Vernacular Housing

THE TERM *VERNACULAR* simply means native to a place. Anthropologists describe vernacular architecture as "ordinary building," which is distinguished by its "communally sanctioned" qualities and its "intensity of social representation," as opposed to individual expression. Vernacular architecture reflects the everyday lives of ordinary people and their relationships with the built environment. It embodies the social and cultural values, customs, and practices of a particular place, often providing insights into history. Due to its cost-effective use of local building materials and techniques, and its climatic and environmental sensitivity, vernacular architecture is considered an important component of sustainable development. Vernacular housing is a subset of vernacular architecture. It refers to individual dwellings built using traditional building styles, as well as the aggregation of such dwellings into larger settlements.

Various building principles, practices, and elements together characterize vernacular housing. Ancient builders are known to have used solar principles and other local climatic characteristics not only for individual dwellings but also for groups of dwellings. For instance, in ancient Greek towns, most buildings had stuccoed walls with few openings. Shadows kept them cool despite the bright sun. In residential buildings, windows were restricted to upper levels to ensure safety. Similarly, traditional dwellings in cold climates were usually sited just below the brow of the hill on a southward slope. The north face of the buildings had few openings whereas the southern façade had the main openings to maximize the benefits of limited sunshine. Such common-sense approaches, which are the foundation of vernacular building traditions, have inspired what is called "green" building today. In a search for innovations to promote sustainability, green builders have begun to adapt vernacular techniques and materials to achieve energy and cost efficiency.

Global housing demand for the projected population of nine billion people by 2050 is expected to have severe social and environmental implications. Promoting vernacular housing, particularly in developing countries, is seen as a long-term sustainable solution to the housing problem given its environmental and cultural sensitivity. Vernacular architecture is estimated to make up almost 90 percent of the world's housing stock. Although not much of the housing seen today in the United States and Europe is vernacular, in parts of Asia, Africa, and Latin America, vernacular architecture still accounts for a majority of the buildings. Since vernacular building traditions are still prevalent in parts of the world with rising populations, they are expected to be the dominant housing pattern in this century.

While vernacular design is mostly guided by unwritten rules, there are also the more formalized, almost normative, vernacular building principles such as those represented by Feng Shui manuals in China or the Vaastu Shastra principles in India, which are immensely popular today. Also, the work of some architects, such as Hassan Fathy in Egypt and Laurie Baker in India, exemplify the skillful interpretation and expression of vernacular traditions in contemporary architecture. For instance, Fathy is credited with reviving the Nubian vault—an ancient building technique dating back to the Pharaonic times—which uses architectonic elements, and the ancient craft of *claustra* or lattice designs in mudwork. His design for Gourna village in Egypt is an example of contemporary vernacular housing that meets the needs of Egyptian Islamic society through a clear demarcation of the private, economic, and religious lives of the community. Similarly, Laurie Baker's use of brick or mud walls, lime mortar made from seashells, recycled materials, and woven bamboo floors showcases the cost-effectiveness, sociocultural sensitivity, and environmental appropriateness of vernacular architecture today.

Technological advances, urbanization, and increased consumption, which accompany processes of globalization, have resulted in cultural changes. They have also created a range of environmental problems—from the depletion of natural resources to the excessive generation of pollution and waste. Consequently, the built environment, both as a cultural category and as a consumer of energy and resources, has a major role to play in addressing some of these issues. Architects, engineers, and planners have been promoting green building technologies in response to the growing environmental crisis.

However, critics point out that efforts to use such technologies in the past, especially for low-income housing in the developing world, have often failed because they tend to impose building types and standards without considering cultural values, local needs, and expectations. They argue that the success of green building technologies in the future will require them to be adaptable to cultural values and local customs. The current anthropological focus in architecture may be a step in that direction as it seeks to study the dynamic processes of living and transcend the simplistic reading of vernacular as just an "organic" physical form.

SEE ALSO: Sustainable Development; Urbanization.

BIBLIOGRAPHY. Lindsay Asquith and Marcel Vellinga, eds., *Vernacular Architecture in the Twenty-first Century: Theory, Education and Practice* (Taylor and Francis, 2006); R.L. Kumar, "What Is Architecture?" in Ashis Nandy and Vinay Lal, eds., *The Future of Knowledge and Culture: A Dictionary for the 21st Century* (Penguin Viking, 2005); Paul Oliver, *Encyclopedia of Vernacular Architecture of the World* (Cambridge University Press, 1997); Paul Oliver, *Dwellings: The Vernacular House Worldwide* (Phaidon, 2003); Amos Rapoport, *House, Form and Culture* (Prentice Hall, 1969).

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Vertical Ecology

CLIMATE IS VERTICAL. The fauna and flora of an area varies not only with the latitude of a region, but also with its elevation. For example, along the Mississippi River walnut trees and red squirrels flourish on the river's floodplains; however, gray squirrels and hickory nut trees flourish higher up on ridges above the river. While the distance between the floodplain and the heights of the river's banks is relatively small, the same vertical ecology occurs around the world. Vertical ecology has significant implications for the niches that are occupied by animals that are specialist feeders like the panda bear, rather than generalist feeders like the raccoon.

Mountain elevations allow different fauna and flora to flourish. In the southern Appalachian Mountains of Georgia, North Carolina, Tennessee, and Virginia the fauna and flora differ from that of the coastal plains and the Piedmont Region. The high elevations of the Appalachians (over the 4,500-foot, or 1,370-meter, level) have a climate and plants that are more like southern Canada. The higher mountains in New Mexico (Cloudcroft) surrounded by the Chihuahuan Desert and Arizona (Chiricahua Mountains) by the Sonoran Desert ecosystem are sometimes called "islands in the sky." In the summer, extreme temperatures and lack of water are fatal to all but desert plants. However, on the tops of the mountains that reach 7,000–9,000 feet, there are trees, springs, animals, and other plants.

The *tepui* (mountain plateaus) in Venezuela are another example of unique ecologies. Extremely isolated, each *tepui* has its own unique set of plants that flourish in its moist environment. Another form of vertical ecology is found in tropical rain forests. The plants on the ground are not the same as those in the canopy. Vertical ecology also occurs in marine ecology. Sea plants, fish, shellfish, and other creatures vary widely with the depths of the water; those in the relative shallows are different from those in ocean depths.

Human beings have long adapted themselves to vertical ecologies of their respective domains. The Apaches in Arizona and New Mexico would spend the colder months of the year in the warmer desert areas and the hot summer in the mountain elevations. The change in location would also allow them greater opportunities for farming, hunting, and fishing. Indigenous people in the Andes Mountains have long practiced agriculture that uses the vertical climate of the region.

Vertical ecological systems are threatened by global warming. As the temperature increases, the warmer ecology advances up the mountainsides; eventually the tops of the mountains may be overrun and alpine fauna and flora may struggle for survival.

SEE ALSO: Cloud Forests; Ecology; Ecosystem.

BIBLIOGRAPHY. K. Derek Denniston, *High Priorities: Conserving Mountain Ecosystems and Cultures* (Worldwatch Institute, 1995); K. Dettner et al., eds., *Vertical Food Web Interactions: Evolutionary Patterns and Driving Forces* (Springer-Verlag, 1997); Colin S. Reynolds and Yasunori Watanabe, eds., *Vertical Structure in Aquatic Environments and Its Impact on Trophic Linkages and Nutrient Fluxes* (E. Schweizerbart'sche Verlagsbuchhandlung, 1992).

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Victoria, Lake

LAKE VICTORIA (or Victoria Nyanza) is the largest freshwater lake in Africa, and the second largest freshwater lake in the world. The lake's total surface area amounts to nearly 27,000 square miles, about the same size as Ireland. Located in Tanzania and Uganda, it feeds the Nile River its greatest supply of water. The lakeshores are highly irregular and numerous reefs and islets are scattered across the surface. More than 200 species of fish are represented in the lake and many have economic value, especially the tilapia. The water surface is almost 4,000 feet above sea level and the lake reaches a depth of nearly 300 feet. The lake was first formed some 400,000 years ago and is vulnerable to rapid climate change. It has dried out more than once, most recently 17,000 years ago.

Large amounts of water, frequently in excess of the existing legal frameworks, are being extracted from the lake, as is also the case for the other great lakes of the continent. The water is used to help in irrigation and in the production of electricity. Birds and fish have been negatively affected by the loss of habitat and this has had an impact on the wider biosphere. It has become more difficult to navigate boats across the lake and this has led to a reduction in the level of trade and commerce. Some parts of the lake's shores are among the most densely settled in all of Africa; many inhabitants have become dependent on the lake for income and food. This process of environmental degradation seems most likely to have begun with the European colonization of the area, which was marked by the large-scale cutting down of trees to create plantations. The lake was named after the British Queen Victoria by the explorer John Hanning Speke, who, like many colleagues, was searching for the source of the Nile.

Degradation has noticeably intensified over the last three decades. The breakdown of previous legislative frameworks with the collapse of the East Africa Community has contributed to the lack of regulations governing fair use of the lake. It is hoped that the creation of the Lake Victoria Fishing Organization, in conjunction with other international agreements, will add a measure of control. The success of many types of fish in the lake, including alien species introduced illegally, has directly led to the extinction or near-extinction of many other species. Remaining species display declining diversity and health and many once-economically important species have disappeared from markets completely.

SEE ALSO: Colonialism; Lakes; Nile River; Tanzania; Uganda.

BIBLIOGRAPHY. Neil Ford, "Africa's Lakes Are Drying Up," *African Business* (v.320, 2006); F. Witte et al., "Species Extinction and Concomitant Ecological Changes in Lake Victoria," *Netherlands Journal of Zoology* (v.42/2–3, 1992).

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Vietnam

SINCE THE *Doi Moi* (renovation) free market reforms of the late 1980s, the Socialist Republic of Vietnam has experienced remarkable economic growth evidenced by an 8 percent Gross Domestic Product (GDP) and 14 percent industrial growth rates per annum; rapid urbanization (4.5 percent per annum); and dramatic increases in the use of motorized vehicles and the manufacture and use of chemicals. Population has tripled over the past 50 years, and now stands at 83,689,518 (July 2005 estimate). Together, these factors have led to significant environmental problems, especially on densely populated coastal plains.

Coastal waters are polluted with suspended solids, nitrite, nitrate, heavy metals, grease, and oil, in some cases at levels four times greater than the

Vietnam is in the top 10 countries for biodiversity, but agricultural expansion and other activities threaten this.

Vietnamese standard. Freshwater is in increasingly short supply as a result of rapid industrial and urban growth and is often polluted by untreated industrial and municipal wastewater discharged directly into rivers and lakes. There exist serious water pollution problems in Ha Noi, Ho Chi Minh City, Hai Phong, and Hue. Freshwater resources, however, are now regulated by the Water Resources Law (effective 2000). Wastewater treatment facilities have been built in the four largest cities and others will be developed in cooperation with international agencies.

Most urban areas experience serious air pollution problems. For example, Ho Chi Minh City's estimated 28,000 factories generate airborne dust content that exceeds Vietnamese standards by 2.1–6.0 times and lead content that is 1.4–3.4 times World Health Organization standards. Greater use of motor vehicles and inadequate fuel and emissions standards have exposed millions to airborne lead, carbon monoxide, and sulphur dioxide. A range of remedial strategies, however, are being pursued, including tightening fuel quality specifications and setting maximum emission limits for motor vehicles.

Solid waste disposal brings unique problems in Vietnam. For instance, as one of the world's largest manufacturers of athletic shoes, Vietnam generates tons of shoe leather waste each day. Solid waste collection efficiency is very low. Only about half of the generated waste is collected, the rest being scattered into waterways and unsafe dumping grounds. Annually, Vietnam produces more than 15 million tons of waste and 80 percent of that is municipal waste. Open dumping is the most popular disposal method but of the country's 91 disposal sites only 17 are sanitary landfills, and 49 have been identified on a national list as hotspots with high environmental and human health risks.

Land degradation is a major issue, particularly in upland areas. Causes include poor logging practices, insecure land tenure, salinization, acidification, pollution, and organic reduction. Agricultural yields now depend on fertilizers and pesticides—use of which increased 200 percent from 1992 to 2002—to the extent that management of agrochemicals is an environmental concern of high priority.

Most of Vietnam's virgin forest and forest with rich standing volume has now been degraded. The government aims to protect 9.6 million hectares of existing natural forests, however, and to recover five million hectares of open lands in the next 20–30 years. Moreover, 150,000–200,000 hectares of new forest, of improving quality, are planted each year.

Vietnam is one of the world's 10 most biologically diverse countries, but that astonishing biodiversity is under threat from forest clearance, illegal wildlife trade, agricultural expansion, and dam and road construction. In response, a protected areas system comprising national parks, nature reserves, and protected landscape areas has been established.

The Vietnam government faces considerable challenges balancing continuing rapid development with effective environmental management. That it is working toward this end is signified by the country's Socio-economic Development Strategy 2001–2010, which gives shared emphasis to economic growth, social equality, and environmental protection, and by the commitment of at least one percent of the state budget to environmental activities from 2006. However, although Vietnam is making considerable progress establishing environmental regulatory systems, a host of legal, institutional, and funding limitations continue to make enforcement a problem.

SEE ALSO: Agent Orange; Land Degradation; Pollution, Air; Vietnam War.

BIBLIOGRAPHY. National Environment Agency, "State of the Environment in Vietnam 2005," www.nea.gov.vn (cited April 2006); Dara O'Rourke, *Community-Driven Regulation: Balancing Development and the Environment in Vietnam* (MIT Press, 2003); United Nations Environment Programme, "State of the Environment in Vietnam 2001," www.rrcap.unep.org (cited April 2006); United States–Asia Environmental Partnership, "Vietnam Accomplishments," www.usaep.org (cited April 2006).

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Vietnam War

THE VIETNAM WAR resulted from the liberation attempt by the Vietnamese people from French colonial rule. Several factions among the Vietnamese cooperated in the struggle including the Viet Minh, which was especially popular in the north of the country and which came under the control of Ho Chi Minh. The eviction of the French in the mid-1950s led the Viet Minh to declare that it was a Communist movement and intended to unite the whole country under Communist rule. A brief period of fragile peace ended with civil war, which was accompanied by the widespread movement of refugees. United States military forces intervened on a massive scale on the side of the West-leaning South Vietnam.

Over the next two decades of intense fighting, approximately one million Vietnamese civilians, 900,000 North Vietnamese soldiers, and 200,000 South Vietnamese combatants were killed, with many wounded and dispossessed. American losses were about 47,000, with other allied forces losing smaller contingents.

The war broadened to neighboring Cambodia and Laos, both of which had hoped to remain neutral, but ended up with Communist governments. The people of Laos, across whose unpoliced borders the so-called Ho Chi Minh Trail passed, became, per capita, the most heavily bombed people in the world. Eventually, U.S.–South Vietnamese troops were overwhelmed by massive popular support for the Viet Minh and their international backers. American interests abandoned South Vietnam and paved the way for the creation of a unified, Communist Vietnam in 1976. Countless thousands of South Vietnamese attempted to escape overland and by boat. Other refugees, such as the Hmong of Laos who fought on the side of the CIA, await relocation to a friendly environment 30 years after the war ended.

The impact of the war on the environment was enormous and remains a significant hindrance to development today. It includes the unexploded ordnance that litters much of the land and claims a steady stream of victims, and landmines that are particularly effective at blowing off limbs, especially legs. The legacy of Agent Orange has been hugely problematic. It was a mixture of herbicides sprayed by U.S. airborne forces from low altitude in great volumes and was aimed at destroying foliage and crops that could be used by the Viet Minh troops and their supporters. Agent Orange is linked with a long series of congenital deformities, miscarriages, cancers, and other deadly illnesses. U.S. troops and their representatives brought a successful lawsuit against manufacturers of Agent Orange chemicals and received a substantial out-of-court settlement. However, this was only one of a range of chemicals used against the people of Vietnam and its neighbors. Estimates of the numbers of deaths caused by the remnants of these chemicals in the years since the war ended exceed 50,000.

SEE ALSO: Agent Orange; Cambodia; Laos; Vietnam.

BIBLIOGRAPHY. Nigel Cawthorne, *Vietnam: A War Lost and Won* (Arcturus Publishing, 2006); Philip Jones Griffiths, *Agent Orange: Collateral Damage in Vietnam* (Trolley, 2004); The Nordic News Network, "Environmental Conference on Cambodia, Laos, and Vietnam," www.nnn.se (cited July 2006).

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Virgin Islands

THE VIRGIN ISLANDS are a group of around 90 small islands and islets that form part of the West Indies and are within 50 miles of Puerto Rico. The islands are divided into two groups, one of which is administered by the United Kingdom (UK) as former colonies; the second group, which had been the Danish West Indies, was purchased by the American government in 1917 and is administered by the United States. The Virgin Islands are often considered to be an extension of the Lesser Antilles Islands. The islands are actually the peaks of mountains that are mostly underwater; the total surface area of the islands is around 190 square miles and the population is a little over 100,000. Annually, as many as two million tourists visit the islands.

The islands were originally settled with slave labor to produce sugar cane in plantations; this industry is no longer competitive. Few alternatives exist for the islanders apart from the tourism industry, which has been successful enough to attract migrant workers from other parts of the Caribbean, leading to some ethnic conflict in recent years.

Tourism has had in some cases a significantly negative impact on the physical environment, as motorboats, divers, and related activities have damaged marine life. The many coral reefs represent a particular attraction. These problems have been exacerbated by a succession of hurricanes, which have devastating effects on many parts of the West Indies. The UK and U.S. governments provide direct assistance to the island groups for which they are responsible, but have been able to do little to address the problems of scarce clean water and fundamentally weak economies.

A large petroleum refining plant is located on one of the U.S. Virgin Islands and attempts are being made to diversify the economy in terms of manufacturing and international finance. This latter issue is controversial because of the islands' reputation, perhaps in some cases unfairly earned, for being linked with tax avoidance and money laundering. The Virgin Islands also suffer from problems such as HIV/AIDS, crime and drug smuggling, and the many nonpoliced beaches and coves make illicit activities comparatively easy to hide.

Climate change leading to intensification and prevalence of hurricanes and related phenomena represent significant threats to the security of the islands. Rapid development of roads, second homes, and related infrastructure on tourist destination islands has contributed to sedimentation and other forms of environmental degradation.

SEE ALSO: Caribbean Sea; Hurricanes; Puerto Rico; Tourism.

BIBLIOGRAPHY. Isaac Dookhan, *History of the Virgin Islands* (University Press of the West Indies, 2000); Lee H. Macdonald, Donald M. Anderson, and William E. Dietrich, "Paradise Threatened: Land Use and Erosion on St. John, U.S. Virgin Islands," *Environmental Management* (v.21/6, 1997); Caroline S. Rogers and Jim Beets, "Degradation of Marine Ecosystems and Decline of Fishery Resources in Marine Protected Areas in the U.S. Virgin Islands," *Environmental Conservation* (v.28/4, 2001).

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Viruses

VIRUSES ARE PRIMITIVE biological infectious agents that live only in the cells of bacteria, plants, and animals. A specific virus invades and reproduces inside of a specific living cell until the cell explodes, spewing hundreds of copies; however, a virus cannot live outside of a cell. Viruses may be spherical, rod-shaped, or in the case of those that attack bacteria, like a screwdriver with clasps. Viruses are so tiny that they can only be seen by means of an electron microscope. Viruses are pseudo-life forms and do not match the commonly used definition of life. They do not have a cell structure, and must reproduce inside of another living cell. When expelled in search of a new host, they are inert until they can connect with a new host. They have characteristics of life forms while in the cells they infect, but not during times outside of an infected cell.

Every plant and animal is susceptible to viruses. Tens of thousands of viruses have been identified using electron microscopes. However, efforts to create a viral taxonomy have not succeeded for several reasons. Their origins are still obscure, and there is little in the way of a fossil record, so they are hard to place in the established domains of biological classification. Several domain names have been suggested such as *Acytota*. Organizations like the International Committee on Taxonomy of Viruses (ICTV) are working to find an organizing scheme. Viruses occur in plants and animals. Tobacco mosaic, a very thoroughly studied virus, is a viral disease in tobacco plants. The virus mottles the leaves and causes them to lose value. The recognition of viruses in plants began in the 1600s in the Netherlands. Tulip break virus was one of the most well-known plant viruses, which causes the petals to become ornamentally variegated.

The study of viruses took a major step when Louis Pasteur was able to use attenuated rabies viruses to make a vaccine against the disease in 1884. In 1892, Dmitri Ivanovski was able to isolate tobacco mosaic viruses, but he was not able to identify them specifically because of the limitations of microscopes. However, his work demonstrated the existence of a disease agent that was not bacterial. Marinus Beijerinck, a Dutch botanist, contributed the name *virus*, using a Latin word for poison. Virology, or the study of viruses, developed rapidly in the early 1900s from work done on viruses by Frederick William Twort and Felix d'Herelle. From their studies, many scientists studied bacterial viruses (phages). In 1935, Wendell M. Stanley identified protein as a part of the chemical makeup of some viruses, which enabled him to crystallize them. Since then, scientists have found that some viruses have a deoxyribonucleic acid (DNA) genome, and others have a ribonucleic acid (RNA) genome around which is a protein coating (capsid). Other viruses have lipids or proteins in their structure.

A single virus (viron) will have a DNA or RNA core surrounded by a protein coating. In some cases, there is additional protein of lipid material present. For example, all of the viral hemorrhagic fevers (arenaviruses, filoviruses, bunyaviruses, and flaviviruses) are RNA viruses covered with a fatty lipid coating. In 1911, it was discovered that viruses could cause tumors in chickens. Since then, other tumor-causing viruses have been isolated and described. In the 1980s, researchers linked some human cancers with viruses. Since then, Pap smears have become routine tests for early detection of the papilloma virus that causes cervical cancer in women. Most cancers in humans do not have a viral origin, but a DNA-type virus causes some cancers. The list of diseases caused by viruses is long. Smallpox (variola), yellow fever, mumps, measles, chicken pox, rabies, influenza, herpes, polio, and hepatitis have long plagued humans.

Antibiotics do not work with viruses once infection has been established. The ability to crystallize viruses enabled vaccines to be developed against polio (poliomyelitis) in the 1950s. Vaccinations do provide protection, but with serious limits. For some viruses no vaccine yet exists. Vaccinations against viruses have to deal with the problem that viruses mutate frequently. Influenza viruses are a global source of infection that can easily reach epidemic proportions. The Spanish Influenza Pandemic at the end of World War I killed millions of people. A source of influenza infections lies in the exchange of viruses that occurs between birds and animals, especially swine in southeast Asia. The exchanges provide opportunities for the viruses to mutate. This in turn means that new vaccines have to be developed to provide protection against the changed viral agent. The common cold is caused by a viral infection, as are a number of other viral infections. The cold virus is highly infectious, but rarely deadly. However, some viruses that cause Ebola, Marburg, and Lassa fevers have extremely high mortality rates that can only be overcome by isolation.

Global air travel since the 1960s is making it possible for new kinds of viruses to emerge from remote places. Influenza such as SARS has been spread in this fashion. Other emerging viruses include the HIV/AIDS virus, which is now killing millions of people globally. The global spread of viruses includes those that infect animals and humans. After the West Nile virus appeared in the United States, it killed millions of birds and a few humans. Viruses spread through casual contact, the ingesting of food from infected sources (hepatitis from oysters), insect bites, or even animal bites. Airborne currents spread respiratory viruses, such as the hanta virus from rodent droppings. Others spread by body fluids. Careful sanitation helps to reduce the rate of infection.

The human immune system fights viral infections in several ways. In infections like measles with a high fever, lymphocytes use antibodies to cover the virus's capsid, or by destroying cells infected with the virus. Mucus is used to capture and expel large amounts of respiratory viruses, while interferon, a protein-like substance made by the body, fights other viruses. Some viruses suppress the immune system and spread in the body rapidly. A few viruses move slowly. Others, like herpes, may be dormant for a long time and then have sporadic outbreaks. Viruses cost billions of dollars annually because of the damage they cause to crops and animals. However, viruses have been used to control insects and invasive species. Rabbits, a serious invasive species in Australia, have been controlled with the myxoma virus.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Disease; Influenza; Parasites; Pasteur, Louis; Vaccination.

BIBLIOGRAPHY. S.J. Flint et al., *Principles of Virology: Molecular Biology, Pathogenisis, and Control of Animal Viruses* (ASM Press, 2003); Laurie Garrett, *Coming Plague: Newly Emerging Diseases in a World Out of Balance* (Penguin Group, 1994); J.B. McCormick, Susan Fisher-Hoch, and L.A. Horvitz, *Level 4: Virus Hunters* *of the CDC* (Barnes & Noble Books, 1999); J.H. and E.G. Strauss, *Viruses and Human Disease* (Elsevier Science & Technology Books, 2002); E.K. Wagner and M.J. Hewlett, *Basic Virology* (Blackwell Publishers, 2003).

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Volatile Organic Compounds

VOLATILE ORGANIC COMPOUNDS (VOCs) are a set of chemical substances that tend to enter gaseous state during normal ground level atmospheric conditions. Owing to various chemical properties, VOCs have numerous uses in industry and in preparing consumer goods of different types, but since they also easily enter the atmosphere, their impact upon health must also be carefully investigated and, where necessary, regulated by government.

VOCs may be produced naturally, through the waste products of animals, or through by-products of hydrocarbons such as petroleum and its derivatives. VOCs may enter land and water sources as contaminants or become present in indoor air, increasing pollution of the air and possibly causing negative health impacts. Somewhat unfortunately, the tendency to increase energy efficiency in housing has led to a greater proportion of air retained inside accommodation, which has led to more indoor air pollution. This can cause minor symptoms, such as eye watering, headaches, and nausea, and more serious effects such as organ damage and cancer.

The main categories of VOCs include mostly carbon-based molecules such as hydrocarbons and aldehydes. A significant outdoor naturally occurring pollutant is methane, which, escaping into the atmosphere, is an important contributor to greenhouse gas global warming. In the United States, the Environmental Protection Agency (EPA) has led research to determine the presence of VOCs both indoors and outdoors in a range of different locations. The presence of VOCs indoors has been found at up to five times the level of outdoor pollutants.

The possibility of VOCs in commercially available products causing negative health impacts has led to a burgeoning industry in lawsuits relating to possible negligence. Consequently, much effort is being spent on defining what are and what are not VOCs and to what extent separate sub-categories of the chemicals should be permitted in domestic use. This is likely to increase in the near future as the long-term health impacts of exposure become clearer and the introduction of new chemical substances and their interaction with existing products is studied more intensely. This will in turn stimulate the creation of new technologies to deal with problems caused by VOCs and the meaning of regulations necessary to supervise their production. Both domestic occurrence and workplace hazards will need to be included in these evaluations as the range of products emitting VOCs is increasing.

SEE ALSO: Environmental Protection Agency (EPA); Global Warming; Methane; Pollution, Air.

BIBLIOGRAPHY. Alpha Barry and Diane Corneau, "Effectiveness of Barriers to Minimize VOC Emissions Including Formaldehyde," *Forest Products Journal* (v.56/9, 2006); Environmental Protection Agency, www.epa.gov (cited January 2007); R.E. Hester and R.M. Harrison, eds., *Volatile Organic Compounds in the Atmosphere* (Royal Society of Chemistry, 1995).

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Volga River

THE VOLGA RIVER, long characterized as "Mother Volga" and renowned as the cultural heart of Russia, rises in the Valdai Hills northeast of Moscow and runs 2,300 miles in a sweeping arc to the south before reaching its complex delta on the Caspian Sea. The Volga is fed by more than 200 tributaries and drains a watershed comprising 40 percent of European Russia, that portion of the country reaching from its western boundaries to the Ural Mountains. The vast Volga watershed embraces 40 percent of the Russian population, 45 percent of the country's industry, and half of Russia's major agricultural sector. An important transportation route in Russia for centuries, the Volga has been compared to the Great Lakes in North America for its key role in economic development. Currently, the Volga carries nearly 70 percent of all cargo on Russia's inland waterways. There are hundreds of ports and industrial docks along its course, and eight major complexes with dams, hydroelectric generating plans, and reservoirs line its bustling banks. The dams and reservoirs have transformed the Volga into a series of expansive lakes.

Boats on the Volga can reach the Black Sea through the Volga-Don Canal, and access to St. Petersburg and the Baltic Sea is possible through the Volga-Baltic waterway, which links the river with Lakes Ladoga and Onega in the north. The Volga reaches Moscow via the Moscow Canal and the Moscow River. Because of Russia's increased connection with the European Union, negotiations have been underway to allow access to the Volga and other Russian inland waterways by other European countries.

The Volga has been subjected to a great degree of pollution from a variety of sources. Industrial wastes, runoff of agricultural chemicals, and infusions of silt from deforested lands have seriously endangered the river. The construction of dams along the river has made it difficult for fish to reach spawning grounds and chemical changes in the water from pollutants have damaged the fishing industry. Pollutants from the Volga entering the Caspian Sea have damaged the immune system of thousands of seals and greatly reduced the fish catch. Especially vulnerable has been the sturgeon, the source of the Russian delicacy caviar. Although the delta of the Volga has thousands of individual streams serving as filters to cleanse the waters, this natural process does not trap all the pollutants carried in the waters.

The environmental degradation of the Volga has attracted international attention. In 2003 President Vladimir Putin stated his intention to double Russia's gross domestic product by 2010. Economists and environmentalists both expressed concern about the difficult task of balancing economic growth and protection of the environment in the Volga basin. Monitoring this situation is now the task of CABRI/Volga, a multinational organization dedicated to addressing risk management in the Volga basin. Institutional members represent the Russian Federation, Germany, The Netherlands, Greece, Italy, France, Hungary, and Malta. The acronym CABRI stands for Cooperation Along a Big River, and the organization has advocated for strong water management and coordination among groups administering environmental protection programs in the Volga basin.

SEE ALSO: Caspian Sea; European Union; Russia (and Soviet Union); Ural Mountains.

BIBLIOGRAPHY. Micha Bradshaw, *A New Economic Geography of Russia* (Routledge, 2006); Tim McNeese, *The Volga River* (Chelsea House Publications, 2005); Lawrence Oliphant, *The Russian Shores of the Black Sea in the Autumn of 1852: With a Voyage Down the Volga and a Tour through the Country of the Don Cossacks* (Adamant Media Corporation, 2000).

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War on Drugs

THE WAR ON DRUGS is the title of the policy of aggressively pursuing the production, distribution and use of illegal drugs that are abused for pleasurable effects. Since 1971, when President Richard M. Nixon launched the War on Drugs, thousands of people who were in some way involved with illegal drugs have been killed, and millions more have been arrested and imprisoned.

Natural drugs from herbs and plants number in the thousands. Most of these are taken as tonics, stimulants, or medicinally; while others are used for religious purposes. With the advances of chemistry in the 20th century many new drugs were developed. At first medicinal drugs were controlled by governments in order to protect people from unscrupulous purveyors of quack remedies. Then, as new synthetic drugs were sold for their pleasurable effects, many governments began to control the manufacture and distribution of synthetic drugs as well as natural drugs in order to protect the public from drug abuse.

All drugs have some "dramatic" impact on the body after being ingested, inhaled, or injected and reaching the target receptors in the body. Drugs may be classified as depressants, stimulants, steroids, hallucinogens, or opiates. Some forms of these, such as alcohol, nicotine, and caffeine, are legal, and others have legitimate medical uses.

Enormous social problems have arisen from the abuse of drugs. People who are addicted often squander their resources, lose moral restraint, and soon engage in a variety of criminal activities. If the drug use reaches a serious level it impedes occupational performances so that productivity is lost, or, in the transportation industry, lives and cargo may be endangered. Drug users involved in work that requires a security clearance may become vulnerable to blackmail.

The value of the illegally sold drugs around the world is estimated to be in the hundreds of billions of dollars. Criminal groups such as the Mafia in Italy have smuggled heroin from Afghanistan or Burma; while drug cartels have smuggled cocaine from South America. The War on Drugs has hindered the traffic in illegal drugs but it has not eradicated it.

ENVIRONMENTAL EFFECTS

The War on Drugs has used a number of environmentally damaging tactics to stop drug trafficking. These have included burning poppy fields, coca tree plantations, and marijuana patches. More damaging has been the use of herbicides to destroy crop areas held by armed local farmers, gangs, and, in some areas, ideologically-driven guerilla bands. In Columbia the aerial fumigation program of the U.S. government has delivered enough herbicides to growing areas to damage fragile ecosystems in some areas of the Amazon Basin and to negatively affect the health of people in the area.

In some areas of Columbia, Mexico, the United States, and other countries, deforestation and destruction of hundreds of thousands of acres of crops have resulted. In many cases the deforestation is in delicate rainforests and cloud forests. Some critics believe that the negative environmental impact of the War on Drugs may soon exceed the costs of drug addiction.

SEE ALSO: Afghanistan; Cocaine; Columbia; Deforestation; Drugs; Herbicides; Opium (and Heroin); Poverty.

BIBLIOGRAPHY. Antonio Escohotado, *Brief History of Drugs: From the Stone Age to the Stoned Age* (Inner Traditions, 1999); Mike Gray, *Drug Crazy: How We Got into This Mess and How We Can Get Out* (Taylor and Francis, 2000); Michael Kerrigan, *War Against Drugs* (Mason Crest Publishers, 2002); Tamara L. Roleff, ed., *War on Drugs* (Thompson Gale, 2004).

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Wars

MANY PEOPLE THINK of peace as simply the absence of war. Peace scholars, however, recognize peace entails far more. “Positive peace” refers to the absence of war as well as conditions of social justice, including full human rights for all. The ability to live in a sustainable environment would clearly be a part of this positive peace.

Every war has impacted the physical, chemical, biological, and human or social environment in a variety of ways, both directly and indirectly. In recent years, environmental damages wrought by warfare have worsened significantly. This is due to the increased intensity of modern warfare as well as the use of new, more destructive, technologies. In addition, scarcity and unequal distribution of needed resources, such as clean water and arable land, have contributed to conflicts both between countries as well as within specific nations. Experts have warned that rapid depletion of these resources will only exaggerate the likelihood that environment will be a precursor for conflict. While all forms of warfare are environmentally damaging, civil war has been found to be more harmful than wars between nations. This is likely due to a number of factors, including the extended length of civil wars.

WAR AND NATIONAL INFRASTRUCTURES

One way war wreaks havoc on the environment is by degrading a country’s infrastructure. Water supply systems and sanitation services, for instance, are often contaminated or rendered completely unusable by bombs or bullet damage to pipes. This then leads to contamination of drinking water, associated with a number of diseases, some of them fatal, to humans and animals. In the current war in Iraq, unreliable electricity due to warfare has led to sewage backups, and waste is being dumped into the Tigris River, Baghdad’s only source of water.

Countries experiencing depleted infrastructures from warfare must prioritize their reconstruction efforts, and environmental damages often end up near the bottom of the list. Many countries ravaged by war have limited, if any, hazardous waste treatment facilities or other means to take care of environmental problems. In Kuwait, Iraqi forces destroyed sewage treatment plants during the 1991 Gulf War, resulting in over 50,000 cubic meters of raw sewage discharged daily into Kuwait Bay.

Sometimes the destruction of parts of a country’s infrastructure is by design. In World War II, destruction of dams and dikes was common. In Sarajevo, soldiers cut off electricity and water pumps. Destruction of facilities designed for war production can lead to a host of other problems.

IMPACT ON PLANTS AND ANIMALS

War also threatens biodiversity. Historically, examples of deliberate destruction of crops and forests can be found in the conflicts between Israelites and Philistines in the 12th century B.C.E. Genghis Khan also authorized the destruction of crops and forests in his conquering of China. Military machinery and explosives damage forests and habitats, which in turn disrupts the ecosystem, leading to erosion as well as concerns about safe water and food. For instance, approximately 35 percent of Cambodia's forests were destroyed by warfare over two decades.

The destruction of oil wells, generally a feature of conflicts in the Middle East, has brought a number of forms of environmental damage. In the 1991 Gulf War, Iraq destroyed more than 700 oil wells, releasing approximately 10 million barrels of oil into gulf waters. The desert of Kuwait, said to be a healthy area prior to the war in 1991, is coated with oil residues that affect water permeability, seed germination, and microbial life. In addition, it took months to cap the oil wells, so crude oil released into the sea killed marine birds and mammals, while the oil itself formed petrochemical lakes. Toxic smoke and fumes from oil spills killed migratory birds. Veterinarians claimed to have seen birds literally dropping from the sky.

As already noted, civil war is perhaps even more devastating to plants and animals than is war between nations. In Angola, decades of civil war have left national parks and wildlife reserves with only 10 percent of their 1975 wildlife levels, a dramatic reduction in the region's biodiversity.

CHEMICAL AND BIOLOGICAL WARFARE

Chemical and biological warfare is especially damaging to the environment. The United States used the pesticide DDT in World War II, primarily in the Pacific. One naval officer reported that the first use of DDT in the Pacific completely destructed the animal and plant life there.

The U.S. military's use of toxic defoliant Agent Orange in Vietnam between 1962 and 1971 destroyed approximately 14 percent of the forests in South Vietnam, including up to 50 percent of the mangrove forests. Agent Orange also resulted in the loss of freshwater fish in Vietnam, as well as half of the commercial hardwood trees and many other rubber trees. Agent Orange contained dioxin, one of the worst carcinogens. Thus in addition to environmental destruction, use of Agent Orange has been linked with birth defects, spontaneous abortions, chloracne, skin and lung cancers, lower IQ, and emotional problems in children.

Biological warfare also poses tremendous environmental risks. Biological weapons were prohibited by the 1925 Geneva Protocol, as well as by the Biological Weapons Convention (BWC) of 1972, which had been signed by 134 nations by the mid 1990s. Biological weapons are still a concern, however, as some nations have continued to develop and use them regardless of international law. Historically, aggressors have spread the bubonic plague, anthrax, typhoid, cholera, dysentery, and a host of others. In 1346, rats and fleas were released during war in what is now the Ukraine. Between 1754 and 1767, the U.S. military infected Native Americans with smallpox, both unintentionally through contact as well as intentionally through the distribution of infected blankets. During the 1937 Sino-Japanese war as well as during World War II, the Japanese experimented with a number of types of biological warfare. Most notably, the conducted experiments on the Chinese, giving them plagued food items as well as intentionally contaminated water sources. More recently, concerns that Iraq had developed, stockpiled, and even used biological weapons was a major impetus for the U.S. waging war.

NUCLEAR WARFARE

Nuclear weapons and facilities are also devastating to the environment. The most notable example is the U.S. bombing of Hiroshima and Nagasaki in 1945, which destroyed over ten square miles of land. In 2003, an estimated 200 plastic barrels containing uranium were stolen from the Tuwaitha nuclear plant in Iraq. Poverty-stricken residents dumped the contents into rivers, then used the barrels to store their water, cooking oil, and other basic amenities. These substances not only harm those who immediately ingest them, but seep into the ground, air, and water and food supplies. It is projected that thousands of hectares of Iraqi land is contaminated from depleted uranium used in the first Gulf War. Lake Karachai in the South Urals is considered the most contaminated body of water on earth due to nuclear testing and production.

Most of what is known about releases of radiation involves the United States. Several major production sites have been found associated with severe environmental contamination, including the Hanford Nuclear Reservation in Washington, the Oak Ridge Reservation in Tennessee, the Rocky Flats Plant in Colorado, and the Savannah River Plant in Georgia. All of these sites have been involved in accidental releases and continued emissions as part of their daily production.

WAR PREPARATION

Weapons production, testing, and maintenance are also destructive to the environment. Fuels, paints, solvents, heavy metals, pesticides, and PCBs, cyanides, phenols, acids, alkalies, and propellants are the waste products of the production, maintenance, and storage of conventional, chemical, and nuclear weapons and of military machinery. Producing semiconductors and other electronic components of weapons and equipment involves many highly toxic chemicals. Likewise, readying troops takes a tremendous toll on large pieces of land. It is estimated that NATO maneuvers in West Germany cost $100 million in damages to crops, forests, and private property per year in the 1980s.

The U.S. military is said to be the largest producer of hazardous materials in the United States and possibly even in the world. More than 7,000 former military properties in the U.S. are being investigated for toxic contamination, and almost 100 bases are already on the Superfund National Priorities List. Military testing in Alaska's Eagle River Flats, near Anchorage, has released high levels of toxic chemicals and contaminants into the soil, air, and water.

WAR REMAINS

The remains of the technology of war are also destructive to the environment. Land mines remain in many countries such as Vietnam and Cambodia, and in addition to the threat they pose to humans, they make agricultural production on the land impossible. It is estimated that some 70 to 100 million antipersonnel land mines are still active world-wide, and another 100 million exist in stockpiles.

Prior to the mid 1980s, there was little public attention to the potential for environmental damage of stockpiled chemical weapons in the United States. Until the late 1960s, surplus weapons were routinely dumped in oceans, burned in the open air, or buried. In 1986, Congress mandated the destruction of the U.S. stockpile of chemical weapons. While the Act stipulated that destruction of these weapons needed to involve environmental protections, it is unclear precisely how well this has been done.

INDIRECT EFFECTS

There are also many indirect environmental effects of war. Since land, roads, and bridges are often destructed, many crops are spoiled. Since people are no longer able to safely live in some areas of war-ravaged countries, over-use of other land contributes to soil degradation, deforestation, desertification, and many other environmental problems.

In many nations, refugee camps are created after a war. It is estimated that there are some 17 million refugees and 25 million internally displaced persons in the world today. These camps are likely another source of environmental damage, causing deforestation, loss of endangered species, water pollution, air pollution, and depleting sanitation systems. Deforestation occurs when land is cut for campsites, housing, and for cooking and heating. Overgrazing can accelerate soil erosion and the silting of rivers and streams. Disposal of solid wastes is difficult, so refugee camps often become breeding grounds for flies, rodents and other pests.

NEW WARS AND THE ENVIRONMENT

Terrorism as a form of violent conflict also poses great threats to the environment. In 1995, the Japanese cult Aum Shinrikyo planted the nerve agent sarin on subways in Tokyo. Raids of Aum's labs showed they were developing the botulin toxin, anthrax, cholera, and Q fever as well. The attacks on the World Trade Center in New York City on September 11, 2001, released asbestos and other hazardous chemicals into the air and land that the EPA is still working on cleaning up.

Yet another form of warfare with effects on the environment is the war on drugs in Latin American. In Columbia, the U.S. began aerial spraying of herbicides in an effort to destroy coca and poppy crops in 2000. While it is still to be determined if this is an effective measure in the effort to reduce drug use and trafficking, no doubt the widespread use of herbicides will damage the soil, plants, and animals beyond the targeted crops.

COSTS OF ENVIRONMENTAL CLEANUP

The cost of repairing the environmental damage of warfare is tremendous. The United States estimates that the cost of nuclear waste management and decontamination from the cold war alone are between $200 an $350 billion, while estimates of the cleanup costs for toxic wastes at U.S. military bases range between $20 and $40 billion. Cleanup costs from the 1991 Gulf War are tremendous. Just to decontaminate 200 hectares of land (of the thousands) will cost four to five billion dollars. Cleanup of the oil released into the Gulf is projected to cost more than $700 million.

Unfortunately, the environmental damage wrought by warfare generally goes unpunished. Although the UNEP labeled Iraq's lighting and dumping of oil in Kuwait in 1991, "one of the worst engineered disasters of humanity," no one was ever tried or punished. The Bern Protocols I and II of the 1977 additions to the Geneva Conventions of 1949 could potentially be used to hold countries' responsible for environmental damages wrought by warfare, but they only apply to half of the nations in the world. The Declaration of 1972 on the Human Environment established that nations have a responsibility to ensure their actions do not cause damage to the environment. It prohibits the targeting of dams, dikes, and nuclear power plants if doing so would release dangerous materials that would endanger civilians. It also prohibits the complete destruction of items required for human survival, including food, agricultural areas, livestock, and drinking water. Some have recommended a fifth Geneva Convention that would specifically address environmental damage in the course of war.

The situation may be changing, however. In 1992, the Rio declaration denounced environmental destruction during war and demanded states respect international law regarding the environment. 1996 marked the First International Conference on Addressing the Environmental Consequences of War. The Chemical Weapons Convention and the Treaty to Ban Landmines, both in 1997, are also tremendous steps toward greater consideration of war's impact on the environment. Unfortunately, several major countries have refused to sign the landmine treaty, which required the destruction of stockpiled landmines within four years of signing and the complete cleanup of all landmines within ten years. Most notably, the world's largest producer of landmines, the U.S., has refused to sign, although the U.S. has stopped production of new landmines.

THE ENVIRONMENT AS A CAUSE OF WAR

Environmental problems can also be part of the cause of war. Thomas Homer-Dixon identifies six types of environmental change that impact violent conflict: water and land degradation; deforestation; decline in fisheries; global warming; and ozone depletion. Norman Myers maintains there are five types of environmental problems that determine or exacerbate conflict: access and availability of water; deforestation; desertification; species extinction and gene depletion; and greenhouse gases.

Some claim the 1967 Arab-Israeli war was, in large part, due to water scarcity. Some groups have greater access to needed and desired resources because of the way geographical boundaries were created by colonial powers, as is the case in much of Africa. Socioeconomic scarcity involves unequal distribution or purchasing power and property rights. Environmental scarcity, in contrast, refers to resources that are becoming scarce because of humans' failure to use sustainable methods. Clearly, underdeveloped countries are at greater risk for both environmental problems and violent warfare. Scarcity undermines the states' capacity to provide for its citizens, and it also leads to economic and political demands.

In the Nigerian Delta, pollution from oil production has caused environmental damage that has disproportionately impacted the native Ogoni peoples. Gas-flaring, pipe leakage, dumping, and spills have all impacted the Ogoni, harming the soil, water, vegetation, and wildlife. The primary oil company in the region, Shell, operates in more than one hundred countries, but forty percent of all their recorded oil spills are in Nigeria. Between 1982 and 1992, 1,626,000 gallons of oil were spilled in 27 different instances. While oil executives live in lavish surroundings from their profits, the Ogoni live in abject poverty. Some Ogonis have organized to protest the degradation of their lands for the profit of oil executives. Their efforts have met with much resistance, most notably when military dictator Sani Abacha had activist Ken Saro-Wiwa and eight others hung in 1995. In 1999 alone, more than 200 people were killed in oil-related riots.

Not only does environmental scarcity lead to violent conflict, but the reverse is true as well. In Liberia and Sierra Leone, fighting destroyed forests. Rebel groups then exploited the scarce timber resources to further finance their warfare. The Food and Agricultural Organization (FAO) and the World Food Programme (WFP) say that civil strife is a tremendous threat to food security in Africa and other developing areas. Although war generally does terrific damage to the environment, it is possible that some positive can come from it as well. Some post-war or former war manufacturing areas are now beautiful nature preserves. Rocky Mountain Arsenal is now one of the nation's premier wildlife refuges, home to some 300 species of wildlife and visited by some 50,000 people each year. Similarly, the U.S. military has turned over approximately 100,000 acres of land by 2000 in Illinois, Maine, California, and northern Virginia to various federal agencies. The demilitarized zone in Korea is home to endangered species and migratory birds and is considered one of the most plentiful in Asia.

SEE ALSO: Agent Orange; Nuclear Weapons; Vietnam War.

BIBLIOGRAPHY: Ken Conca and Geoffrey Dabelko, eds., *Environmental Peacemaking* (Woodrow Wilson Center Press, 2002); E. Conteh-Morgan, *Collective Political Violence* (Routledge, 2004); Paul Diehl and Nils Petter Gleditsch, eds., *Environmental Conflict* (Westview Press, 2001); Barry Levy and Victor Sidel, eds., *War and Public Health* (American Public Health Association, 2000); Max Manwaring, ed., *Environmental Security and Global Stability* (Lexington Books, 2002); E. Russell, *War and Nature* (Cambridge University Press, 2001); Judith Shapiro, *Mao's War Against Nature* (Cambridge University Press, 2001); United States Department of State, "Hidden Killers: The Global Problem With Uncleared Landmines" (Department of State, 1993).

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Waste, Human

HUMAN WASTE (SOMETIMES referred to as *raw sewage*) is becoming an increasing problem for people, animals, and the environment. Untreated human waste, as it runs off into streams, rivers, lakes, and oceans, is causing significant problems for humans and marine life. People are negatively affected by human waste because it contributes to illness and disease. Raw sewage is a significant factor in the sickening of over one million people annually. The bacteria, viruses, and parasites common in human waste can lead to diseases such as hepatitis (a liver disease), meningitis (an inflammation of the membranes that cover the brain and spinal cord), and cholera (an acute intestinal infection). It is estimated that each year approximately 900 people die from contamination of this kind. Exposure to human waste can be caused by drinking contaminated water; swimming in oceans, lakes, and streams that have raw sewage in them; and eating food that has been in contact with human waste.

Not only is the toll on humans significant, but human waste contamination in oceans is also causing problems for marine life. When untreated human waste makes its way into the oceans, it can poison shellfish. It is also a contributor to "dead zones" in coastal waters where oxygen levels are too low to sustain life. The nitrogen found in human waste (which is also found in fertilizers and emissions from vehicles and factories) contributes to this problem. Nitrogen, emitted into the ocean, fertilizes microscopic plant life and causes it to flourish. When the plankton die, they fall to the ocean floor and are digested by microorganisms. This process removes oxygen from the water and creates the dead zones.

Human waste seeps into the water primarily through septic tanks and antiquated sewage systems in municipalities. Many homes in the United States have septic systems in which wastewater is piped into the septic tank from the home and the excess flows out into the ground, where it is absorbed. It is estimated that one person puts out seven pounds of nitrogen a year into a septic tank, and about half of this nitrogen reaches the water table. Antiquated sewage systems are very costly to modernize and expand. Many cities have sewage pipes that were laid in the 1800s, and most lack the funding necessary for improvements. It is estimated that human waste seeps into streams and lakes 40,000 times every year as a result of this.

There are ways to minimize the impact of human waste on the environment. When developing new areas, cities must continue to build sewage systems that can accommodate a surge in population. Better maintenance of current sewage systems (such as having crews check lines to keep tree roots and grease clogs out of the system) helps. In addition, new regulations provide incentives to control human waste contamination in water.

SEE ALSO: Disease; Groundwater; Marine Pollution; Pollution, Water; Septic Systems; Sewage and Sewer Systems; Wastewater.

BIBLIOGRAPHY. Tom Vanden Brook, "Sewage Pouring into Lakes, Streams," *USA Today* (August 20, 2002); Centers for Disease Control, www.cdc.gov (cited April 2006); Cheryl Lyn Dybas, "Dead Zones Spreading in World Oceans," *Bio Science* (v.55/7, 2005); Elizabeth Weise, "As Suburbs Grow, So Do Environmental Fears," *USA Today* (December 28, 2005).

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Waste, Nuclear

THE PROCESSING OF nuclear material such as plutonium and enriched uranium for energy production results in spent material. A nuclear power station with a 1,000 megawatt capacity will typically produce in excess of 20 tons of spent fuel annually. This material must be disposed of as safely as possible because it is highly radioactive and dangerous to human health, causing cancer and other illnesses. However, the material may sometimes be reprocessed. The fission materials produced by the original processing may be removed and the spent material can either be recycled or collected into weapons-grade plutonium or uranium.

Approximately 270,000 tons of nuclear waste has already been produced globally, and current projections are for an additional 12,000 tons to be produced annually for the next 25 years. In addition to nuclear power plants, nuclear waste is produced by nuclear-powered surface ships and submarines, and by some private research institutions. In all of these situations, regulations exist to ensure safe handling. In the case of the accidental meltdown at the Chernobyl nuclear power plant in the Ukraine, it is not clear whether regulations were properly policed.

Spent material is processed in a separate facility from where it was used. It is placed in steel canisters with additional overcoats; the canister is then welded shut. This method is considered the safest means of dealing with the spent fuel. However, depending on the type of spent fuel involved, and the methods by which it has been treated, alternative means of disposal are also possible. For example, French nuclear power station technicians have devised a special method for nuclear waste disposal. Solid residue is first melted and then formed into borosilicate blocks that solidify within steel canisters approximately one meter tall and up to almost a half meter in diameter. The steel canisters are then deposited into a safe repository.

Despite accidents such as those at Chernobyl and Three Mile Island in the United States, the demands for nuclear energy are great and will only intensify in the future as a result of problems with fossil fuels such as emission of greenhouse gases and the secure sourcing of oil. Demand for nuclear energy will presumably be greatest in those countries with the highest requirements for energy and those that do not have access to alternative energy sources. Many countries are unable to store nuclear waste within their own borders because of geological, geographical and political reasons. As a result, it is necessary to consider the creation of a cross-border trade in the disposal of nuclear waste.

Understanding of safety issues surrounding nuclear waste has improved significantly since the end of the 20th century. Since nuclear waste is radioactive and slow to decay, it can cause harm for thousands of years. Considerable political and technical controversy surrounds issues relating to the safe storage of the waste. Safety issues must be considered in transporting radioactive material to a desired location. The risks involved include accidental leakage of the radioactive material while en route and attempts to seize the material for purposes of terrorism or extortion. There is also the threat of geological rupture. For example, if an earthquake occurred, it could break open the containment materials holding the nuclear waste. The method widely considered viable for nuclear waste disposal is to contain the radioactive material within a non-reactive barrier and bury it deep within the earth's crust in a region not known for geological disruption.

The Yucca Mountain project in the state of Nevada in the United States has been designated as one such possible place for nuclear waste disposal. This has, understandably, led to great concern among local residents, as well as those who live near transportation routes. Located some 70 miles from Las Vegas, the site is the only one under active consideration by the U.S. government for the development of high-level nuclear waste disposal. It has been estimated that the use of this facility would require movement of radioactive material through 43 U.S. states and more than 100 cities, and passage through the Great Lakes. Shipments would pass within a mile of millions of American citizens. Throughout the 1990s, the rate of rail accidents involving hazardous material averaged 33 per year. Approximately 10,000 people are also evacuated from their homes each year as a result of the nuclear waste transportation. Accident rates for trucks and barges, which would also be required, are comparable. More than 108,000 shipments of nuclear waste are projected by the U.S. Department of Energy in the next 38 years based on existing trends.

People opposed to the use of nuclear power point to these alarming statistics to argue that it is impossible to guarantee safety. People in favor of nuclear power say that there is little choice but to make sure that the methods of disposal are as safe as possible though some level of risk does exist. Public skepticism about the ability of science to deal with nuclear waste may be a result of the poor image of the nuclear power industry. To create a more positive perception of this industry, there are a variety of ongoing public relations efforts in many nations.

Many scientists have concluded that the practical difficulties involved with deep disposal are surmountable. However, the political controversy surrounding this method of disposal, not to mention the costs involved, means that no such facilities yet exist. Many believe that Australia would be an appropriate repository for the long-term disposal of internationally-produced nuclear waste. They note that Australia is a perfect candidate because of its large central desert area that is lightly populated. Its stable geology and the fact that it is a modern democracy are also pluses. Technical requirements for a nuclear waste repository require a 200-meter-thick barrier between ground level and the disposal area. In addition, there should be predictable and low flows of groundwater and dense sedimentary ground formation. There should also be an absence of any resources, including freshwater. All of these factors are important in choosing a location as they would reduce the likelihood that people would ever live nearby.

Nuclear power undoubtedly leads to some serious risks, including the possible consequences resulting from an accident or malicious intervention. However, it seems likely that there is a need for the use of nuclear energy as an alternative energy source in place of oil and hydrocarbons. It is necessary for science to minimize the risks involved in nuclear waste disposal and for society to determine whether those risks are indeed acceptable.

SEE ALSO: Chernobyl Accident; Greenhouse Gases; Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); Nuclear Weapons; Three Mile Island Accident; Uranium; Yucca Mountain.

BIBLIOGRAPHY. Rodney C. Ewing and Alison M. MacFarlane, *Uncertainty Underground: Yucca Mountain and the Nation's High-Level Nuclear Waste* (MIT Press, 2006); Tom Quirk, "The Safe Disposal of Nuclear Waste," *Institute of Public Affairs Review* (v.57/2, 2005); Peter D. Riley, *Nuclear Waste: Law, Policy, and Pragmatism* (Ashgate Publishing, 2004); Sierra Club Nuclear Waste Task Force, "Deadly Nuclear Waste Transport," www.sierraclub.org (cited November 2006).

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Waste, Solid

SOLID WASTE, ALSO called *trash* or *garbage*, commonly refers to domestic waste. Waste generated

Modernization and higher standards of living are often followed by an increase in paper and plastic waste.

from households includes food scraps, paper, newspaper, clothes, packaging, cans, bottles, grass clippings, furniture, paints, batteries, and more. In developing countries, it is often contaminated by hospital waste, industrial waste, and other hazardous waste. The World Health Organization (WHO) defines waste as "something which the owner no longer wants at a given place and time, and which has no current perceived value." According to P.R. White, waste often contains the same materials found in useful products; it only differs in its lack of value.

Solid waste is also the term used internationally to describe nonliquid waste materials arising from domestic, trade, commercial, industrial, agricultural and mining activities, and from public services. Solid waste comprises countless different materials: Dust, food, packaging, clothing and furnishings, garden waste, agricultural waste, industrial waste, and hazardous and radioactive waste, to name a few. Municipal solid waste includes wastes that result from municipal functions and services such as street waste, dead animals, and abandoned vehicles. In waste management practice, however, the term is applied in a wider sense to incorporate domestic wastes, institutional wastes, and commercial wastes that arise in an urban area.

The quantity of waste generated depends on the socioeconomic conditions, cultural habits of the people, urban structure, density of population, extent of commercial activity, and degree of salvaging at source. Some of the factors that contribute to an increase in solid waste generation are growth in Gross Domestic Product (GDP), rise in disposable incomes, and a structural change in the pattern of production. The kind of waste generated and, hence, the way it should be handled changes with modernization and urbanization. People in rural areas tend to generate different kinds of waste; there is always an increase in paper and plastic and a decrease in ash and earth content in waste as a society urbanizes. Another difference between developed societies and developing countries is the difference in the amount of organic waste generated. Developed countries relying more on packaged and canned food have shifted organic waste production from domestic to industrial sources (where the food is packaged or canned).

Poor solid waste management, especially uncontrolled dumping, can cause health problems and environmental problems such as pollution of surface and groundwater from leachate production. If waste is not managed properly, unhygienic conditions put people at risk of acquiring infections of the skin and of the gastrointestinal and respiratory tracts. Poor waste management or accumulated garbage can trigger epidemics of foodborne infections. Uncovered and mismanaged waste attracts flies, mosquitoes, and rodents, leading to the spread of vectorborne diseases. Health hazards can be caused by the presence of human excreta, hospital and clinical waste (including medicines, syringes and infected human parts), and hazardous waste from small-scale industries. Therefore, appropriate solutions—minimization at source and appropriate disposal, whether through recycling, reuse, composting, incineration, or disposal at landfill—are necessary.

Integrated waste management is one of the recommended ways to handle waste effectively. It is a complex, multi-stage process that covers generation, collection, storage, transportation, and disposal of waste from beginning to end. Effective waste management involves all stakeholders, including the communities that generate the waste. Changes in policies or methods usually require changes in people's behavior; therefore, municipalities are finding ways to involve communities in coming up with innovative ways of dealing with the challenges of increased waste generation.

A solid waste management system should not only ensure human health and safety, but it should also be both environmentally and economically suitable. To be environmentally sustainable it must reduce the environmental impacts of waste, including energy consumption; pollution of land, air, and water; and loss of amenities as much as possible. To be economically sustainable, waste management options should be such that the cost is acceptable to the community, including private citizens, businesses, and government.

Environmental and economic objectives cannot always be achieved at the same time, and a balance, called the Best Practicable Environmental Option, often needs to be struck to minimize the overall environmental impacts of the waste within an acceptable level of cost.

SEE ALSO: Disease; Garbage; Landfills; Pollution, Water; Recycling; Waste, Human; Waste Incineration.

BIBLIOGRAPHY. V.I. Grover, S.G. McRae, W. Hogland, and B.K. Guha, *Solid Waste Management* (Oxford and IBH Ltd., Delhi, 2000); J.R. Holmes, ed., *Managing Solid Wastes in Developing Countries* (John Wiley & Sons, 1984); M. Suess and J.W. Huismans, "Management of Hazardous Waste," *European Series* (v.14, 1983); G. Tchobalogious, H. Theisen, and S.A. Vigil, *Integrated Solid Waste Management* (McGraw-Hill, 1993); P.R. White, M. Franke, and P. Hindle, *Integrated Solid Waste Management: Lifecycle Inventory* (Blackie Academic & Professional, Glasgow, Chapman and Hall, 1995).

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Waste Incineration

HISTORICALLY, AND EVEN today in some developing countries, the easiest way of disposing of waste has been to burn it in open air. Incineration of raw waste has been practiced throughout the history of humanity in the most crude form of incineration: Indiscriminate burning. The indiscriminate open burning of waste on a large scale, however, causes air, water, and soil pollution. Current incineration technology has come a long way from open burning to sophisticated incinerators. The purpose of burning has also changed from simply getting rid of waste to reducing waste volume and recovering energy. Nevertheless, adverse environmental impacts like air pollution and water pollution have made this process unpopular.

As solid waste constitutes a low-grade fuel, it has become a tradition in recent years, wherever possible, to recover part of the energy content of waste. The energy recovered can be used for energy requirements of the waste facility itself or for heating or residential, industrial, or commercial power generation. Incinerators and waste-to-energy facilities are more common in urban industrialized areas, largely because of the nature of the urban waste stream; rural waste does not normally have sufficient calorific value to make energy recovery efficient.

Incinerators can be classified by the type and form and waste input, by throughput capacity, by rate of production of heat, by the state in which residue emerges from the combustion chamber, and by the shape and number of furnaces. The key systems involved in incineration are the tipping area, storage pit, equipment for charging the incinerator, combustion chamber, bottom ash removal system, and gas cleaning equipment and boiler, if energy has to be recovered.

The process that takes place inside an incinerator is called pyrolysis, the thermal decomposition of waste at high temperatures in the absence or near absence of oxygen. The products of incineration are in all three forms—solid, liquid, and gaseous. It is important to regulate the temperatures of the furnace depending on the quality of waste so that more hazardous products are not produced upon decomposition and released into the environment.

The impact of emissions from waste incinerators on human health is of great public concern, especially the release of toxins like dioxin. Research has identified numerous toxic compounds emitted in gases and in ashes (e.g., organic pollutants such as chlorinated and brominated dioxins, PCBs and PCNs, heavy metals, sulphur dioxide, and nitrogen dioxide), as well as many unidentified substances of unknown toxicity. This leads to contamination of the environment and to potential exposure of humans to hazardous pollutants that may cause health problems such as cancers.

Besides polluting air, incinerators emit wastes to water from cleaning equipment. While published data on air pollution through emissions from burning waste, fly ash, and bottom ash is available, emissions to water from incineration remain largely understudied. Wastewater from wet exhaust gas cleaning, however, is known to contain heavy metals, the most significant being lead, cadmium, copper, mercury, zinc, and antimony. Wastewater from wet slag removal equipment contains high levels of neutral salts and also contains unburned organic material from the residue. Based on some of this evidence, it can be argued that use of incinerators ignores the adoption of the precautionary principle.

The advantages of incineration include:

1. Incinerators can be built close to the source of waste, reducing transport costs.
2. Incineration is suitable for many flammable, volatile, toxic, and infectious wastes that should not be land-filled.
3. It produces no methane, unlike landfill sites.
4. It reduces the amount of waste requiring landfill disposal.

On the other hand, the disadvantages of incineration are:

1. High capital and operating costs make it a relatively expensive method of waste disposal.
2. Reliance on incineration could restrict choices of future disposal options, including a proper consideration of waste minimization or recycling.
3. There is significant danger of atmospheric pollution (though some modern incinerators do meet the strict emission criteria); some incinerators generate toxic liquid effluent.
4. The volume of residue is still 40–50 percent of equivalent waste in compacted landfills.
5. It concentrates toxic materials in the residue and most residues still have to be land-filled.

The competitive demand for declining fossil fuel supplies has led to the search for energy from renewable sources, including waste. Recovering energy from waste does hold promise for the future, especially with new technologies for emission control that might meet more strict emissions criteria. Also, it is the basic principle of an ecologically-oriented waste management policy or waste hierarchy that waste should be reused and recycled. When waste cannot be avoided, recycled, or reused, moreover, it has to be subjected to special treatment before its ultimate disposal to prevent any further environmental burden or impact. One of the most flexible ways to do this is the thermal treatment of unavoidable and unrecoverable residues in modern waste incineration plants equipped with special flue gas cleaning processes. In these plants, the pollutants of the flue gases are eliminated to such an extent that they do not cause any environmental burden.

An example of an incinerator with strict emission control is in Vienna, where an eminent painter was even invited to paint a mural on the incinerator to promote it and increase public awareness of the better emission control system in the incinerator. However, for developing countries, incineration should be used with care.

Although incineration generally reduces the quantity of waste going to landfill sites, it is mainly recommended for medical or hazardous waste in such countries, where resources remain scarce and modern equipment is too expensive to procure for standard waste streams.

SEE ALSO: Garbage; Landfills; Pollution, Air; Pollution, Water; Recycling; Waste, Solid.

BIBLIOGRAPHY. M. Allsopp, Pat Costner, Paul Johnston, and David Santillo, "Incineration and Human Health: Characterization and Monitoring of Incinerator Releases and their Impact," in V.I. Grover, V.K. Grover, and W. Hogland, *Recovering Energy From Waste* (India and Science Publishers, Inc., 2002); E. Ardevol et al., "Environmental Tobacco Smoke Interference in the Assessment of the Health Impact of a Municipal Waste Incinerator on Children Through Urinary Thioether Assay," *Public Health* (v.113, 1999); Helmut Loffler, "Thermal Treatment of Waste in Vienna: An Ecological Solution?" in V.I. Grover, V.K. Grover, and W. Hogland, *Recovering Energy From Waste* (India and Science Publishers, Inc., 2002).

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Wastewater

WASTEWATER IS NOT just sewage. Defined as domestic, industrial, agricultural, and storm water flows that drain into sewage collection systems, wastewater reflects the geographic character of communities and environments. Sewage, or refuse liquid and waste matter produced by residences and commerce, is often labeled "wastewater;" yet sewage is technically limited to discharge channeled by sewer pipes. Wastewater, however, pulls from a broader array of social and environmental sources: Storm drains, overflowing creeks, septic tank leaks, and runoff from parking lots and pavements, the crop field, and the industrial dump site. Wastewater quality and quantity are thus related to the patterns and politics of water availability, governance, and waste-making practices.

Wastewater composition is approximately 99 percent water by weight, but it contains numerous biological, chemical, and material compounds ranging from pathogenic bacteria to pharmaceutical compounds and trash. In large quantities, these compounds produce adverse effects on human and ecological systems. For example, in municipalities with combined storm drains and sewer infrastructure, storm water mixes with wastewater after severe rainfall events, often resulting in combined sewer overflows. These overflows, in tandem with renegade wastewater flows and increased urban runoff, frequently result in poor water quality. For this reason, many laws and regulations (such as the U.S. Clean Water Act) mandate wastewater treatment to decrease environmental contamination and improve water quality.

Wastewater treatment plants intervene at critical points in the water cycle. Although septic tanks are still common in rural areas, the majority of municipal wastewater is treated in large-scale plants. There are no holidays for wastewater treatment: Most plants operate 24 hours per day, seven days per week. Treatment plants are designed to reduce harmful substances and pollutants in wastewater before flows are returned to rivers, oceans, or the broader environment. In general, there are three stages of wastewater treatment: (1) primary treatment (physical removal of floatable and settleable solids; (2) secondary treatment (biological removal of dissolved solids); and (3) tertiary or advanced treatment (removal of nutrients and chemicals).

Primary treatment extracts solid particulates and oils from wastewater. First, influent is screened to remove large objects, such as rocks, corpses, or condoms, which could plug sewer lines or block tank inlets. Next, flows enter a grit chamber and decrease in velocity, allowing sand and grit to fall out. Macerators (revolving cylinders with rotating knife edges) are sometimes used in place of screens to cut solids into smaller, collectable particles. Finally, wastewater is slowly moved through sedimentation tanks (also called clarifiers or settling tanks). Fecal solids settle out in the tanks and are pumped away, while oils, grease, and plastics float to the surface and are skimmed off.

Secondary treatment typically utilizes aerobic biological processes to further degrade the supernatant (remaining flows after primary treatment) and convert nonsettleables to settleable solids. This level of treatment removes approximately 85 percent of the total suspended solids (TSS) in wastewater and is the minimum level of treatment required by the U.S. Clean Water Act. Secondary treatment is a balance of engineering, siting politics, budgets, and local environmental conditions. Secondary systems are classified either as suspended growth or fixed film, although systems may use elements of both. The most common suspended growth option, activated sludge, uses microorganisms to break down organic material via aeration, agitation, and settling. The sludge, which contains fungi, protozoa, and aerobic bacteria, is continually recirculated through the aeration basins to speed the process of organic decomposition. In general, suspended growth systems require less space, but may not be able to handle shocks in biological loading.

In many older plants, fixed film processes are used. For example, wastewater is sprayed into the air (a process called aeration) and allowed to trickle down through coarse media, such as beds of stones or plastic. Microorganisms, attached to and growing on the media, break down organic material as wastewater seeps past. These secondary systems provide higher removal rates for BOD (biological oxygen demand: an indicator of pollutant quality) and are better able to cope with quantity variability, but require large tracts of land and are often rejected by nearby communities for aesthetic and political reasons.

Tertiary treatment is the polishing stage of wastewater treatment. In response to successful litigation by environmental groups and higher regulatory standards, many wastewater facilities increasingly employ advanced tertiary methods to improve effluent quality. Tertiary treatment includes a broad range of methods, such as physical, biological, or chemical processes to remove nitrogen and phosphorus, carbon adsorption to remove chemicals, and disinfection using chlorine, ozone, or ultraviolet light.

Tertiary treatment is needed to produce reclaimed water: Highly treated and recycled wastewater commonly used for nonpotable and nonagricultural uses (such as the irrigation of parks and public spaces). However, due to increasing population, water consumption patterns, and demand for new supplies, many areas are now considering broader uses for reclaimed water. For instance, water providers in Orange County, California, use reclaimed water for indirect potable recharge: The method of blending reclaimed water with other drinking sources through groundwater recharge or reservoir augmentation. For better or for worse, the debates over reclaimed water use in the municipal sector have focused attention on wastewater treatment plants as key links between water quality and quantity.

Despite advances in engineering and treatment, problems associated with wastewater pollution, management, and disposal continue to plague communities and environments worldwide. Approximately 2.6 billion people lack access to improved sanitation: A broad category that includes ventilated pit latrines, composting toilets, and toilets connected to septic tanks or piped sewers. Although global sanitation coverage rose from 49 percent in 1990 to 58 percent in 2002, access to potable water supply still outstrips sanitation access. The United Nations (UN) Millennium Development Goals aim to halve the proportion of people without access to basic sanitation by 2015; yet the UN estimates that if the 1990–2002 sanitation trend continues, roughly 2.4 billion people will be without improved sanitation in 2015, almost as many as are without today.

Developed nations have not escaped the problems of wastewater either. Many European and North American countries feature excellent rates of sanitation access, well-established institutions, and strong regulatory mechanisms; yet, non-point-source pollution, high rates of water consumption, and excessive waste-generating practices have contributed to wastewater problems in many major cities. For example, on a daily basis, California sends billions of gallons of partially treated sewage into the Pacific Ocean. The sewage usually meets state and federal effluent standards, but increased nutrient loading, urban runoff, and wastewater discharges have caused massive algae blooms, turning coastal waters into toxic soup for marine mammals, fisheries, and recreational users.

SEE ALSO: Recycling; Septic Systems; Sewage and Sewer Systems; Sewer Socialism; Water; Water Demand; Water Quality.

BIBLIOGRAPHY. Robert L. Droste, *Theory and Practice of Water and Wastewater Treatment* (J. Wiley, 1997); George Tchobanoglous, Franklin L. Burton, and David H. Stensel, *Wastewater Engineering: Treatment and Reuse* (McGraw-Hill, 2003); United Nations (UN) World Wide Water Assessment Program (WWAP), *Water, A Shared Responsibility: The United Nations World Water Development Report 2* (UN Educational, Scientific, and Cultural Organization and Berghahn Books, 2006); Kenneth R. Weiss, "Sentinels Under Attack," *Los Angeles Times* (July 31, 2006).

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Water

WITHOUT WATER, LIFE would not be possible on earth: Water is an essential part of any ecosystem and is indispensable for human development, health, and well-being. In December 2003, the United Nations (UN) General Assembly proclaimed the years 2005–15 as the International Decade for Action, Water for Life. Water's molecular arrangement is very simple: Two hydrogen atoms attached to an oxygen atom. The elements are the two most common in the universe. This special substance has many properties, including the ability to change state. Water can be found in nature in three different forms: Solid, liquid, and gas. Solid water is found in glaciers and snow, vapor in the atmosphere, and liquid water in the oceans and seas, rivers and lakes, and underground water. Water on the surface of earth is constantly changing between these three states. These continuous changes create a cycle of repeating events called the water cycle.

This cycle starts when the sun's heat provides energy to water on the earth's surface, causing evaporation into the atmosphere. By this process, water changes from a liquid to a gas. Plants also contribute water to the air by transpiration. Water vapor condenses in the atmosphere to form clouds, and when the weather conditions are adequate, precipitation occurs in the form of rain or snow and water returns to the land and oceans and the cycle can start all over again. In this process, water vapor turns into liquid water (rain) or solid water (snow). Snow stays on the top of mountains for a long time until it finally melts and runs into the streams and rivers. Sometimes, snow turns into ice, and ice becomes a glacier. Most of the rain falls in the oceans and rivers, but some of the precipitation soaks into the ground, forming aquifers that store much drinking water. The water cycle never ends, and it is the only way that earth can be continually supplied with freshwater.

Although 70 percent of the earth is covered with water, only a small part is freshwater. Unfortunately, 98 percent of surface water is in the oceans—the remaining two percent accounts for the freshwater supplies of the world. Ninety percent of this freshwater supply is either in the poles or remains underground. Therefore, humans actually have access to only 0.000006 percent of the water available on the planet. Only 0.26 percent of freshwater resources are available for human consumption. There are also factors that contribute to the diminution of freshwater resources supply and to the rise of demand, all of them reducing water quantity and water quality.

DEMAND-INCREASING FACTORS

The world demand for water increased six-fold between 1900 and 1995. Apart from the water needed for maintaining natural ecosystems, both world population growth and urbanization contribute to this increase by pressing for domestic supply and economic use. Industrial and agricultural use is concurrently increased, which leads to a greater intersectorial competition for this resource.

One of the most worrying factors of this century is world population growth. The population living on the planet increased from 1.5 billion in 1900 to 6.0 billion at present. As a consequence, there has been a worldwide increase in water demand. Within the next 25 years the world's population could face severe water shortages. Greater demand for water for domestic purposes creates conditions in which some sectors do not receive water at all, and some receive it in lower quality and at a high cost. Moreover, this growth produces an increase in water use for industrial operations and for food production worldwide, but especially in poor countries that record the highest agricultural population growth rates. At the same time, excessive water use leads to surface and groundwater resource exhaustion, which produces a chronic shortage.

Water is used for household consumption, agriculture, industry, communication, as an energy source, and for recreation. It also contributes to environmental sustenance. Water used for household purposes represents 10 percent, just a small part of its total consumption. Approximately 90 percent returns to rivers and aquifers as wastewater. Most water is used in agricultural and industrial operations; industry uses between 20 and 25 percent of world freshwater reserves. Increases are expected to occur mostly in countries facing fast industrial growth. Industry only consumes approximately five percent of the total water extracted—the rest becomes wastewater that may contribute to the pollution of water reserves.

For the most part, freshwater is used for agricultural purposes. During the last half of the 20th century, food production increased 25 percent, slowly increasing world nutrition. On the other hand, agricultural irrigation uses at present between 60 and 75 percent of the water consumed on the planet. Irrigation systems are crucial but inefficient as they use and waste large amounts of water. Moreover, most irrigation is done by pumping subsurface water at a rhythm that makes it difficult for aquifers to recharge and depletes the amount of water available. According to the World Bank, the world's population will need an increase of 55 percent in food production by 2030 in order to survive. Most of this increase will derive from irrigation, and three-fourths of irrigated surfaces will be in developing countries.

SUPPLY-DECREASING FACTORS

Human beings modify the environment and misuse water resources that are also constantly threatened by pollution. At the same time, one-third of world population lacks adequate water supply. All these factors affect the quality and quantity of world freshwater supply. According to the Water Pollution Control Federation, more than 90 percent of drinkable water in the world is groundwater. Human beings extract water to develop domestic, industrial, and agricultural activities. But most of the water extracted from surface or underground sources is wasted or used inefficiently. The Second UN Report on the Development of World Water Resources states that 25 to 40 percent of potable water consumed in the world comes from under the ground. Groundwater is important where surface water is scarce. However, the rhythm of water extraction from aquifers is so fast that it prevents them from being recharged, which leads consequently to their depletion.

Most of the world's water available for human consumption is polluted, mainly by human activity. Industrial and agricultural development affect water quantity and quality as they return bad quality water to the hydrographic system. On one hand, fertilizers and pesticides often pollute the water returned to surface water and groundwater through irrigation. Industry and urban areas also return polluted water to surface water and groundwater. Thousands of effluents are emitted into lakes and rivers without previous treatment, and others form leachate, which is mixed with groundwater. Industries, including mining operations that emit toxic, sulfide, and metallic elements, and the food sector, which uses organic raw material that produces organic pollutants, contribute to water pollution with millions of tons of discharge per year. Moreover, household wastewater, which carries organic matter, pollutants, and bacteria of fecal origin, is discharged without previous treatment.

Although at present, people live more healthily than the previous generation, more than 20 percent of world population do not have access to good quality water. There are more than one billion people who lack access to potable water, and more than two billion do not have access to sanitary sewer systems. Most of these people live in developing countries and have medium to low income—the poorest and most vulnerable population. Developing countries have also historically lacked territorial planning that helps them distribute their populations in a more balanced way. This concentration of millions of persons in large metropolises causes great pressure on the environment with a lessening of water quality. Especially in Latin America, most people live in huge cities where the water is usually contaminated, which becomes a permanent threat to their health.

At the same time, these countries use fewer resources, while developed countries consume resources in excess. For instance, in Canada the average use of water for a typical family is 91 gallons a day and in Europe the average is around 42.9 gallons a day, while in Africa it is 5.2 gallons a day. The UN estimates that around 50 percent of the freshwater supply systems in developing countries are being lost due to inadequate maintenance and the lack of investments. Water, sanitation, and hygiene have important impacts on health and disease. More than five million people per year are estimated to die from diseases caused by bad quality water use. Diarrhea, schistosomiasis, filariasis, trachoma, malaria, cholera, typhoid fever, and other water-transmitted diseases cause deaths that could be prevented if the population were provided with potable water and adequate sanitary facilities.

One of the consequences of population growth is the simultaneous increase in the demand for forest goods and services. These include the forestry industry, which also produces fuel, wood, and paper, as well as farming operations. When trees are bulldozed or burned, apart from the huge biodiversity loss implied, the lack of vegetal cover exposes the ground to weather erosion, making the ground less fertile. Another consequence of deforestation is the loss of water sources. The forest cover acts as a sponge, retaining water from precipitation in order to gradually release it later, thus minimizing downstream floods and drought conditions. If the vegetal cover is removed, the leaking is superficial since water never reaches the deep tree roots. It precipitates rapidly and can cause floods. It also causes water quantity and water quality reduction, especially in urban areas.

Floods and droughts are two sides of the same coin affecting the poorest the most. On one hand, bulldozers, road building, and intensive soil use for agricultural purposes often increase erosion and sedimentation. This may cause floods in the intermediate zones of river valleys and a reduction of downstream flow. On the other hand, in arid and semiarid areas, the transformation of habitats for human use, mostly agricultural, and the increase of over-exploitation including overfarming, have led to the degradation of more than 20 percent of the ecosystems with severe results: Desertification, drought, and biodiversity loss. It is necessary to highlight that one-sixth of world population lives in arid and semiarid basins, constituting about three-fourths of the poorest population.

Water resources are inextricably linked with climate, so the prospect of global climate change has serious implications for water resources and regional development. The major cause of global warming is the excessive emission of greenhouse gases in industrialized countries caused mostly by fossil fuel burning. The annual emission is estimated at about six billion tons of carbon, mostly in the form of carbon dioxide. An additional two billion tons, or about 25 percent of total emissions of carbon dioxide, are thought to be a consequence of deforestation and forest fires. These excessive emissions accumulate more heat near the planet, leading to a more unpredictable climate coupled with sea level rise and over warming. The negative consequences of global warming are catastrophic: Desertification and drought increase, bad harvests, melting of polar ice cover, coastal floods, and replacement of the principal vegetation regimes.

UNEVEN DISTRIBUTION

The small fraction of freshwater accessible to humans is extremely unevenly distributed. Some researchers refer to regions with water “scarcity” and water “stress,” usually defined as regions with less than 1,000 and 1,667 cubic meters per person per year, respectively. Quantities depend on precipitation that is scarce and light in arid regions. In many countries like Australia the availability of water is seasonal. In absolute values, the largest volumes of water resources are those of Asia and South America. They do not fully reflect water availability within the continents, as they differ so much in area and population number. Also, groundwater resources may play an important role in contributing to the total volume of renewable water sources.

However, these resources are unevenly distributed, both among countries and within them. On the continental scale, Europe appears to have abundant water resources. But there are many water resources in the Nordic countries and central and eastern Europe, while in western/central Europe they are scarce. In Africa, there are deserts in the northern and southern sub-regions of the continent where almost no rain falls. But in tropical humid areas in the eastern, western, and central sub-regions there is too much water. The UN declared in its World Water Development Report that by the middle of this century, at worst, seven billion people in 60 countries will be water-scarce, at best, two billion people in 48 countries.

SCARCITY AND CONFLICT

At the national or local level, water conflicts are related to access to and use of water among different users and sectors. On one hand, the way water supply is distributed among industry, agriculture, and urban activities has an impact on those sectors’ development. On the other hand, the way sanitation facilities and protected water supplies are allocated and distributed affects people’s health and livelihoods. At the international level, conflicts are related to countries sharing water resources. Almost 40 percent of the world population lives in countries that share river basins or aquifers. According to Aaron Wolf, water resources have played a role in shaping political forces and national boundaries. Westing has suggested that “competition for limited…freshwater…leads to severe political tensions and even to war,” and Michel Klare and other authors give many examples of water conflicts.

The most important cases are related to the Nile, Jordan, Euphrates, Tigris, and Indus Rivers. At 4,184 miles long, the Nile River is the longest river in the world. It has three mayor tributaries and flows from east Africa to the Mediterranean through nine countries: Tanzania, Burundi, Rwanda, Congo, Kenya, Uganda, Ethiopia, the Sudan, and Egypt. The Nile serves as a constant source of water for these countries. It has a vital role in agriculture and it also plays a major role in transportation. Access to and control of the Nile's waters has already been defined as a vital national priority by these countries, so conflicts among neighbors cause tension and instability in the region. Though the conflict still remains among the main actors: Sudan, Egypt, and Ethiopia, it is probable that all the countries in the Nile basin will be affected while the population continues growing and water needs increase. There were some agreements and treaties to share the use of river water, but these were only bilateral, without including all of the countries of the Nile Basin.

The Jordan River flows through Syria, Lebanon, Israel, Palestine, and Jordan and ends in the Dead Sea. In the Ghawr Valley, it defines the border between Jordan and Israel, and Jordan and Palestine, a region with plenty of ideological, religious, and geopolitical differences and historical rivalries. Israel was created in 1948 although surrounding Arab states did not recognize its claim to the land. The region is extremely arid. The rainy season is short, and rains are insufficient for basic agriculture, so these countries rely on the Jordan River—especially Israel, because it is the only natural and clean river it has access to. According to the Arab States, Israel is using the river illegally.

Turkey, Syria, and Iraq share the Euphrates-Tigris water basin. The Euphrates and Tigris Rivers begin in Turkey, but then the Euphrates River goes southwest to Syria, and the Tigris River enters Iraq. Both rivers flow through the Mesopotamian region and join up again near Qurna, in Iraq, to form the Shatt al-Arab and end in the Persian Gulf. These nations suffer from serious water scarcity; therefore the Euphrates-Tigris Basin plays an important role in economic development and freshwater supply. The three countries have built dams in order to produce electricity, stop water from flowing, and for irrigation purposes. But the completion of these dams caused serious tensions among Turkey and the downstream countries, Iraq and Syria.

The Indus River is the longest in South Asia. Originating in Tibet, it runs through Kashmir in India, and then flows through Pakistan. The Indus is a strategically vital resource for agricultural production, industries, and water supply in Pakistan and India. The river is also sacred for Hindus who live in both countries. In 1947 India was divided into two separate states, India and Pakistan, and the basin was also divided, creating a conflict over the use of the river's resources. The Treaty of Indus Water signed by both countries is considered an example of water conflict resolution, although territorial disputes for Kashmir remain.

In all these cases, river systems are situated in arid regions with severe water scarcity, and the only source of water supply for economic and social development has to be shared, so access to the river's waters has already been defined as a vital national priority. Also, these basin systems are situated in the middle of historically tension-filled regions. Water's uneven distribution and scarcity exacerbates the existing crisis over transboundary water resources. There are presently 261 international river basins, and 145 nations have territory in shared basins. While conflict can be dangerous, it also carries the possibility of producing creative cooperation. The need for integrated and cooperative solutions with special emphasis on the economic, environmental, and security dimensions of integrated water management is necessary to find a nonconfrontational way to resolve water disputes.

SUSTAINABLE WATER USE

Sustainable water resource management has involved several groups. Industrial and agricultural sectors have to improve water use strategies, use clean technologies, re-use water, reduce contamination in their operations, and take care of groundwater storage. Reform in the economic sector alone is not sufficient—water institutions and policies also need reform. The water crisis is related to a crisis of governance because weaknesses in governance systems have greatly impeded progress toward sustainable development and the balancing of socioeconomic needs with ecological sustainability.

The International Conference on Water and the Environment in Dublin in 1992 declared that popular participation should be a cornerstone of government policies in order to achieve sustainable water planning. Citizens have to reclaim the chance to participate in decision-making; ensuring sustainable use of water will require changes in both the economic-political approach and in societal attitudes.

SEE ALSO: Aral Sea; Nile River (and White Nile); Population; Tigris-Euphrates River; Wastewater; Water Conservation; Water Demand; Water Harvesting; Water Law; Waterlogging; Water Markets; Water Quality.

BIBLIOGRAPHY. M. Barlow and T. Clarke, *Blue Gold* (Stoddart Publishing, 2002); R.O. Collins, *The Waters of the Nile* (Clarendon Press, 1990); P.M. Kennedy, *Preparing for the Twenty-First Century* (Random House, 1993); M.T. Klare, *Resource Wars: The New Landscape of Global Conflict* (Henry Holt and Company, 2001); United Nations (UN) World Water Assessment Program, *First United Nations World Water Development Report: Water for People, Water for Life* (UNESCO and Berghahn Books, 2003); UN World Water Assessment Program), *Second United Nations World Water Development Report: Water, a Shared Responsibility* (UNESCO, 2006); A.H. Westing, *Global Resources and International Conflict: Environmental Factors in Strategic Policy and Action* (Oxford University Press, 1986); A. Wolf, "Conflict and Cooperation along International Waterways," *Water Policy* (v.1/2, 1998).

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Water Conservation

WATER CONSERVATION AIMS at influencing water utilization in order to achieve more efficient, equitable, and sustainable water consumption levels. It is mainly a tool for on-site and watershed approaches, since it originally focused on conserving water as stored soil moisture and groundwater. With increasing population and water demand, conservation of this limited resource becomes ever more important. The notion that freshwater is a finite resource arises as the global hydrological cycle on average yields a fixed quantity of water per time period. Humans cannot yet alter this overall quantity significantly, although it frequently is depleted by human-made pollution. Drought, water stress, and scarcity are often the strongest incentives for end-users to implement water conservation strategies. As water demand continues to grow, a choice must be made: Either to augment water supplies or to limit demand—the latter is more effective.

USER BEHAVIOR

Agriculture, especially irrigation, is globally the largest user of freshwater, consuming about 70 percent of all water withdrawn from rivers, lakes, and groundwater. Efficient water management practices and improved irrigation technologies are crucial in reducing water use in agriculture. Irrigation scheduling involves managing the soil water reservoir in such a way that water is available when crops need it. It is necessary to determine all variables of the water cycle. The easiest method of soil moisture monitoring is to observe the soil appearance at various soil depths within the root zone. Other methods to measure soil moisture content, like tension-meters, determine the suction head a plant needs to abstract water from the soil. Monitoring air temperature, precipitation, air humidity, and evapotranspiration is important to determine how much water is available for the crop and helps to estimate when and how much water should be used during irrigation.

In developed countries, sophisticated digital recording systems are used to control and monitor water availability, as well as water applications. Many types of irrigation systems are available, such as sprinkler, center-pivot, furrow, and flood irrigation systems. However, drip irrigation is the most efficient method as far as water and nutrient applications are concerned, and it can be effectively applied on uneven terrain and in high-value greenhouse crops. With all irrigation systems, drainage of irrigation water is a crucial component of avoiding water pollution. Inefficient irrigation and drainage management, together with inappropriate irrigation, lessens water quality and causes severe soil salinity problems.

In areas where sprinkler systems are used, care should be taken to ensure that the system is not over-designed; furthermore, sprinkler use in hot climates is a cause of increasing soil salinity, since precipitating water droplets evaporate easily, leaving salt crystals behind. Automatic systems should incorporate an override to prevent the sprinklers from operating during wet periods. Plants with similar water needs should be grouped together so that they can be watered for the same length of time and in the same amounts. In cases where expensive irrigation systems are used, they should be equipped with a soil moisture controller that will restrict irrigation to when it is needed.

In small-scale schemes, irrigation should be restricted to the early mornings when evaporation is lowest and crop water demand is highest. Many varieties of grasses used in the lawns of housing areas in developed countries are not drought-resistant and require regular irrigation, though drought-resistant species are available. Small trenches can harvest natural runoff and irrigation water to the areas where needed. Creating micro-basins around specific plants will enable them to be watered individually. Spreading mulch reduces the water lost to evaporation by up to 70 percent, as well as preventing excessive runoff, inhibiting weed growth, and supplying nutrients to the soil. Drip irrigation uses significantly less water than normal irrigation systems and is equally effective. With increasing prices for piped water, the investment for the drip systems may pay off quickly. While small-scale farmers in developing countries often lack resources to invest in pumps or sufficient energy for technical irrigation, low-cost irrigation technologies (such as treadle pumps and drip irrigation) are becoming more widespread.

An increasing number of industrial enterprises in developed countries implement efficient water consumption programs. Industrial ground and surface water utilization and the use of water taken from public supply networks have been reduced considerably, mainly in industrialized countries. More and more industrial enterprises are transferring to a rational use of water through the multiple use of water or closed production cycles. Water-saving reduces overall costs and saves energy at the same time (for example, energy saved from a reduced use of water pumps and a reduced amount of water that needs to be cleaned afterwards). Water management plans should consider if groundwater can be substituted by surface water, and if the use of drinking water quality is necessary for different production processes.

Domestic water consumption can be greatly reduced through individual technical measures, such as flow-limiting taps or water-stop flush buttons for toilets. Installation of individual meters (for a household) to monitor usage and the costs related to it is essential. Modern washing and dishwashing machines are significantly more water efficient than earlier models (down from 150 to less than 60 liters in 25 years, reaching less than 30 liters per washing cycle in Europe). Moreover, changing personal behavior could halve total water consumption; for instance, through the replacement of a seal from a dripping tap, and stopping the tap while brushing teeth. It is important to encourage end-users to install water-saving devices at the time of their investment, for example, when they build a house or factory. End-users will only do so if they are aware of the water-saving options and the benefits in terms of cost savings. End-users would need to be encouraged to invest in water-efficient fittings through the amendment of by-laws and codes that regulate building practices. However, the best tool in developed countries for reducing water consumption and waste is to increase the price of water for a high standard product.

MEASUREMENT OF LOSSES

In developing countries, most water supplies are unmetered. In many instances, water standpipes or blocks of houses have never been fitted with meters, or they have broken. In these cases, neither water departments nor individual end-users know how much water is being used. Effective billing cannot take place, and water demand management plans cannot be implemented effectively. The calibration, repair, and replacement of meters are important components of a water conservation strategy. A periodic calibration of system supply and customer meters provides a more accurate measurement of the water supply and use. Furthermore, unlicensed use of water, water losses through broken pipes, and water wastage can only be determined if appropriate metering takes place.

COST RECOVERY

In many countries, fees or taxes do not cover the costs of providing water. This may result in low service levels, water coverage insufficiencies, and under-funded operating costs. As a consequence, infrastructure deteriorates and service quality declines. Inadequate cost-recovery will result in an inability to operate and maintain existing supplies with consequent increases of leakages, supply interruptions, and likely deterioration in the quality and quantity of the water supplied. This leads to increased public health risks, with possible increases in disease, morbidity, and mortality rates.

The commercialization of water provision aims at introducing appropriate water tariffs that consider the full costs for water provision. At the same time, it is known that users are only willing to pay a price for a quality product that is available when needed. It is known from rural and peri-urban areas in Africa, with water provision from vendors and public stand posts, that prices for potable water are often more than five times higher than in high-income areas with house connections. Willingness to pay often exceeds the ability to pay. Therefore, block tariffs and cross subsidies are essential for sustainable and cost-covering water provision at sufficiently high technical and service standards. An important factor in cost-recovery is the setting of adequate standards of service. It has been shown that consumers are willing to pay for good quality services and are prepared to pay increased costs for improved services in terms of water quality and supply continuity.

Commercialization should not be misunderstood as the privatization of public water providers. For investments in low-income areas, government subsidies remain important. Many water suppliers argue that in order for them to raise the capital required to improve service quality, tariffs which reflect the cost of doing this need to be charged immediately; which may lead to unaffordable prices for many. However, from a public health point of view, it is vital that service quality improvements in poor areas should be implemented immediately. There is a significant risk that users will disconnect from an expensive, but poor quality service. This will inevitably lead to greater health risks as unprotected water sources are used for water supplies.

CLOSED WATER LOOP CONCEPT

The closed water loop concept is a management tool within water demand management. At the scale of the household, neighborhood, community, industry, or institution, water can be managed as a closed loop. Water inputs of various qualities can be brought into the closed water loop for the various water applications where the water quality is matched with the intended application requirements. Every drop of water can be used at least twice before it is sent out of the loop. After water is used, the generated wastewater is segregated according to the level and type of contamination it contains. The wastewater streams are treated and the recycled water is kept in the loop and used in the appropriate applications.

At the scale of the household and residential buildings, the highest quality water is reserved for drinking, food preparation, and hygiene requirements. Water of lower quality can be used for landscaping or toilet flushing. Grey-water is separated, treated, and kept in the household water loop for landscaping or toilet flushing. Wastewater from the toilets and kitchen can be treated in a septic tank followed by a sub-surface wetland. The sub-surface wetland can aid the treatment process and be built within the household landscape to grow ornamental plants. The treated effluent can be applied though sub-surface irrigation networks to irrigate trees and to create habitat. This concept offers the potential of increased water conservation worldwide.

While water conservation (and conservation in general) is largely regarded as a positive environmental activity, there are important caveats. In many cases, conservation of water in water-scarce environments by individuals or communities may leave more water available in the system to allow growth or expansion of new settlement or economic activity, with concomitant water use problems as well as other undesired environmental outcomes. In other words, individual efforts at conservation may simply lead to increased consumption elsewhere. Sometimes called "Jevon's Paradox," this critical approach to conservation does not deny or refute the importance of reduced consumption for overall sustainability of ecosystems, however. Water conservation is therefore a complex problem not only in technical terms (i.e., how) but also in political and economic ones (i.e., why or why not).

SEE ALSO: Irrigation; Septic Systems; Wastewater; Water; Water Demand; Water Harvesting; Water Law; Water Markets; Water Quality; Watershed Management.

BIBLIOGRAPHY. R.G. Allen et al., "Crop Evapotranspiration: Guidelines for Computing Crop Water Requirements," *Irrigation Drainage Paper 56* (Food and Agriculture Organization, 1998); M.A. Blackmore et al., "A Comparison of the Efficiency of Manual and Automatic Dishwashing for the Removal of Bacteria from Domestic Crockery," *Journal of Consumer Studies and Home Economics* (v.7/1, 1983); J. Boberg, *Liquid Assets, How Demographic Changes and Water Management Policies Affect Freshwater Resources* (RAND Corporation, 2005); W.J. Cosgrove and F.R. Rijsberman, *Water Vision: Making Water Everybody's Business* (World Water Council, 2001); B. Gumbo et al., "Training Needs for Water Demand Management," 4th WaterNet/WARFSA Symposium: Water, Science, Technology and Policy: Convergence and Action by All (Gabarone, 2003); *Toward Water Security: A Framework for Action* (Global Water Partnership, 2000).

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Water Demand

WATER DEMAND IS defined as the volume of water requested by natural and human users to satisfy their needs. Water sustains human health, well-being, food production, and economic development. But less than three percent of earth's water is freshwater, out of which nearly 70 percent is stored in glaciers and icebergs, and is not available for direct human use. The freshwater that is available comes from precipitation, surface, or groundwater sources.

Due to rapid population growth, potential water availability worldwide decreased from 12,900 cubic meters per capita per year in 1970 to less than 7,000 cubic meters in 2000. In densely populated parts of Asia, Africa, and central and southern Europe, current per capita water availability is between 1,200 and 5,000 cubic meters per year. The global availability of freshwater is projected to drop to 5,100 cubic meters per capita per year by 2025. It is estimated that three billion people will be in the water scarcity category of 1,700 cubic meters per capita per year by 2025.

Approximately two-thirds of total water consumption is used by the agricultural sector, 20 percent is consumed by industry, and 10 percent by private households. However, regional differences exist. In Europe, more than half of the water consumption is used by industry. In Asia and Africa, the agricultural sector consumes more than 85 percent of the available water. It has been estimated that the global water demand will rise by 20 percent for agriculture, about 50 percent for industry, and 80 percent for private households until 2025.

AGRICULTURAL WATER DEMAND

Plants require adequate water at the right time for establishment and growth. Crops have specific water requirements that vary depending on local conditions. Sources of water for crop production are rainfall, shallow groundwater, and irrigation water, which is water diverted from surface flows or groundwater. For instance, water withdrawals for agriculture account for about 91 percent of all water withdrawals in the Middle East and North Africa and 95 percent in Central Asia. Drylands, where irrigation plays an important role, have the highest level of water withdrawal for agriculture.

In most developing regions, hundreds of millions of people are served by hand-pumps fed by boreholes, hand-dug wells, or communal stand-posts or yard-taps fed by elevated tanks and distribution networks. The daily task of fetching and carrying water remains a major burden for women and girls throughout the developing world; valuable time is lost for schooling and education. The world's irrigation areas totaled approximately 253 million hectares in 1995. By 2025, they are expected to reach about 330 million hectares. Therefore, irrigation systems urgently have to be modernized to reduce water consumption and wastage.

Thingyan

In tropical countries where water is not in short supply, there are a number of festivals celebrating its abundance. The annual Burmese New Year Water Festival, Thingyan, takes place in the Burmese month of Tagu (roughly mid-April), and covers the four or five days before the New Year. During Thingyan, people douse each other with water. Thingyan has its origins in Hindu mythology in which Arsi, the King of the Brahmas, was beheaded and the head of an elephant placed on his body—making him Ganesha. The story was that the original head was so powerful that if it was thrown into the sea, the water would evaporate immediately. As a result, it is the duty of the people to douse everything and everybody with water.

On the first day of Thingyan, people start preparing for the event with everybody from older people to very small children, but especially the youth, getting buckets, pots, water pistols, and hoses ready. On the second day, *a kya nei*, the water festival begins in earnest. People go up to others and pour water over them, usually in a good-humored manner. Most local people make sure not to damage tourists' cameras and the like, and wait for the moment when a tourist puts away his or her camera. Only monks and pregnant women are spared. When Thingyan coincides with the Christian Easter, the Christian churches change their services to midnight to allow worshipers to come and go from the churches without being soaked to the skin.

From wooden balconies built on all the major roads around Yangon and other cities, large numbers of people aim their hoses at people and passing cars. Some young people remove the doors of their cars, to allow the driver and passengers to be doused, and to let the water flow out afterwards. This continues for several days, sometimes with fire trucks using fire hoses. For the diplomatic corps, they receive a symbolic splash of water from the foreign minister.

INDUSTRIAL WATER DEMAND

In the industrial sector, the biggest share of freshwater is stored in reservoirs and dams for electrical power generation and irrigation. Industrial uses account for about 20 percent of global freshwater withdrawals. Of this, 57–69 percent is used for hydropower and cooling in nuclear power generation, 30–40 percent for industrial processes, and 0.5–3 percent for thermal power generation. Not all withdrawals are consumptive, as water is recharged into the water cycle after use. The volumes of industrial water demand are quite different within individual branches of industry and from country to country, and depending on the technology of the manufacturing process.

Increasingly, industrial enterprises convert to more rational water uses, for example through water reuse and closed water cycles. Water saving reduces overall costs and saves energy. Environmental pressures and water pricing have stimulated an increasing amount of recycling and reuse by industries in the developed world, but so far, there has been less progress made in developing countries.

DOMESTIC WATER DEMAND

Around one-tenth of global water consumption directly meets the needs of private households. This includes, besides drinking water, the use of water for cooking and hygienic purposes. Another important domestic use of water is for productive purposes around the household, including activities such as growing vegetables and fruit trees or giving water to small stock. Enormous regional differences exist: In rural areas of dry land regions in Africa, water consumption amounts to less than 20 liters per day per capita, while the United States on average it reaches 295 liters per day per capita. According to the World Health Organization (WHO), a minimum of 25 liters per capita a day is needed to meet basic needs (for drinking water, cooking, hygiene).

The classic domestic water cycle of better-off urban residents involves house connections to deliver enough high-quality water for all lifestyle needs, and sewer connections to take away the wastewater for centralized treatment and return to watercourses. In many crowded peri-urban settlements, construction of water mains and sewers remains unattractive for government and private investors, and therefore impractical. There, residents depend on communal water points or water vendors, and on a range of often unhygienic ways of disposing of solid and liquid waste. This situation may be changing: One United Nations (UN) Millennium Development Goal is the aim to halve the proportion of people who lack access to hygienic means of sanitation by 2015.

WATER POLLUTION PROBLEMS

Water pollution is the contamination of streams, lakes, groundwater, bays, or oceans by substances harmful to nature and humans. The quality of water sources is often negatively affected by pollution from agriculture or industry. Excess fertilizer applications, improper disposal of hazardous materials from industry, municipal dumping, poorly constructed septic tanks, or poorly managed transport systems are major pollutants. Plants and animals require water that is moderately pure, and they cannot survive if their water is loaded with toxic chemicals or harmful microorganisms. If severe, water pollution can kill large numbers of fish, birds, and other animals, in some cases killing an entire species in an affected area. People who ingest polluted water and consume polluted aquatic resources become ill, and, with prolonged exposure, may develop cancers or bear children with birth defects.

Around 80 percent of all diseases in developing countries are caused by the lack of access to clean drinking water and sufficient sanitation. Two of five persons in the world do not have access to an adequate sewage system. Approximately 1.1 billion people do not have access to clean drinking water. About 90 percent of the wastewater in developing countries infiltrates freely into the ground, or runs into rivers, and returns into the water cycle.

SEE ALSO: Pollution, Water; Wastewater; Water; Water Conservation; Water Harvesting; Water Quality.

BIBLIOGRAPHY. H. Bouwer, "Integrated Water Management for the 21st Century: Problems and Solutions," *Journal of Irrigation and Drainage Engineering* (v.128/4, 2002); F. Fischer and A. Hossein, "Optimal Water Management in the Middle East and Other Regions," *Finance and Development* (v.38/3, 2001); R.B. Jackson et al., "Water in a Changing World," *Ecological Applications* (v.11/4, 2002); J. Lundquist et al., *New Dimensions in Water Security: Society and Ecosystem Services in the 21st Century. Land and Water Development Division* (Food and Agriculture Organization, 2000); I.A. Shiklomanov and J.C. Rodda, *World Water Resources at the Beginning of the Twenty-First Century* (Cambridge University Press, 2003).

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Water Harvesting

WATER IS ESSENTIAL to life, therefore, it is important that adequate supplies of water are available. However, water supplies should be developed in such a way that ecosystem functioning and the hydrological cycle are not negatively affected. Within this context, water harvesting has received increasing attention worldwide. The harvesting of rainwater refers to the collection of water from surfaces on which rain falls, and subsequently storing this water for later use. For as long as humans have occupied and cultivated dry lands, water harvesting has been practiced. It has been the basis of living and has allowed the establishment of civilizations in dry lands. Water harvesting has provided for drinking, domestic needs, livestock, crops, pastures, and trees, and a way to replenish groundwater levels. There is a range of rainwater harvesting systems, operating at large and small scales. The choice of system depends on physical and human considerations, and matching the needs of the farmers with environmental, economic, and political conditions.

Water harvesting can occur in multiple contexts and at a variety of scales. The collection of rainwater from the rooftops of buildings is suitable for urban areas and requires little investment or technology, as only roof gutters and storage tanks are needed to capture rainwater. Measures may be needed to keep insects away from the stored water, to avoid increases in waterborne diseases such as malaria. The water harvested from rooftops is suitable for nonpotable purposes, such as watering plants, washing clothes, and flushing the toilet. It is also possible to achieve drinking water standards through additional treatments, such as filtration. In many regions, however, rooftop water harvesting is problematic due to the type of building materials customarily used (such as thatched roofs), and due to the lack of storage facilities.

Water harvesting for agriculture aims to secure the water supply for human use, irrigation, and livestock without tapping surface or groundwater sources. In the past, rainwater harvesting was the backbone of agriculture in dry lands. Thousands of years ago, indigenous populations in dry lands throughout the world developed water-harvesting systems that sustained large civilizations (such as the Nabataeans in the Negev). After being neglected for some time, these systems have received new attention, particularly for small-scale agricultural development in the dry lands of developing countries for poverty reduction efforts. Throughout the developing world, food insecurity and low agricultural productivity continue to be a concern. In many water-scarce areas, rainwater harvesting offers a viable option, as it increases the availability of water for irrigation and consequently reduces the risk of crop failure. Moreover, low-cost technologies are becoming available that particularly benefit resource-poor farmers. Water harvesting will continue to play an important role in supplementing rain-fed agriculture in areas where rainfall is variable, as well as in working toward poverty and food security targets.

Micro-catchment rainwater harvesting systems collect runoff from a small catchment and store the water in an adjacent infiltration basin. This infiltration basin is usually planted with a single tree, bush, or annual crop. The system is simple to design, and cheap. Soil and water conservation measures are often carried out on cultivated lands to increase on-site water harvesting. Micro-systems are suitable for any terrain. Medium-sized rainwater harvesting for human and animal consumption and small-scale irrigation can be conducted by redirecting runoff into storage facilities. The catchment generally has a size of up to 200 hectares, depending on local conditions. The collected rainwater is stored in ponds or cisterns, then used for supplemental irrigation. The cultivated areas are located outside of the catchment. The cropping area is often terraced or located in level terrain and may have a slope of five to 50 percent. These systems are often used in combination with water conservation measures, such as water-efficient drip irrigation systems.

Larger scale rainwater harvesting includes catchments with a size of many square kilometers, from which runoff flows through a riverbed of an ephemeral stream. It requires more complex structures of storage dams and water distribution networks. The two most common systems are floodwater harvesting and floodwater diversion. The former blocks the runoff to inundate the valley bottom of the whole flood plain, forcing the water to infiltrate and using the wetted area for crop production or pasture. The latter system diverts floodwater from the ephemeral stream to adjacent agricultural fields. Both systems were commonly used in ancient cultures in the Negev, China, and Pakistan.

In the United States the ability to harvest rainwater varies from state-to-state based on water law. In the state of Colorado, for example, harvesting of rainwater by homeowners is illegal under prior appropriation law, since the water technically belongs to a downstream user with an earlier right to the water. In other states such harvesting is legal, as long as the water is not used for agricultural purposes. This variability in the legal status of harvested water, along with the potential restrictions it imposes, creates a disincentive for employing this ancient and common-sense approach to water conservation and management.

SEE ALSO: Irrigation; Prior Appropriation; Water; Water Conservation; Water Demand; Water Law; Water Markets; Water Quality.

BIBLIOGRAPHY. H.J. Bruins, M. Evenari, and U. Nessler, "Rainwater Harvesting Agriculture for Food Production in Arid Zones: The Challenges of the African Famine," *Applied Geography* (v.6, 1986); M. Evenari, L. Shanan, and N. Tadmor, *The Negev: The Challenge of a Desert* (Harvard University Press, 1971); Food and Agriculture Organization (FAO), *Water Harvesting For Improved Agricultural Production. FAO Expert Consultation* (FAO, 1994); T.A. Oweis and A. Hachum, "Water Harvesting and Supplemental Irrigation for Improved Water Productivity of Dry Farming Systems in West Asia and North Africa," *Agricultural Water Management* (v.80, 2006); T.A. Oweis, A. Hachum, and J. Kijme, "Water Harvesting and Supplementary Irrigation for Improved Water Use Efficiency in Dry Areas," SWIM Paper 7 (International Water Management Institute, 1999); D. Prinz, "Water Harvesting: Present and Future. In Sustainability of Irrigated Agriculture," NATO Advanced Research Workshop (Balkema, 1994); C. Reij, P. Mulder, and L. Begemann, "Water Harvesting for Plant Production," World Bank Technical Paper (World Bank, 1988).

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Water Hyacinth

THE WORLD CONSERVATION Union calls common water hyacinth (*Eichhornia crassipes*) one of the worst weeds in the world. A floating aquatic plant, water hyacinth grows rapidly, causing extensive ecological and economic damage in water systems. The plant displaces other species, obstructs waterways, blocks water intake pipes, and interferes with fishing. Dense populations of the species damage fish spawning grounds, increase water evaporation rates, and deposit a great deal of organic matter in a system. When this organic matter decomposes, the oxygen level in the water is lowered, and fish populations suffer.

Water hyacinth can double its mass every two weeks and has been called one of the worst weeds in the world.

Water hyacinth grows in slow-moving or still water. Under ideal conditions, it doubles its mass every two weeks. The species survives a variety of environmental conditions. It tolerates a wide range of pH and temperatures, both fresh and brackish water, and fluctuations in water levels. It also survives some toxic substances. The plant has spikes of eight to 15 flowers and round, shiny leaves. Each flower has six purple to lavender petals, the uppermost of which has a bright yellow spot. Leaves are four to eight inches in length. Thick, upright stalks lift both the flowers and the leaves above the water surface. When the wind catches these upright leaves, plants are dispersed throughout the water body. Roots are four to 118 inches (10–300 centimeters) in length, make up about half of the mass of the plants, and contain compounds that may prevent predation from insects. The plant produces stolons, or short stems that develop into new plants. Stolons are the most common form of reproduction; seed production also occurs. Seeds maintain their viability for up to 20 years.

A native of Brazil, water hyacinth now thrives in most tropical and subtropical regions of the world. Because of its showy flowers, the plant was intentionally moved around the world for its ornamental qualities. It is believed to have been introduced to the United States in 1884 at an exhibition in Louisiana. It arrived in Africa in 1879, in Asia in 1888, and in Australia in 1890.

Water hyacinth populations have been managed with herbicides, hand pulling, mechanical harvesting and biological control. Hand pulling works for small infestations, but is too labor-intensive to control larger populations. Herbicides, including copper sulfate, 2,4-D, and glyphosate, reduce populations of water hyacinth but damage other organisms in the ecosystem. Several of water hyacinth's natural enemies, including insects and fungi, have been used to control populations with varying degrees of success. Five of these biocontrol agents are used in the United States: Two weevils, a moth and two types of fungi. Attempts to use explosives and fire to keep populations in check have not been successful.

Some populations of water hyacinth have been successfully controlled. In the 1950s, water hyacinth occupied 126,000 acres of Florida's waterways. A combination of herbicides, harvesting, and biocontrol methods reduced Florida's water hyacinth population to 2,000 acres.

Although the harm caused by the species generally outweighs its benefits, a few uses have been found for water hyacinth. It has been fed to pigs, used to remove toxins from sewage, and made into paper. One study in Bangladesh found arsenic in water can be removed by water hyacinth, producing safer drinking water.

SEE ALSO: Herbicides; Invasions, Biological; Plants; Native Species; 2,4-D; Weeds.

BIBLIOGRAPHY. Michael S. Batcher, *Element Stewardship Abstract for* Eichhornia crassipes *(Martius) Solms* (The Nature Conservancy, 2000); Columbia University, "Introduced Species Summary Project: Water Hyacinth (*Eichhorinia crassipes*)," www.columbia.edu/itc/cerc/danoff-burg/invasion_bio/invbio_home.html (cited December 2006); Florida Department of Environmental Protection, "Weed Alert: Water Hyacinth (*Eichhornia crassipes*)," www.dep.state.fl.us/lands/invaspec (cited December 2006); Mir Misbahuddin and Atm Fariduddin, "Water Hyacinth Removes Arsenic from Arsenic-contaminated Drinking Water," *Archives of Environmental Health* (November–December 2002); World Conservation Union, "*Eichhornia crassipes* (Aquatic Plant)," www.issg.org (cited December 2006).

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Water Law

GIVEN THE PRIME importance of water in all human activities, available water resources need to be protected, conserved, and managed in terms of both quantity and quality, for which water legislation becomes critical. Two important issues water law deals with are the ownership of water resources and the nature and distribution of water rights (which are usually usufructuary rights).

Early codifications related to water are found in the Pharaonic Water Regulations (of ancient Egypt), in the Laws of Manu (or Manava-Dharma-Shastra) in India, in the Hammurabi Code (of Babylon), in Chinese water regulations, and in Roman and Moslem law. The philosophy of the early water regulations depended (as it still does today) on geo-climatologic and physical factors, as well as on the social, technical, economic, and political situation of the countries or areas concerned. Thus, in regions where water was abundant, water regulations were largely directed toward defense against the harmful effects of water (e.g., flood control); in areas where water was scarce, regulations were concerned with the need to conserve available water supplies and with efficiency in allocation.

The old water codifications are not just of historical interest, but have also had considerable influence on current legal regimes in water. For instance, the principles of early Chinese water law (which are based on a belief of a close inter-connection between the human order and the natural cosmic order) have influenced water regulations in China, Japan, Korea, and Vietnam, at least until recently. But it is ancient Roman law that has exerted the greatest influence on the legislation of practically all modern nations. Hence, it is useful to briefly consider the form that it took.

Early Roman law recognized three classes of water rights—private, common and public. Under private rights, the owner of the land owned everything located above and below the land. This was the precursor to the riparian doctrine now followed in many countries, according to which use of such waters was private, unlimited and unrestricted, subject to sale, acquisition or transfer of the land over or under which the waters are located. That is, the riparian doctrine links control over water to control over land. Common rights permitted the use of water that was not yet occupied or without any owner to everyone without any limit or permission. In the case of public water (i.e., water owned by the state), use was subject to the state's control.

The doctrine of public trust, which is found today in some countries, is derived from this. The idea here is that the particular characteristics of water resources (e.g., its unbounded nature) and its importance in different facets of life mean that it is not justified to make it an object of private ownership. Instead, water should be included under the public domain, which implies that the state should protect the resource for enjoyment by the general public, rather than permit its use for private ownership or commercial purposes.

These early Roman principles took three major directions. The first is found in a number of European countries such as Spain, France, and Italy as well as Cambodia, Laos, and Indonesia. Water law in these countries derives from the Napoleon Code (a code of law adopted in France in 1804). Water could be public (subject to government control) or private (freely utilizable on the basis of the riparian doctrine).

The second variant is the water law of the "Common Law" countries, which is derived from the English application of the original Roman law. This Common Law of England is found in the United Kingdom (at least until recently), the eastern United States, and many former British colonies. Here, the original principles of Roman law are basically followed, although the use of water could be limited via court decisions, administrative ordinances, or regulation.

The third direction that Roman law took was the so-called new American doctrine of prior appropriation, which is found in some of the western states of the United States. According to this, water rights are vested with the first claimant and user. Judicial decisions in the United States have now limited this doctrine by the provisions of "correlative rights" and "beneficial uses of water." Some of the tenets included under this are: Water is not to be obtained for speculation or let run to waste, that the end use must be generally recognized and socially acceptable, that water is not to be misused, and that the current use must be reasonable as compared to other uses. Since the relevance of water rights is related to the availability of the resource, many water laws (other than those in the western United States) now have provisions that require the effective use of water. For instance, the notion that water rights risk forfeiture if not used according to the terms of a license or permit and is found in the laws of a number of countries such as Germany, Spain, and Mexico, although the terminology varies.

These different legal regimes have varying implications for equity. For instance, riparian rights—as traditionally constituted—usually have a negative impact on downstream users, in spite of the requirement that upstream riparians should not reasonably interfere with their rights. Similarly, the doctrine of prior appropriation is unfair to latecomers.

Apart from changes in the basic regimes of water rights over time, the content and scope of water legislation has also undergone change over time. Older water laws tended to promote water utilization, and were more concerned with punishing those who would harm existing uses or structures. For instance, an ancient article of water law traceable to the Code of Hammurabi of the Babylonian era (dated around 1700 B.C.E.) reads: "If anyone opens his irrigation canals to let in water, but is careless and the water floods the field of his neighbor, he shall measure out grain to the latter in the proportion to the yield of the neighboring field." However, as a result of population growth and technological progress, water laws have begun to deal with newer questions such as priorities across different uses, setting of quality standards, conservation of water, and prevention and regulation of pollution. For instance, the policies of the 1992 Mexican Water Law include the preservation of water quality and the promotion of sustainable development. In the United States, the Safe Drinking

Water Act of 1974 directs the Human Health Subcommittee of the U.S. Environmental Protection Agency to ensure that both public and noncommunity water systems meet minimum standards for protecting public health.

Note that water law usually differs in the case of surface water and groundwater. In general, legislation pertaining to surface water has been most clearly and explicitly articulated. In the case of groundwater, the traditional Roman rule or English rule (that the owner of surface land was also the owner of the water under the ground) is usually followed. But with the advent of modern technology and the consequent overexploitation of groundwater, many countries have begun to regulate and control groundwater too as public property or by invoking the police power of governments.

Water law, whether dealing with surface water or groundwater, with questions of ownership and allocation, or regulation of use, varies not only across different nations, but also often within nations. This is especially true in those cases where provincial or local governments have jurisdiction over water. Furthermore, different kinds of water issues are also often divided under different ministries such as environment, agriculture, industry, health, and so on. As a result, many countries now have a plurality of laws relating to water, often conflicting with each other and known only to the administration of a particular agency of water resources development. In spite of this plurality of laws, provision to deal with various aspects—such as ownership, pollution, and coordination between different uses—is still inadequate, and/or the institutional structure necessary to ensure effective implementation of the laws is missing.

Apart from water legislation at the national level and within nation-states, water laws are also formulated at the international level. International water law derives from a number of sources: Conventions (bilateral or multilateral treaties over sharing of water resources), international customs (general principles of international behavior recognized by most nations), and judicial decisions. Two important principles found in many water treaties at the international level are: (1) the principle of equitable utilization, which states that the uses and benefits of a shared watercourse should be divided in an equitable manner, and (2) the requirement that a state—through its actions affecting an international watercourse—may not significantly harm other states. Both principles are found in the 1966 Helsinki rules governing the uses of waters of international rivers, and the Convention on the Law of Non-Navigational Uses of International Watercourses (adopted by the United Nations General Assembly in 1997). There is also a settled requirement under international law (which would also include the law on international watercourses) that states cooperate, consult, and negotiate in cases where the proposed use of a shared resource may have a negative impact on their rights and interests.

Apart from statutory law (the body of law laid down in acts of legislature and in subordinate legislation), water law (like any other law) also derives from other sources such as local uses and customs. Such laws and rules which are based on long-standing practice, and are not codified in written form, are called customary law. It is important to take these into account while preparing formal legislation, as otherwise customary users could be marginalized.

At present, water legislation is in a state of flux in many countries, partly as a response to the perception of a water crisis, but more often as part of a larger reform agenda (such as structural adjustment programs at the macro level). One important change is that state ownership as well as state involvement in development and distribution of the resource is slowly giving way to private decision-making. This in turn is leading to new kinds of rights such as the nonconditioned water rights in Chile, which do not have the requirement of effective and beneficial use. Another recent and important landmark in water legislation is found in South Africa, where an explicit right to water in the constitution is matched with an explicit right in implementing legislation (the Water Services Act of 1997 and the National Water Act of 1998).

SEE ALSO: Prior Appropriation; Riparian Rights; Water Conservation; Water Demand; Water Harvesting; Water Markets.

BIBLIOGRAPHY. Dante Caponera, “Water Legislation in Asia and the Far East,” *Water Resources Series* (v.35

1968); K.K. Framji, B.C. Garg and S.D.L. Luthra, *Irrigation and Drainage in the World: A Global Review* (International Commission on Irrigation & Drainage, 1981); Stephen C. McCaffrey, " Water, Politics and International Law," in Peter Gleick, ed., *Water in Crisis: A Guide to the World's Fresh Water Resources* (Oxford University Press, 1993); Miguel Solanes, "International and Legal Issues Relevant to the Implementation of Water Markets," in *Water Policy International*, www.thewaterpage.com (cited April 2006); Sanjay Upadhyay and Videh Upadhyay, *Handbook on Environment Law: Water Laws, Air Laws and the Environment* (LexisNexis, 2002).

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Waterlogging

WATERLOGGING IS A term used to describe the saturation of ground or wood. The saturation renders the ground, wood, or other object unfit for use. When an area of ground is waterlogged, water saturation is so complete that the land cannot be used for a variety of activities, such as sports or recreation. Heavy rains or floods can waterlog ground for a period of time. Ground that is waterlogged has a water table that is virtually the same as the surface of the ground. In some cases, this can have positive consequences. For example, rice shoots are planted in ground that is flooded, and as the water recedes the rice continues to grow, but it would be damaged by waterlogging near harvest time.

Most agricultural production is harmed by waterlogging, with salinization a consequence. Many crops need oxygen in their growing process. Soil that is loose and allows the presence of air aids the growth of some plants, and waterlogging blocks the oxygen from the plant. If the roots of plants are blue-black, they are exhibiting a typical sign of waterlogging. Other signs are a smell of sour rotting or leaves that turn yellow and wither or whose midribs turn dark. Evergreens are very prone to leaf coloration changes that turn leaves brown. In addition because the plant cannot take in water properly, shoots at the extremities may die and bark may easily peel off of the shoots. Plant growth is also stunted.

Herbaceous plants are intolerant of waterlogging and may fail to sprout. Or they may sprout in the spring, open leaves, and then die. If the ground in an area or region has an impermeable layer, such as a clay layer under a thin topsoil, waterlogging can occur. Areas with a water table that is perched on top of an impermeable clay lay will drain only slowly in the direction of the lowest level. Agriculture in such an area can suffer from heavy rains. When fields are irrigated excessive waterlogging can occur. Fields that are poorly drained or that have soils that absorb and retain water are prone to this condition. If the irrigation comes from canals that seep into the water table, water is raised to the surface and thereby harms the crops in the affected fields.

Researchers have estimated that approximately 10 percent of the arable land in the world is waterlogged. This has caused a crop loss of approximately 20 percent in the affected areas. In contrast to farmland that suffers from waterlogging, wild lands, swamps, and other forms of wetlands benefit from it. The great basin in south Florida in which the Everglades and Lake Okeechobee are situated are areas in which waterlogging is extremely beneficial and necessary. The wetlands of the area constitute a form of natural wealth because they serve as natural pollution filters, water sources for the recharging of aquifers, places that support fisheries, and protection from storms and storm surges.

SEE ALSO: Floodplains; Floods and Flood Control; Swamp Land Acts; Water; Wetlands.

BIBLIOGRAPHY. S.K. Gupta ed., *Crop Production in Waterlogged Saline Soils* (Scientific Publishers, 1997); Edward Malthy, *Waterlogged Wealth* (Earthscan, 2006).

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Water Markets

WITH DEMAND FOR water fast outstripping its supply, experts are turning to water markets as an innovative strategy to manage water. Like all markets, water markets allow for the trade—buying and selling—of water for commercial or noncommercial uses. The price of water in a water market is determined by the exchange of water rights. Such rights are either customary or established through laws and regulations and they define entitlements to and ownership of water.

Meeting demand by expanding existing water systems is becoming increasingly difficult due to prohibitive environmental and economic costs. In countries where water use exceeds its natural recharge, groundwater levels are dropping—reducing available water and raising the cost of pumping, or causing salt water intrusion and contamination. Moreover, water is highly underpriced, leading to wasteful practices and lack of funds to maintain water infrastructure. Experts, therefore, argue that pricing water is a good way to check demand and reallocate water from current uses for a more efficient management of the resource.

In developed countries, the most active forms of water markets are those where water for irrigation is sold to water districts under long-term contracts specifying the quantity to be delivered and its cost per acre-foot. Such markets are best established in the western United States (states such as Colorado, California, Utah, and Nevada). Many states in the U.S. Pacific northwest have also adopted laws facilitating the trading of water to increase in-stream flows. For instance, to protect endangered salmon, an environmental organization in Oregon pays farmers to use less water for irrigation so that more water is available in the rivers. However, water markets are still in their infancy and there are various factors that limit their growth. For example, buyers and sellers in water markets often cannot find trading partners or lack adequate market information on pricing and terms of trade. Moreover, to protect water rights, government agencies require all transfers to undergo an approval process, which can often be lengthy and expensive.

In developing countries, water markets have primarily emerged in response to the scarcity of water due to different reasons—harsh climate; drought; pollution; lack of access due to social, economic or political reasons; or the failure of public water providers. They operate at various scales ranging from private vendors who buy water from farmers and landowners and sell it at costs determined by distance and demand to multinational corporations that sell bottled water. In most informal settlements where there is little or no access to formal water supply systems, people depend on water vendors and often pay as much as 10 to 20 times more per liter. The regulatory framework within which water markets function in developing countries is weak and can often lead to groundwater overdraft where farmers and landowners are eager to make quick profits by selling large quantities of water. Since there is no mechanism to monitor the quantity of water being withdrawn, it is difficult to minimize wastage. Moreover, where property rights regarding water are less defined or enforced, it is very difficult to ensure responsible individual behavior.

More problematically, the record of implementing water markets in the developing world suggests that the outcomes for the poor can be disastrous. Privatization of water in Chile has led to some abridgment of access rights of poorer citizens. More dramatically, when the water system in Cochabamba, Bolivia, was privatized and put under the control of a consortium led by a global corporation, International Water Limited (IWL) (itself in-part owned by the U.S. company Bechtel Enterprise Holdings), prices quickly rose to a point that made basic access to water a near impossibility for some of the poorest citizens, and led to protests that paralyzed the city and government until a reversal of policy occurred. Water markets can therefore be quite controversial.

SEE ALSO: Groundwater; Irrigation; Markets; Underdeveloped (Third) World; Water Demand; Water Law.

BIBLIOGRAPHY. K. William Easter, Mark W. Rosegrant, and Ariel Dinar, eds., *Markets for Water: Potential and Performance* (Kluwer Academic Publishers, 1998); V. Galaz, "Stealing from the Poor?: Game Theory and The Politics of Water Markets in Chile," *Environmental Politics* (v.13/2, 2004); Ganesh Pangare, Vasudha Pangare, and Binayak Das, *Springs of Life* (Academic Foundation, 2006); Sandra Postel, *Last Oasis: Facing Water Scarcity* (W.W. Norton, 1992); Property and Environment Research Center, www.perc.org (cited April 2006).

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Water Quality

FRESHWATER IS A scarce but essential resource, and its quality is of utmost importance as increasing numbers of people and living organisms depend on it for survival. While water scarcity from lack of quantity often receives more attention, water quality becomes more critical than quantity when available water is degraded or polluted. Water quality is important in the ways that it affects human health, livelihoods, agriculture, industry, recreation, and ecosystem services.

Lack of water quality can thus jeopardize socioeconomic development and environmental sustainability, and the availability of clean and good quality water is increasingly recognized as a key factor for sustainable development. Water quality issues are a serious problem in much of the developing world, where lack of access to clean and safe water leads to high rates of morbidity and mortality (e.g., two million children die each year due to inadequate sanitation and clean water). Globally, 1.1 billion people do not have access to safe drinking water, making water quality a serious global concern.

Water can be polluted from a variety of sources, both human-made and natural. Important sources of water pollution can be microbial (viruses, bacteria), chemical (metals, salts, pesticides/herbicides, solid waste), and radiological. Water quality can be measured using a number of parameters: pH, salinity, oxygen content, turbidity, color, odor/taste, dissolved chemicals, total suspended solids, biochemical oxygen demand, and dissolved oxygen. Common water quality treatments include aeration, chemical treatment, filtration, and ultraviolet light treatment. Water quality can be degraded via point source pollution (e.g., oil spills) or diffuse pollution (e.g., agricultural wastewater seepage).

Due to the connectivity of groundwater and surface water sources, the pollution of one may threaten the water quality of another connected source. As such, water pollution containment and monitoring is challenged by the flow and connective nature of water, as well as by increasing numbers of sources and types of pollution. How water quality is managed thus reflects society's priorities in water use and management, and the value placed on water quality. Water that is safe for organisms (plants and animals) to survive in, as well as for human use, is at the center of much of the environment-development debates; poor quality water affects different groups of organisms and human society differently across temporal and spatial scales. Given the dialectical nature of human-environment relationships, poor water quality that affects ecosystems also affects society, and vice-versa.

What is deemed to be acceptable levels of pollution of a water source depends on its use, linkages to other water sources, and costs of alternative water usage as well as cleanup or reduction of polluting sources. For instance, agricultural wastewater and industrial effluents can pollute a variety of water sources, making them unsuitable for domestic water purposes as well as aquatic species survival. Pathogens and microbial quality issues are important to humans in drinking water and the spread of waterborne diseases that can affect human society; similarly, overloading of organic matter and chemicals can reduce the ability for aquatic species to survive (e.g., by increasing the biochemical oxygen demand [BOD] to break down pollution). Water quality is generally monitored and regulated through systems of permits and fines that can act as deterrents to pollution or degradation of water sources. Water quality issues become a problem when different uses of a water source are directly threatened. Drinking water quality usually receives the most attention in water quality discussions. When a water source that provides drinking water is contaminated or polluted, it generally becomes important to address that more quickly than nonconsumptive water.

Irrigation water's quality, however, also needs to be monitored and ensured to prevent crop and soil damage and contamination. Dependency of livelihoods directly on water quality is also an important factor in how people value and organize around water quality issues. For instance, farmers who need good quality water for agricultural production are more likely to be concerned than those whose livelihoods are not directly dependent on irrigation water quality. Similarly, recreationalists may place greater importance on clearer water in lakes or rivers, while governments may deem that it is economically not viable to maintain such quality levels.

Societal power relations are reflected in the ways water quality is assessed, monitored, and judged.

Different societies will place different priorities and valuations on the water quality desired, and thus in the different levels of allowable quantities of pollutants in the water. As such, there aren't universal water quality indicators that are enforced, but there are international guidelines on safe levels and degradation indicators. These guidelines generally are followed by national governments and water authorities in areas of drinking water, wastewater treatment, recreational water facilities, and agricultural production. For instance, the World Health Organization (WHO) provides details of safe and allowable limits of the many pollutants (biotic and abiotic) for drinking water quality in order to maintain human health.

There can be different interpretation of the same data and quality issues, however, depending on the position of the viewer as well as broader societal understandings of what is deemed safe or unsafe. Notions of acceptable risk come to the fore, as different societies and people will perceive risk or threat from water quality differently. As such, different countries may follow slightly different sets of guidelines in monitoring and evaluating water quality for the different uses. In the United States, the Environment Protection Agency (EPA) is largely responsible for monitoring and evaluating water quality and setting guidelines. The Clean Water Act of 1977 is an example of one of the important regulatory mechanisms by which the EPA monitors and control wastewater pollution from industrial sources.

Conflicts over water uses can stem from the different valuations of water. For instance, the same water source may provide drinking water supplies as well as receive industrial and agricultural wastewater, thus necessitating management of the water source so that its quality is maintained for multiple uses. Economics, as well as value systems, also influence water quality issues due to the costs involved in maintaining or returning to a certain level of quality. Similarly, the attention to scale is important, as the scale of a water quality problem will influence the scale of treatment or management needed, and the number of actors involves as well as ecosystems influenced. As such, water quality management necessitates sufficient flexibility and responsiveness in surveillance, quality control, and management mechanisms in order to address different societal and environmental needs.

Given the growing scarcity of good quality water, increasing focus is being given to reusing water and increasing productivity from limited quantities of water. While such technological solutions provide important ways to use scarce water more efficiently and productively, questions remain about social access to safe water and the role of water quality in the broader political economy of development. As such, water quality is as much an environmental and technological question as a political and developmental one.

SEE ALSO: Clean Water Act (U.S. 1972); Safe Drinking Water Act (U.S. 1974); Sewage and Sewer Systems; Wastewater; Water; Water Conservation; Water Demand; Water Law.

BIBLIOGRAPHY. J. Bartram and R. Balance, eds., *Water Quality Monitoring—A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programmes,* www.who.int (cited April 2006); International Water Management Institute, www.iwmi.cgiar.org (cited April 2006); J.W. Kijne, R. Barker, and D. Molden, eds., *Water Productivity in Agriculture: Limits and Opportunities for Improvement*, CAB International, www.iwmi.cgiar.org (cited April 2006); J. Perry and E. Vanderklein, *Water Quality: Management of a Natural Resource* (Blackwell Publishers, 1996); J. Trottier and P. Slack, eds., *Managing Water Resources: Past and Present* (Oxford University Press, 2004); United States Environmental Protection Agency/United States Agency for International Development (USAID), *Guideline for Water Reuse* (USAID, 2004); World Health Organization, *Water, Sanitation, and Health*, www.who.int (cited April 2006).

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Watershed Management

A WATERSHED IS the land from which water drains into a stream, river, lake, or other body of water. All land, and the humans and wildlife found on that land, are part of a watershed. The term *watershed* is commonly used in North America, and is equivalent to *drainage basin*, a term used in Europe. Watershed management is a process of managing an area in order to protect and rehabilitate land and water and associated aquatic and terrestrial resources through human activities (intervention). This is done while recognizing the benefits of orderly growth and development with the aim of contributing to the environmental, social, and economic health of the area for sustainable development. To manage and protect the watershed better, plans should be made based on the areas delineated by watersheds and not the political boundaries; or in other words, many water quality and ecosystem problems are best prioritized, addressed, and solved at the watershed level rather than at the municipal level or the level of a single body of water or individual discharger.

The watershed management approach requires crossing traditional boundaries and considering various uses of water when making a policy, and considering all the point as well as nonpoint sources of pollution. This is important to solve local watershed pollution problems, since all of them are interrelated and can be best dealt with using an integrated approach. This means that the watershed approach essentially coordinates a framework for environmental management that focuses efforts to address problems of ground and surface water flow within hydrologically defined geographic areas. According to the Ohio Watershed Academy, watershed management is a process for managing water resources that involves integrating sound science and social values, incorporating stakeholder involvement, and making management decisions that are appropriate for local conditions.

The watershed approach goes beyond just hydrological- and science-based decisions to good governance involving all stakeholders in managing local watersheds. The basic concept has been extended to incorporate participatory decision making, which brings additional benefits, as informed users apply local self-regulation in relation to issues such as water conservation and watershed protection far more effectively than regulations and surveillance can achieve. The stakeholders involve public and private sectors, including all the users of water such as industry, farmers, fishermen, institutions, shopping malls, and the community. The watershed approach also requires a gender-balanced approach in planning, which means involving both women and men in decision making. Since all watersheds are unique in the sense of living and nonliving organisms present in the area, and how they interact with each other, understanding of local conditions and use of local knowledge are both important in the watershed approach. The emphasis is also on broadening decision making to take into account overall social and economic goals, including the achievement of sustainable development.

As discussed by the U.S. Environmental Protection Agency (EPA), there are six phases of management to achieve watershed management goals: 1) identification of issues and data gathering; this phase should have a multiyear strategy to portray existing information on physical, chemical, biological, and habitat conditions and comprehensively monitor waters, 2) as an outcome of watershed planning processes, new or revised water quality standards for the waters within a watershed can be formulated to reflect agreements made by the stakeholders to meet the watershed goals like adopting precisely defined uses given the chemical, physical, and biological characteristics of the water body, 3) planning or/and prioritizing; the watershed approach should take into consideration findings and priorities established under pre-existing initiatives, 4) each watershed partnership should develop management options and set forth a watershed or basin management plan that should set objectives, identify indicators, and set forth milestones, 5) due to the participatory nature of watershed approaches, responsibility for implementation of watershed plans will fall to various parties relative to their particular interests, expertise, and authorities, and 6) monitoring and evaluation; the watershed management cycle should include monitoring to ascertain the environmental and socioeconomic impacts of watershed plans. Progress should be reported and results of monitoring should help guide decisions about continued implementation.

Watersheds usually cover vast amounts of land, both public and privately owned; it can be difficult to bring all the stakeholders to the table to come up with a plan to manage these huge areas. To understand the interactions among different living and nonliving organisms in a watershed can also be challenging; this is further complicated by the study of how human activities affect watershed functions. As there are so many different users in the watershed, there is always a conflict between different stakeholders and between stakeholders and management goals; resolving these conflicts can be tough, but is necessary to accomplish to achieve watershed management. Also, watershed management requires time and resources to generate interest and to build relationships between stakeholders. Funding agencies and stakeholders may grow impatient with the lack of observable outcomes.

Watershed management has evolved and become an integrated and comprehensive approach to addressing a broad range of water protection issues. This approach allows the evaluation of the important links between land and water, between surface and groundwater, between water quality and water quantity, and between watershed management and municipal planning.

SEE ALSO: Lakes; Pollution, Water; Riparian Areas; Rivers; Water; Water Conservation; Water Law.

BIBLIOGRAPHY. A.O. Akan, *Urban Hydrology, Hydraulics, and Stormwater Quality: Engineering Applications and Computer Modeling* (John Wiley & Sons, 2003); K.N. Brooks et al., *Hydrology and the Management of Watersheds* (Iowa State Press, 2002); I.W. Heathcote, *Integrated Watershed Management: Principles and Practice* (John Wiley & Sons, 1998).

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Watt, James G. (1938–)

JAMES G. WATT served as the U.S. Secretary of the Interior from January 23, 1981, to November 8, 1983, during President Ronald Reagan's first term. Watt is a Wyoming native and a staunch Republican. Prior to being appointed to the Interior position, Watt drew the attention of President Reagan for his work as founder and leader of the Mountain States Legal Foundation (MSLF), an organization that supported and encouraged the expanded extraction of oil, timber, and mineral resources. The MSLF was identified as a strong antienvironmental organization. Earlier in his governmental career Watt worked as Secretary to the Natural Resources Committee and Environmental Pollution Advisory Panel of the U.S. Chamber of Commerce. In 1969, Watt received appointment as Deputy Assistant Secretary of Water and Power Development in the Department of the Interior. He also worked briefly for the Federal Power Commission before founding the MSLF.

During his tenure as Secretary of the Interior, Watt was widely criticized for his positions on environmental programs. In April 1981, just three months after his appointment, the Sierra Club and other environmental organizations were calling for his dismissal. Over a million signatures demanding his dismissal were presented to Congress as evidence of general displeasure with his stance on the environment. Watt cut funding for the Endangered Species Act and strongly suggested expanding the offering of oil and gas leases in wilderness areas and in offshore regions.

Watt is remembered for his statements linking stewardship of the land and religion. In February 1981 in testimony before the House Interior Committee, Watt said, "I do not know how many future generations we can count on before the Lord returns; whatever it is we have to manage with a skill so as to leave the resources needed for future generations." There is a hint of the conservationist in this statement, but further statements suggested otherwise. Watt stated on one occasion that "We will mine more, drill more, cut more timber." It is this philosophy that quickly caught the attention of environmentalists. Watt's political stance was never in doubt; in 1982 he stated, "I never use the words Democrat and Republican. It's liberals and Americans."

Watt was politically linked with Anne M. Gorsuch, administrator of the Environmental Protective Agency, who reduced the effectiveness of the organization and sought to ease environmental regulations on industry. Environmental organizations such as the Sierra Club and the National Audubon Society were able to significantly increase their membership ranks in response to the actions of the two perceived antienvironmentalists. Watt was forced to leave his post following comments he made about his staff to members of the U.S. Commission on Fair Market Value Policy for Federal Coal Leasing to the U.S. Chamber of Commerce on September 21, 1983: "We have here every mixture you can have. I have a black, a woman, two Jews and a cripple. And we have talent." Within weeks of this statement, Watt resigned.

When President George W. Bush appointed Gale Norton as Secretary of the Interior, environmentalists were again concerned. Norton had served as a staff member under Watt in the MSLF and it was feared that she would replicate the environmental stance taken by Watt. Under President Bush, environmentalists saw a resurrection of many of the goals Watt furthered in the early 1980s. The notion of placing production ahead of conservation, presented in a speech by Vice President Richard Cheney in 2001, is a clear reflection of the Watt philosophy. Watt himself commented on the Bush position in an interview for the *Denver Post* in 2001, "Everything Cheney's saying, everything the president's saying—they're saying exactly what we were saying 20 years ago, precisely."

SEE ALSO: Bush (George W.) Administration; Department of the Interior (U.S.); Endangered Species Act (U.S.); Reagan, Ronald Administration; Sagebrush Rebellion; Sierra Club.

BIBLIOGRAPHY. S.P. Bratton, "The Ecotheology of James Watt," *Environmental Ethics* (v.5/fall, 1983); G.C. Coggins and D.K. Nagel, "Nothing Beside Remains: The Legal Legacy of James G. Watt's Tenure as Secretary of the Interior on Federal Land Law and Policy," *Boston College Environmental Affairs Law Review* (v.17/spring, 1990); Carolyn Merchant, *The Columbia Guide to American Environmental History* (Columbia University Press, 2002).

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Weapons of Mass Destruction (WMD)

THE MEANING AND definition of *weapons of mass destruction* (WMD) continue to evolve over time and with technology. Though the phrase was first used in a *New York Times* article in 1937, referring to a saturation bombing during the Spanish Civil War, the first administrative use of the term came when the United Nations established the Atomic Energy Agency in 1946. Originally referring only to atomic weapons, through treaties and international conventions, WMD has come to include all types of nuclear, biological, chemical, and toxic weapons. Today an exact definition of WMD is nonexistent, varying by place and policy. However, in general WMD are broken down into the following four categories of weaponry: Nuclear, biological, chemical, and radiological.

Due to the longevity and range of destruction that they are capable of unleashing, nuclear weapons indisputably pose the gravest risk to the living environment. Though only used twice in warfare, in Japan in 1945, nuclear weapons have been detonated thousands of times around the world by countries testing their nuclear weapon technology—China, France, India, Pakistan, Russia, the United Kingdom, and the United States. Other states have been pursuing, or have declared that they possess, nuclear weapons (i.e., Iran, Israel, and North Korea.) Hypothetically, if enough nuclear weapons are detonated at approximately the same time, a "nuclear winter" would be the result. This would entail a drastic cooling of global temperatures due to particles in the atmosphere blocking the sun's radiation from reaching the surface. There is a good chance that no life forms would survive such an event on the planet Earth. The state possessing the most nuclear missiles in the world, and thus from an environmental standpoint the most dangerous state to ecological longevity, is the United States.

Biological weapons are the oldest of the contemporary WMD. They include the use of any poisonous or toxic pathogens for military advantage. However, the military usefulness of biological weapons is dubious. Though potentially resulting in the deaths of thousands of people, animals, and natural fauna, there would be little possibility of preventing biological WMD from afflicting one's own forces or population. Moreover, biological weapons take longer to infuse themselves than many other types of WMD, making them largely inefficient for conventional military campaigns. Nonetheless, over the

Hans Blix

Hans Blix was born in 1928 in Uppsala, Sweden, to a family from the Norwegian nobility. He studied at Uppsala University, Columbia University, and the University of Cambridge in Britain, from where he graduated with a doctorate in law. He was an associate professor in international law until 1961, when he was appointed to the Swedish delegation to the United Nations (UN), a post he held until 1981. He also served as a member of the Swedish delegation to the Disarmament Conference in Geneva. He was the foreign minister of Sweden from 1978 until 1979.

In 1981, Hans Blix was appointed head of the International Atomic Energy Agency, spending much of his time traveling around the world inspecting nuclear facilities. This involved visits to many well-known plants, and also to Iraq and North Korea. He went to Osiraq near Baghdad several times before the Israeli aerial attack in 1981 that destroyed much of the plant. The Israelis had claimed that nuclear weapons were in the early stages of development there, although Blix never found any evidence of this.

In January 2000 Hans Blix was appointed the first executive chairman of the UN Monitoring, Verification, and Inspection Commission, a post he held until June 2003. During this time, he was involved in the search for Iraqi weapons of mass destruction (WMD). Although no stockpiles were found, he did locate some missiles that the Iraqis had been making illegally—and which they dismantled. Blix was always extremely critical of Saddam Hussein, the Iraqi leader, who tried to hide his weapons after the Gulf War of 1990–91, but also felt too much was made of WMD as the excuse for the invasion of Iraq in 2003.

last quarter century biological agents have become the most readily available WMD for use in bioterrorism (e.g., anthrax attacks in the United States during 2002).

Chemical weapons are far more efficient WMD than biological ones, but often far more deadly. Their effects are often immediate and severe, their effects taking hold through breathing, ingestion, or skin contact. Chemical weapons are unique in the fact that it is rare that the weapon system delivering them is the cause of carnage (unlike in nuclear or conventional weapon attacks). Instead, toxic agents are dispersed by the weapon delivery system. Unlike nuclear weapons, chemical weapons are relatively cheap and easy to produce. Over 70 different chemical agents are known to have been created. It is presumed that numerous countries maintain stockpiles of chemical agents. Several states are known to have used chemical agents in battle over the past 50 years. International treaties have largely been ineffective in controlling the development of chemical weapons, partially due to the fact that treaties are based on chemical structures and countries can create new chemical weapons that are undetectable.

Radiological weapons are a relatively new addition to WMD and may better be classified as weapons of mass hysteria. None are known to have ever been used in warfare or terrorist attack. Often referred to as “dirty bombs,” models illustrate that radiological weapons would likely do more psychological harm to a community than ecological devastation. The ingredients for such a bomb would likely come from nuclear power waste, and regardless of what type of radioactive material was used, the radiation would either dissipate too quickly to cause widespread damage or it would take a long time to exterminate local living organisms.

The potential environmental impact of WMD is enormous. Obviously with a nuclear Armageddon, humankind’s longevity on the planet would be placed in jeopardy. Ecological destruction would be complete and limit the chances of continued life on earth. Even the detonation of a single nuclear weapon has been shown to have a devastating impact on the environment—most of these weapons make areas uninhabitable for decades, if not hundreds of years. Radiation exposure lies behind many diseases, many longitudinal, as were witnessed in Japan after World War II. Though biological and chemical weapons are both cheaper and easier to create than nuclear weapons, their impact on local environments may be just as devastating. Capable of killing all life forms and, in the case of biological weapons, diffusing via communicable means, these WMD may pose the greatest risk for humans in the future. Finally, radiological weapons do not pose as much of a risk to the environment as their sources do—that is, nuclear waste from power plants. However, if placed in an urban area and or set off without detection, the impact on human life could be devastating.

Though numerous treaties have been passed on almost all WMD, the fact is that there is no commission to enforce compliance. Moreover, now that the United States has determined that it is justifiable to preemptively strike states that may have WMD, it appears that diplomacy may no longer be a viable option for supervising and controlling the diffusion of WMD around the world. Nuclear nonproliferation had largely been effective throughout the Cold War era, but since the decline of the Soviet Union has become a major concern for Western states around the world, as many "rogue states" choose to pull out of the treaty. WMD are also an enticing weapon for terror organizations due to their ubiquity and potentially devastating effects.

SEE ALSO: Radioactivity; Nuclear Weapons; Wars.

BIBLIOGRAPHY. Anthony H. Cordesman, *Terrorism, Asymmetric Warfare, and Weapons of Mass Destruction: Defending the US Homeland* (Praeger Publishers, 2001); Global Security, "Weapons of Mass Destruction," www.globalsecurity.org/wmd (cited March 2006).

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Weather

WEATHER IS THE condition of the atmosphere in a local environment or region over a short period of time, ranging from an exact instant to a few days. This is distinct from climate, which refers to persistent atmospheric systems over larger areas and greater time periods. The atmospheric conditions may be hot or cold, dry or humid, rainy or dry, windy or calm, cloudy or clear in combination.

The atmosphere is the envelope of air that surrounds the surface of the earth. It has four layers: They are the troposphere, the stratosphere, the mesosphere, and the thermosphere. The term atmosphere also means the weight of the air pressing against the earth at any given point on earth. At sea level the weight of the air is 14.7 pounds per square inch (1.03 kilograms per square centimeter) of surface. At places below sea level such as the surface of the Dead Sea the atmospheric pressure is greater than one atmosphere. On mountaintops the atmospheric pressure is less. This natural feature of the weight of the atmosphere at various places on the earth's surface is an important feature in the weather and in the climate.

Climate differs from weather. Weather is the immediate atmospheric conditions. Climate is the average of the weather over an area for a long period of time. Almost all weather takes place in the troposphere that extends from the surface to six to ten miles above the surface of the earth. Most of the atmosphere, water vapor and heat are in this layer.

Weather conditions involve temperature, air pressure, wind, and moisture. A weather report will combine all of these to show the weather as it is currently, or more importantly as it is expected to be in the hours or days ahead in order that people may respond appropriately.

Temperature readings measure the amount of heat in the atmosphere. The heat comes from sunlight shining on the earth. However, sunshine does not strike the earth everywhere with the same effect. At the equator the sun shines directly on the earth making the weather at the equator warm. The further from the equator and the closer to the North Pole or the South Pole the more the sun strikes the earth's surface at an angle. In addition, as the earth rotates around the sun in its yearly circumnavigation it presents either the Northern or the Southern Hemisphere to the sun more directly, which produces summer or winter.

As the sun strikes the earth's surface it may strike water or land. Since the oceans and the continents present different surfaces to sunshine the effect generates different amounts of heat. In desert regions the heat is reflected away from the surface of the earth. At night the radiant heat quickly turns the desert into a chilly place. However, in land areas of moisture and extensive plant growth heat is absorbed by the plants and retained in the locality. In the oceans the heat is absorbed and distributed by currents, evaporation, and by reflection in a different pattern.

Another factor affecting the temperature of the atmosphere is the greenhouse effect. This occurs because the carbon dioxide given off by humans, animals, in natural springs, or by industry blocks some of the escape of radiant heat creating conditions similar to a green house or to a thermal cover on a swimming pool.

The varying temperatures on the surface of the earth create atmospheric pressure differences. As air is heated it expands and rises. The heating of the earth at the equator, and especially in the equatorial ocean waters, sends warm air upward. In contrast, the air at the poles is colder and more condensed than warm air. The effect is that warm air creates areas of low atmospheric pressure (lows) because the weight of the atmosphere at that locality is less than in areas where low temperatures condense air and create places of high atmospheric pressure (highs). The condensing of air at the poles and the rising of air in the equator creates pressure differences between the two regions. The rising air of the equator moves toward the poles and the sinking air of the poles moves toward the equator creating wind.

Winds, which are named for the direction from which they flow, blow from highs to lows. Conversely, as cooler air moves toward a low it forces the rising warmer air to move upward more rapidly. The higher the elevation the warmer air reaches, the more it cools and contracts. The moisture in the warmer air then condenses into clouds and precipitation.

Most of the rain that falls on earth is from water vapor that evaporated from the oceans. Humidity is the amount of water vapor in the atmosphere. When a volume of air has absorbed as much moisture as it temperature and pressure will allow, then it is saturated. The dew point is the temperature at which a volume of air is saturated with moisture. If a given volume of air continues to cool beyond its dew point then moisture is converted into dew, or if cold enough, into frost. Moisture-saturated air that is cooled to the dew point that is near the ground or the ocean may also create fog. If the cooling continues, then the moisture in the air condenses into either liquid precipitation (rain) or frozen precipitation (hail, sleet, or snow).

Most places on the surface of the earth have changing atmospheric patterns that vary with the seasons. At the poles the seasons are long periods of daylight in the summer or total darkness in winter. The freezing temperatures make the poles both cold deserts where most of the moisture has been squeezed out by the lower temperatures. The weather in tropical zones is marked by periods in which it is hot and dry followed by rainy seasons.

Weather reports are of great importance to farmers, sailors, and others operating in the open such as military field commanders. Weather predictions can also be of great value to people in areas that are vulnerable to extreme weather such as tornadoes, hurricanes, blizzards or heat extremes. The weather affects humans directly and constantly. In cold weather heating for homes or businesses is needed; in hot weather protection from extreme temperatures or from dehydration is necessary. In rainy or stormy weather shelter and protective clothing are necessary to prevent hypothermia or injury or death from lightning or strong winds.

Weather affects agriculture, industry, transportation, and communications. Storms such as violent thunderstorms, tornadoes (cyclones), and hurricanes (typhoons), or even dust and sand storms can create disasters for civilization in many areas of the world.

SEE ALSO: Atmosphere; Climate; Drought; Greenhouse Effect; Hurricanes; Precipitation; Thunderstorms; Tornadoes.

BIBLIOGRAPHY. Edward Aquado and James Burt, *Understanding Weather and Climate* (Pearson Education, 2006); Marq De Villiers, *Windswept: The Story of Wind and Weather* (Walker and Company, 2006); Storm Dunlop, *Weather* (Smithsonian Institution Press, 2006); Terry J. Jennings, *Weather Patterns*. (Smart Apple Media, 2005); David M. Ludlum, *National Audubon Society Field Guide to North American Weather* (Alfred A. Knopf, 1998); Vincent J. Schaefer and John A. Day, *A*

Field Guide to the Atmosphere (Houghton Mifflin Co., 1981); Jack Williams, *The Weather Book* (Knopf Publishing Group, 1997).

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Weather Modification

WEATHER MODIFICATION IS the process by which, deliberately or otherwise, human intervention changes or attempts to change weather conditions. Deliberate interventions include attempts to weaken hurricanes or to change patterns of precipitation for agricultural purposes. Inadvertent interventions include the widespread burning of carbon fuels that leads to global warming and has various impacts upon weather systems. Speculation exists as to whether the use of weather modification in warfare is a viable concept. The limited success with which weather modification has been completed for peaceful purposes would suggest that it is not possible.

Perhaps the most common attempt to modify the weather comes from the use of substances such as dry ice or silver iodide to seed clouds with supercool particles to alter rainfall. Experiments in this area began on a systematic basis with the work of Vincent J. Schaefer and Irving Langmuir, recipient of the 1932 Nobel Prize for chemistry. They determined that super-cooled clouds could be made to dissipate in certain circumstances or else to begin precipitation because ice crystals are formed that are too large to remain part of clouds. The use of this technology can help to organize precipitation at a time deemed suitable for agricultural or social purposes (to prevent rain during parades, for example, which Soviet scientists attempted).

In the United States, this has caused a number of state-level bodies to pursue legislation to determine ownership of clouds because of concerns over access to needed water resources. However, the degree to which the precipitation can be affected remains largely unpredictable, owing in part to the complexity of atmospheric conditions. Nevertheless, this has not deterred governments of countries around the world from trying to modify cloud behavior by spreading particles from airplanes, distributing them by rockets or artillery, or otherwise causing them to be lifted on air currents. The ability of scientists to modify weather conditions systematically and consistently remains low, although it is possible that Soviet scientists were able to influence the fall of hail on a predictable basis. Consequently, the hope that it will be a useful weapon in the struggle against intensified and more prevalent dangerous weather conditions such as hurricanes and droughts remains impractical.

SEE ALSO: Atmospheric Science; Climate Modeling; Climatology; Weather.

BIBLIOGRAPHY. Stanley A. Changnon, "Inadvertent Weather Modification in Urban Areas: Lessons for Global Climate Change," *Bulletin of the American Meteorological Society* (v.73/5, 1992); Congressional Research Service, *Weather Modification: Programs, Problems, Policy, and Potential* (University Press of the Pacific, 2004); John A. Day and Vincent J. Schaefer, *A Field Guide to the Atmosphere* (Houghton Mifflin, 1998); Weather Modification Association, www.weathermodification.org (cited July 2006).

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Weeds

JOHN LELAND, a natural historian, defines a weed as a "plant out of place." The Bureau of Land Management (BLM) states that weeds constitute "any plant growing where it is not wanted." Weeds can be native or nonnative, invasive or noninvasive, and noxious or nonnoxious. According to the Animal and Plant Health Inspection Service of the U.S. Department of Agriculture, a weed is "any plant that poses a major threat to agriculture and/or a natural ecosystem." This particular definition is significant because it highlights the economic and ecological impact that weeds can have on human communities, landscapes, and natural ecosystems. Some weeds have been categorized as "noxious" by federal agencies and state and local governments. A noxious weed is a plant that poses a major threat to agriculture, public health, recreation, wildlife, or property. The BLM defines noxious weeds as those plants that are "competitive, persistent, and pernicious" and out of place.

European purple loosestrife has cost U.S. taxpayers $45 million annually in efforts to control its spread.

CHARACTERISTICS AND PROLIFERATION

Weeds can be found worldwide. A few of them, like plantain and henbit, have medicinal qualities. Others, such as dandelion, can be eaten. Most weeds, however, are nuisances and some pose severe problems to human communities and natural ecosystems. Each year, landowners spend billions of dollars on herbicides in a never-ending fight to eliminate weeds in their yards. Yards and lawns are not the only place to find weeds. In the United States, it is estimated that over 5,000 nonnative, exotic, and alien plants (which include many weed species) have escaped into natural ecosystems. Some of these weeds have been naturalized and assimilated into the forest community. Others, though, pose a severe threat to both land and aquatic ecosystems.

One of the most significant factors in the proliferation of weeds is human activity. Weeds came to North America with the early explorers and settlers. American colonists, for example, brought along with them plants for food and medicinal purposes, including dandelions, which, over time, became "naturalized" weeds. Some weeds came to the New World accidentally as stray seeds in livestock and human food supplies. Other American weeds, like crabgrass and Bermuda grass, came from early global networks involving Africa and the slave trade. During the late 19th century, a whole array of weeds, like kudzu, honeysuckle, and wisteria, came to the United States as ornamental plants. Commercial ventures, too, are responsible for the great profusion of weeds. The fish aquarium industry, for example, is directly linked to the accidental introduction of the Asian aquatic plant hydrilla to native ecosystems in the United States. Today, the introduction of weeds to new areas has significantly increased due to globalization and an exploding human population.

Although there exists an immense variety of weeds throughout the world, they all share certain characteristics. For one, weeds are hardy survivalists and are able to thrive in new habits due to their ability to adapt to adverse conditions, such as poor soils and extreme climates. For this reason, weeds have been identified in some of the world's harshest natural environments. Since many invasive and noxious weeds are rapid colonizers of barren soil, they tend to favor habitats that have been disturbed through human activities and natural occurrences.

In addition to being resilient, weeds are aggressive, fast-growing plants, and they have a tendency to out-compete natural vegetation for essential nutrients, space, and light. Superior competition among invasive weeds may be enhanced by a lack of natural predators or the diseases that, in the weeds' natural environment, would tend to keep them under control. Once established, aggressive weed species encroach on native vegetation and eventually endanger local plant communities. In some areas, weeds have completely replaced native plant species. Dense weed infestations tend to retard natural succession and reforestation and thus decrease biodiversity. According to the Nature Conservancy, 42 percent of the species listed as endangered or threatened under the Endangered Species Act are connected to invasive weeds and exotic plants.

Weeds thrive, also, because of superior reproduction capabilities. One of the most common means of reproduction among weeds is through seeds that have high germination rates, although this is not the only way that weeds propagate. In the southern states, Johnson grass utilizes both seeds and an expansive rhizome root system to form new colonies. In addition to seed and root reproduction, hydrilla can also replicate asexually through its leaves or leaf particles. To enhance their survival, some weeds, over time, hybridize with native plant species, altering their genetic make-up. Hybridization occurs when human activity inadvertently brings together two similar plant species. In many instances, the hybrid offspring is more competitive—and destructive—than either parent.

DANGERS TO THE ENVIRONMENT

Weeds present many problems to both human and natural environments. In the United States alone, "alien" weeds make up nearly 65 percent of the total weed flora and the costs associated with their control are enormous. In 1994, it was estimated that Americans spent $20 billion on weed control. In that same year, agricultural losses due to weeds exceeded $10 billion.

The impact of weeds on ecological systems is tremendous. In many instances, they completely alter natural functions within ecosystems by modifying nutrient and hydrology cycles. In this respect, weeds have the potential to change natural habitats. One example of habitat alteration concerns the hybrid cattail, which has replaced native white top and wild rice in North American wetlands. European purple loosestrife, which came to North America during the 19th century as an ornamental plant, has invaded most of the wetland areas in the United States. Today, the plant has negatively impacted wetlands by reducing native plant species and threatening wildlife habitat. Consequently, native plant destruction caused by the European purple loosestrife has directly contributed to a decline in the box turtle population, due to a reduction in its natural food supply. It has also cost taxpayers $45 million annually in efforts to control its spread. Not only do weeds pose threats to endangered species of plants and animals, they also prevent or retard the natural succession of native vegetation by forming dense mats of infestation. Certain species of weeds, such as leafy spurge, are also toxic to cattle. Additionally, weeds like thistle have reduced native forage plants in pastures, rangelands, and forests and have had a significant impact on the ability of cattle to graze.

SEE ALSO: Biodiversity; Colonialism; Dandelions; Ecosystems; Endangered Species; Herbicides; Invasions, Biological; Invasive Species; Lawns; Pesticides; Water Hyacinth; Wetlands.

BIBLIOGRAPHY. Bureau of Land Management Weeds Website, www.blm.gov/weeds (cited April 2006); Federal Noxious Weed List, www.aphis.usda.gov (cited April 2006); "Invasive and Exotic Species," www.invasive.org (cited April 2006); John Leland, *Aliens in the Backyard: Plant and Animal Imports into America* (University of South Carolina Press, 2005); David Pimentel, Lori Lach, Rodolfo Zuniga, and Doug Morrison, "Environmental and Economic Costs Associated with Non-Indigenous Species in the United States" (1999), www.news.cornell.edu (cited April 2006).

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Wells

WELLS ARE HOLES dug, punched, or drilled into the ground to access water or some other liquid such as oil or brine, or gas such as methane. The technology for digging wells has developed from shallow wells dug with hand tools to wells that are drilled thousands of feet into the surface of the earth. Water wells are dug because there is no surface or groundwater available, or because the supply of groundwater is insufficient for the needs of people, livestock, or industry. Shallow wells dug by hand were the primary source of water for people for thousands of years. Wells are considered shallow if they descend to less than 50 feet. Shallow wells reach either the water table (water table wells), which is the level at which the soil is saturated with water, or a well may be dug through an impermeable layer of clay or rock to an aquifer, which is a permeable layer of either soil or rock through which water flows, but which is capped by at least one impermeable layer (aquifer wells).

In many third world countries, shallow wells are still being dug and used by people as a substitute for sharing a waterhole with wild animals. Typically a shallow well is dug using hand tools and local labor. The well is dug during the dry season to the local water table and then a little deeper. Digging during the dry season insures that the lowest point the local water level descends to below ground will be the lowest level for water in the well at any time. The bottom of the well is covered with sand and gravel to inhibit mud incursions. This will keep the water freer from particles of dirt. If suitable rock is unavailable, then mud bricks are made on site. After the mud bricks have been fired and cooled they are solid enough to not dissolve in the water and will last for a long time. The bricks are then used to line the well from bottom to top and are joined together with cement.

Wells such as those built in some African countries are usually covered with a locally made cement top that has a hole in it. PVC pipe is put through the hole in the well top, which may be called a cap. Then a locally made pump, which is like a bicycle pump, is attached to the PVC pipe. When the pump is propelled water flows out of the lip in the top of the well. Wells of this type can cost $300 or less to build. They then provide water for a whole village that may number 100–200 people or more. Wells that are properly dug will be located well away from possible sources of pollution or from runoff that may carry pollution. In addition a good well will have a sanitary seal made of cement grout or bentonite clay and its pump will be designed to protect the wellhead.

Wells can be drilled with machinery as well as dug with hand tools. The drilling of wells began in the mid 1800s. The well diggers of that time adopted a machine that drove or "pounded" a bit into a hole into the ground. The bit was attached to a cable and was dropped repeatedly into the drill hole. The cable tool drilling method was slow and inefficient. The rotary drilling method replaced it in the 1900s. The rotary drill bit is made of tungsten steel or other tough metals. Attached to a drill pipe, it is rotated to grind up rock that it encounters in drilling the well. It operates inside of a larger pipe that is regularly flushed with water to cool the drill bit and to wash out the cuttings, dirt, gravel, and sand. The outer pipe acts as a wall and prevents the drill hole from collapsing, which would block the drill hole. As the drilling progresses the well driller keeps an accurate log of the depths of the drilling and the levels at which water is encountered.

Many drillers use a "down-hole air hammer" when drilling in hard rock. The compressed air blows the crushed rock debris out of the well hole along with any water that has entered the hole. After the well is drilled the hole has to be finished to prevent collapse and contamination by pollutants. Lining it with well casing usually made of steel or plastic seals a well. The casing is smaller than the well hole. The space between the well hole and the casing will be filled with a "grout" to prevent contamination. The "grout" is either cement or volcanic clay called bentonite. The space may also be filled with a special kind of fine rock. Usually, only the top 20 feet are grouted. Well drilling equipment is commercially available in units for individuals who wish to drill wells of depths less than 300 feet that can be used for irrigating lawns, gardens, or other farm or home operations. Proper drilling and maintenance of water wells is needed to ensure that the well's water remains safe. In many locations the accelerating exploitation of well water has had a negative impact on aquifers.

SEE ALSO: Drilling (Oil and Gas); Water; Water Demand; Water Harvesting.

BIBLIOGRAPHY. Michael D. Campbell and Jay H. Lehr, *Water Well Technology: Field Principles of Exploration, Drilling, and Development of Ground Water and Other Selected Minerals* (McGraw-Hill, 1973); Michael Detay, *Water Wells: Implementation, Maintenance and Restoration* (John Wiley & Sons, 1997); Ulric P. Gibson and Rexford D. Singer, *Water Well Manual: A Practical Guide for Locating and Constructing Wells for Individual and Small Community Water Supplies* (Premier Press, 1971); P. Howsam, *Water Wells—Monitoring, Maintenance, Rehabilitation: Proceedings of the International Groundwater Engineering Conference Cranfield Institute of Technology* (Taylor & Francis, 1990).

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West Nile Virus

WEST NILE VIRUS (WNV) is a vectorborne infectious disease of the family Flaviviridae and is found in both tropical and temperate regions. WNV normally transmits among birds, mosquitoes, and mammals (especially humans and horses). The virus circulates in the blood of birds (reservoir hosts) for a few days after infection. Mosquitoes, particularly *Culex pipiens, C. restuan, C. tarsalis* and *C. quinquefasciatus*, become infected when they feed on infected birds. Infected mosquitoes (vectors) can then transmit WNV to humans and horses through their bites. They also infect other birds when they bite again. The virus is injected from the mosquito's salivary glands into the blood stream where it can multiply and cause illness. It was initially believed that direct human-to-human transmission was impossible and that humans are dead-end "hosts." However, in 2002, the Centers for Disease Control and Prevention (CDC) discovered the transmission of WNV through blood transfusion and organ transplants as well through breast milk, prenatal infection, and occupational exposure.

The typical incubation period for West Nile virus is 2–6 days, although it can be as long as 15 days. Most people (80 percent) infected with West Nile virus will be asymptomatic or experience a flu-like illness. In others, the virus causes West Nile fever. Very few infected people will develop the more severe form of West Nile, i.e., West Nile encephalitis (inflammation of the brain), and meningitis (inflammation of the lining of the brain and spinal cord), both of which can be fatal.

The geographic distribution of this virus has expanded since its discovery in Uganda in 1937 and now includes Africa, Asia, Europe, North America, central and south America, and the Caribbean. In the United States, the virus first appeared in the Bronx borough of New York City in 1999. Since then, it has spread rapidly west and south from its initial focus. By 2003, 45 states and the District of Columbia had reported human cases of WNV. From 1999 through 2001 the CDC confirmed 149 cases of human WNV infection, including 18 deaths. In 2002 the count increased to 4,156 cases and 284 fatalities. WNV outbreaks reached a peak in 2003 when the CDC reported 9,862 case and 264 deaths. At least 30 percent of those cases were considered severe, involving meningitis or encephalitis. However, in 2004, there were only 2,539 reported cases and 100 deaths. In 2005 there was a slight increase in the number of cases, with 2,949 cases and 116 deaths reported. Canada, Israel, and Romania also experienced outbreaks of WNV in recent years.

The distribution of WNV is dependent on the occurrence of susceptible avian reservoir hosts, competent mosquito vectors, and abundance of preferred hosts (humans and horses) for the infected mosquitoes. These factors are in turn affected by potential environmental and social factors. Several studies have highlighted land use and land cover change, elevation, abundance of vegetation, physiographic regions, stagnant water bodies, temperature, precipitation, spatial and temporal differences in periods of drought and rain, close proximity to dead birds and mosquito vectors, and farmland created by irrigation as potential environmental factors. Social factors influencing the distribution and transmission of WNV are human population density, age, income, race, age of housing, mosquito control activities, location of scrap tire stockpiles, and location of organic wastes from chemical industries.

In spite of a plethora of research on WNV, a vaccine for humans is not yet available. However, a vaccine for horses exists. Nevertheless, following precautionary measures as indicated by mosquito control agencies can mitigate the risk of infection. These measures include staying indoors at dawn and dusk when most mosquitoes are active, wearing long-sleeved shirts and long pants during outdoor activities, applying mosquito repellent sparingly on exposed skin, and removing any water holding containers from property.

SEE ALSO: Center for Disease Control; Disease; Malaria; Mosquitoes; Viruses.

BIBLIOGRAPHY. J.S. Brownstein et al., "Spatial Analysis of West Nile Virus: Rapid Risk Assessment of an Introduced Vectorborne Zoonosis," *Vector Borne Zoonotic Disease* (2, 2002); L.M. Bugbee and L.R. Forte, "The Discovery of West Nile Virus in Overwintering *Culex pipiens* (Dipters: Culicidae) Mosquitoes in Leigh County, Pennsylvania," *Journal of the American*

Mosquito Control Association (v.20/3, 2004); Center for Disease Control and Prevention (CDC), "West Nile Virus Activity—United States, 2001," *Morbidity and Mortality Weekly Report* (51, 2002); CDC, "Testing and Treating West Nile Encephalitis in Humans, West Nile Virus" (CDC, 2003); Samantha Gibbs et al., "Factors Affecting the Geographic Distribution of the West Nile Virus in Georgia, USA: 2002–2004," *Vector-Borne and Zoonotic Disease* (v.6/1, 2006); Marilyn Ruiz et al., "Environmental and Social Determinants of Human Risk During a West Nile Virus Outbreak in the Greater Chicago Area, 2002," *International Journal of Health Geographics* (v.3/8 2004).

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Wetland Mitigation

WETLAND MITIGATION REFERS to efforts to reduce the negative impacts of development on wetlands, and has been required by U.S. law under the Clean Water Act (CWA), the National Environmental Policy Act (NEPA), and other elements of environmental law. The CWA §404 permit program, established in 1972, is administered by the U.S. Army Corps of Engineers (Corps) and overseen by the U.S. Environmental Protection Agency (EPA); wetland mitigation is often required in order to obtain a §404 permit to fill or dredge in a wetland. However, in the 1970s mitigation was not consistently required, and Corps leadership did not agree that requiring mitigation was a necessary part of administering the §404 program.

The White House Council on Environmental Quality drafted NEPA regulations on November 29, 1978 defining mitigation as including five components: Avoidance, minimization, rectification, reduction, and compensation. All federal agencies are required to comply with NEPA; thus the EPA adopted a modified version of mitigation on December 24, 1980, known as the "§404(b)(1) Mitigation Guidelines." Because these guidelines are binding on the Corps issuance of wetland fill permits, they formalized the administrative requirement for wetland mitigation. The guidelines require a permit applicant to achieve all practicable avoidance and minimization of impacts to wetlands before a permit can be issued. The Corps can require compensation for any remaining unavoidable impact that constitutes "significant degradation." These three elements constitute mitigation under the CWA, and the Corps must deny a permit where mitigation cannot eliminate significant degradation. The third step, compensatory mitigation, has become an extremely common and important feature of U.S. wetland policy, and has come to symbolize the principle that one environmental feature can replace another, which has become part of the American conception of sustainability (embodied in the policy slogan "no net loss of wetlands" from the late 1980s). This principle is not widely accepted in environmental policy outside the United States, and compensatory mitigation for wetland impacts is rare.

Compensatory wetland mitigation is the restoration, creation, preservation, or enhancement of a wetland using techniques of environmental restoration. As early as 1982, reports began to emerge indicating that compensation sites were of poor quality. These reports became increasingly common, culminating in an infamous report on compensatory mitigation in Florida that found that only 33 percent of required sites had even been constructed. The Corps' limited attention to compliance monitoring continues to be blamed for this. The principal debate over wetland mitigation in the 1980s concerned the Corps' position that extra compensation could reduce the need for avoidance and minimization. The EPA held that all practicable avoidance and minimization must be achieved before compensation can be considered, and this position was formalized into joint EPA and Corps policy in the 1990 Mitigation Memorandum of Agreement (MOA). Since 1990, wetland mitigation has been understood to occur in a sequence: The permittee must first avoid, then minimize, and finally compensate.

The 1990 MOA also established a general preference for compensatory mitigation to occur on the site of the impact, and to be of the same kind of wetland as the impacted wetland; this was known as the "on-site in-kind preference." As various kinds of off-site and third party mitigation methods became more prevalent in the 1990s, such as wetland mitigation banking and in-lieu fee mitigation, the on-site in-kind preference gradually relaxed. Historically, most compensatory mitigation has been performed by the permittee, and nearly all compensation was on-site in the 1980s. This was in part because the Corps was reluctant to consider the requirement of off-site compensation "practicable" and therefore simply did not require compensation in cases where on-site compensation was not feasible. The practice of consolidating many compensation sites into a single large "bank" site—often constructed in advance of impact—had been used since the U.S. Fish and Wildlife Service issued guidance on the subject in 1981. However, the effort to streamline environmental regulations, led by a report from Vice President Quayle's Council on Competitiveness in 1991, resulted in the turn to market-led approaches to wetland compensation.

The first entrepreneurial wetland bank, selling wetland "credits" that permittees can purchase to satisfy their compensation obligations, was approved in 1992, and commercial mitigation banks quickly came to far outnumber public or single-client banks. As of 2006 permittees could purchase compensation credits in 32 of the 38 Corps districts, rather than construct their own compensation site. In-lieu fee compensation also became a relatively common form of mitigation, in which a permittee pays a set fee per acre of impact into an aggregate account (often controlled by a state agency or a non-profit organization). The fund is then used to fund assorted wetlands-related projects. By 2003, 60 percent of wetland compensation was performed by the permittee, 33 percent was performed at banks, and seven percent was performed through in-lieu fee programs. Furthermore, 67 percent of all wetland compensation was entirely off-site, or had an off-site component (16 percent). The effects of this "mitigation migration" on the hydrology and landscape ecology of wetlands are poorly understood. Recent U.S. Supreme Court cases have restricted the jurisdiction of the CWA, reducing the types of wetland impacts for which the Corps can require mitigation.

SEE ALSO: Army Corps of Engineers (U.S.); Clean Water Act (U.S. 1972); Environmental Protection Agency; Pollution, Water; Restoration Ecology; Water; Water Law; Wetlands.

BIBLIOGRAPHY. William Kruczynski, "Mitigation and the Section 404 Program: A Perspective," in Jon Kusler and Mary Kentula, eds., *Wetland Creation and Restoration: The Status of the Science* (Island Press, 1990); National Research Council, *Compensating for Wetland Losses under the Clean Water Act* (National Academy Press, 2001); Tom Yocom, Robert Leidy, and Clyde Morris, "Wetlands Protection Through Impact Avoidance: A Discussion of the 404(b)(1) Alternatives Analysis," *Wetlands* (v.9/2, 1989).

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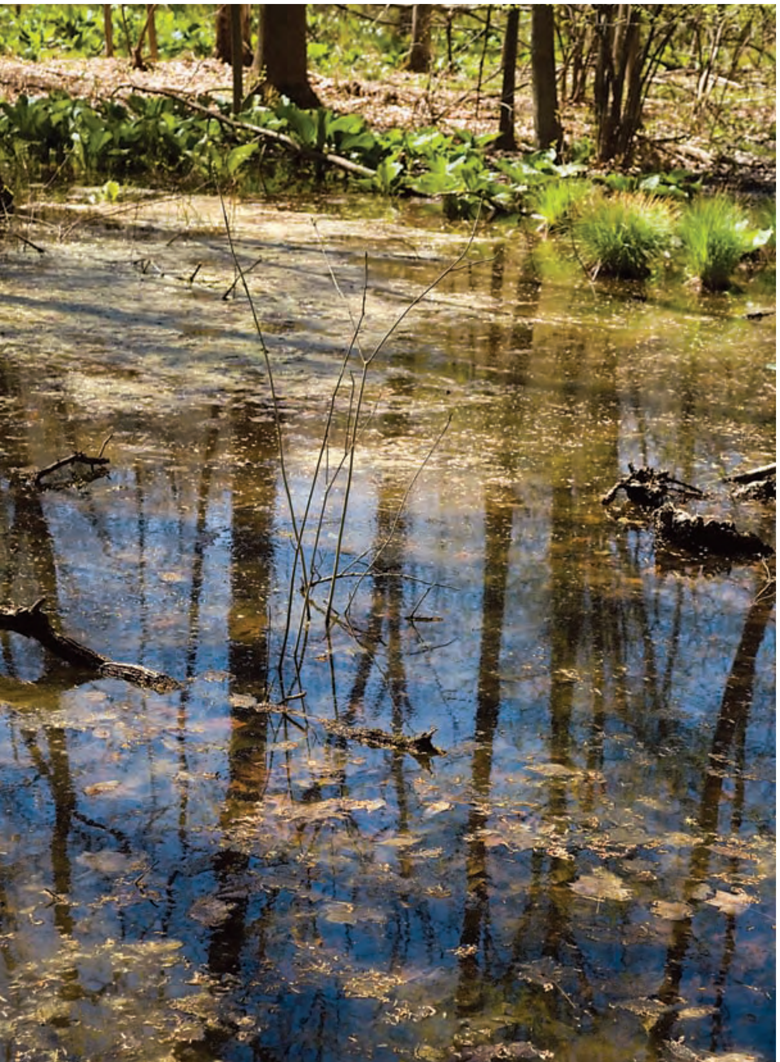
Wetlands

WETLANDS ARE AREAS in which shallow standing water or saturated soil occurs for a period long enough or with enough regularity to influence the development of biotic assemblages and/or soil characteristics. Wetlands can be fresh, brackish or saline, can be inland or coastal, can be connected to or isolated from other aquatic systems, and are generally shallow enough to support rooted vegetation that emerges from the water surface, even if that vegetation is not present at all times. Wetlands are locations of focused ecological flows and changes of state. Many inland wetlands, for example, are areas of groundwater discharge or recharge. In recharge wetlands, nearby contaminants may easily enter the groundwater profile; conversely, in discharge wetlands, rare biotic communities may be supported by the outflow of nutrient-rich groundwater. Coastal wetlands are the site of important ecological interactions between marine and terrestrial environments, where the larval and juvenile stages of many marine animals are supported by nutrient fluxes from the nearby landmass.

Wetlands can be classified by hydrology, which is a function of climate and the wetland's position in a landscape. Wetlands perched high in a watershed will tend to be recharge wetlands, where precipitation and surface water become groundwater. They may be ephemeral, rather than permanent. Because precipitation is nutrient-poor, they may be oligotrophic or have low species diversity. Wetlands in the middle of a watershed will tend to be flow-through systems, experiencing groundwater discharge and recharge, and are more likely to be biotically diverse and permanent. Wetlands low in a watershed are likely to be permanent, experiencing groundwater discharge and/or fringing larger water bodies such as lakes, rivers, and oceans. Fens are wetlands that are largely dependent on groundwater for their hydrology; their ecology is highly dependent on the chemistry of the groundwater, and very sensitive to groundwater fluctuations. Fens in areas of limestone bedrock often receive very calcium-rich water, and are known as calcareous fens or marl flats, hosting a highly specialized flora. Bogs are wetlands that are largely dependent on rainwater for nutrients and hydrology (ombrotrophic), and tend to be low-diversity and nutrient-poor.

Biotic community and habitat can also classify wetlands. The Western folk taxonomy of wetlands relies primarily on vegetative structure, distinguishing "swamps" (forested wetlands) from "marshes" (grassy wetlands). Community composition is often effective shorthand for classifying certain wetland types dominated by characteristic vegetation, as with the cordgrass marshes of the American East Coast, or the mangrove swamps of tropical coasts worldwide. Wetlands serve to store surface water in a landscape, often reducing, delaying, and desynchronizing flood peaks. Coastal wetlands often act to reduce storm surges and coastal erosion; the loss of wetlands in coastal Louisiana was widely cited in 2005 as a culprit in the devastation caused by Hurricane Katrina. Wetlands provide essential habitat for many species, including most game birds and a large number of endangered species. Wetland soils, rich in organic matter, have proven extremely productive under agriculture once the technical challenges to draining were overcome in the early 1900s.

Control over wetlands is often linked to state expansion and the assertion of control over territory.



Wetlands have long been seen as waste areas to be reclaimed or ignored, and the many synonyms have also served as metaphors for undesirability or difficulty, such as: Swamped, quagmire, spewy, or bogged down. Few, even among the European and American Romantic tradition in the 1800s, saw transcendent beauty in wetland areas. They have been associated in many cultures with wilderness or the supernatural and nonhuman, and used as burial places or as refuges from colonial incursion and control. Control over wetlands, using large-scale technologies of drainage, is often linked to state expansion and the assertion of control over state territory (for example, in the Florida Everglades, Italy's Pontine Marshes, and the Tigris/Euphrates marshes in Iraq). Only with the 20th-century environmental movement, and the publication of such popular-science books as Bill Niering's *Life of the Marsh*, have wetlands become the object of societal concern, aesthetic appreciation, and legal protection at the local, national, and international level. They are one of the few ecosystems defined by statute: The U.S. federal government defines them as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation adapted for life in saturated soil conditions" (40 CFR 232.2).

The U.S. Federal Water Pollution Control Act (Clean Water Act) of 1972 established a permit system by which anyone wishing to dredge or fill a wetland must apply for permission to the U.S Army Corps of Engineers. The act also required an accounting of wetland loss in five-year reports, the first of which appeared in 1984 and reported that the continental United States had lost over half of the wetlands present at American independence, a loss rate of 60 acres per hour. Following these reports, wetland protection became a major electoral issue in the 1988 U.S. presidential election, which was marked by George H.W. Bush's extensive use of the campaign slogan "no net loss of wetlands." The U.S. government has assessed the status of wetlands since 1956, and claims that in 2004 there were 107.7 million acres (43.6 million hectares) of wetlands in the conterminous United States, 95 percent of which are freshwater and five percent of which are estuarine or saline.

International wetland conservation efforts are structured around the Ramsar Convention on Wetlands, signed February 2, 1971, in Ramsar, Iran. Signatory countries pledge to designate at least one Wetland of International Importance and to adopt policies and programs that promote wetland ecosystem health and awareness. In late 2006, there were 153 signatory nations and 1,629 wetland sites totaling 145.6 million acres (58.9 million hectares). The North American Waterfowl Management Plan (NAWCA) implements the Tripartite Agreement on wetlands between the United States, Canada, and Mexico, which directs funding and research on wetlands throughout the continent. Both the Ramsar Convention and the NAWCA focused originally on wetlands as bird habitat, but have expanded their scope considerably.

SEE ALSO: Clean Water Act (U.S. 1972); Swamp Land Acts; Water; Watershed Management; Wetland Mitigation.

BIBLIOGRAPHY. William Mitch and James Gosselink, *Wetlands* (Van Nostrand Reinhold, 1993); National Research Council, *Wetlands: Characteristics and Boundaries* (National Academy Press, 1995).

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Whales and Whaling

WHALES BELONG TO the mammalian order Cetacea (whales, dolphins, and porpoises), which in turn is divided into two extant groups, Mysticeti (baleen whales) and Odontoceti (toothed whales). The former group includes most of the large or "great whale" species, such as the blue whale and humpback whale, all of which are filter feeders. These latter whales use baleen plates (mostly made of the protein keratin) in place of teeth to sieve prey species out of seawater. The mysticete whales breathe through two closable blowholes, as opposed to one blowhole in the toothed whales. The odontocetes include the other "great whale," the sperm whale, and a variety of other families of cetaceans including beaked whales (family Ziphiidae), dolphins (family Delphinidae), and porpoises (family Phocoenidae). The moniker *whale* historically refers to a large cetacean and is not a biological term. Indeed, several "whales" such as killer whales and pilot whales are, in fact, dolphins.

Humans have utilized cetaceans since prehistory. In Europe, the Anglo-Saxon and Nordic peoples conducted hunts for large baleen whales, primarily coastal species such as the now extinct Atlantic gray whale, from at least the 9th century. Indeed, whales were so much a part of Nordic life that several laws were drawn up in the middle ages as to the ownership and disposition of whale carcasses. Whaling also took place in Japanese waters since at least the 3rd century C.E. by "driving"—that is, trapping whales and dolphins in small bays where they were then killed.

Whaling as a commercial activity began with the French and Spanish Basques in the middle of the 11th century, who hunted North Atlantic right whales, bowhead whales, and Atlantic gray whales. Much of the Basque whaling was originally concentrated around the Atlantic coasts of Spain and France; however, as whales became scarce in the Bay of Biscay, whalers expanded their area of activity and were hunting in Canadian waters as early as 1526. Commercial whaling operations by the Dutch and English began in 1610, often using experienced Basque whaling men on their crews. The Danes followed suit shortly after. Colonists of New England began whaling in the early 17th century, although Native Americans had been practicing whaling since before the arrival of Europeans. Germans began whaling in 1694, but Dutch and British fleets dominated the industry in the 17th century, with the British taking the lion's share in the 18th century.

These whaling activities again focussed on North Atlantic right whales and bowhead whales in arctic and subarctic Atlantic waters. Indeed, the right whale gains its name because it was considered to be the "right" whale to hunt—it was slow, primarily found in coastal waters, it had a thick blubber layer that yielded much oil, and when the animal died it did not sink. Although records and archaeological evidence are scarce, the Atlantic gray whale is believed to have been rendered extinct during this period, with whaling possibly being the final straw for a perhaps already vulnerable species.

Early Basque whalers used every part of the whale, from the consumption of the meat, to the use of the feces as an orange-colored dye for clothing. However, the main product of commercial whaling was whale oil, which was used not only for lighting but also in industrial processes such as soap making. Baleen was also utilized, and in many respects this "whalebone" was the plastic of its time, being strong yet flexible. Many European whalers indeed concentrated on whalebone as a resource, particularly when the ladies' fashions of the day enlarged the market for whalebone-reinforced garments. In other nations, whalebone was used to make household tools, such as brooms in Barbados.

EXPANSION OF COMMERCIAL WHALING

As commercial whaling progressed, the focus shifted to collecting only the most profitable oil and whalebone. The most famous description of commercial whaling is Herman Melville's 1851 novel *Moby-Dick*. The book describes sperm whale hunting, which began in 1712 and had its heyday between 1740 and 1880. The head of the sperm whale contains a fine oil known as spermaceti, which was used to lubricate clockwork and delicate machinery in particular. The stomachs of sperm whales also occasionally contained lumps of a waxy substance called ambergris, also a valuable commodity. It was used as a fixative in the production of perfumes and was literally worth more than its weight in gold. Sperm whale meat was considered inedible and was rarely consumed by whaling crews.

The method used to catch whales in this era involved setting down a number of rowed catching vessels. When close enough to the whale, the harpooner—a practitioner of an extremely skilled, valued, but dangerous profession—would hurl his harpoon into the side of the whale, where its swiveling head would lodge firmly. The wounded whale would then try to escape or dive. However, the harpoon would be attached by rope to the catching boat, which would then act as a buoy, and be dragged along by the fleeing whale in what became known as a "Nantucket sleigh ride."

Eventually the whale would become exhausted or fatigued due to blood loss, and the catcher boat could approach more closely, when it would finish off the whale with a number of strikes from a long, thin whaling lance. This type of catching technology limited the size, species, and locations of whales that could be caught. However, in the mid-19th century, the development of steam-powered whaling ships and catching boats, grenade-tipped harpoons, and cannons to fire them meant that larger and faster whales could now be caught, including species such as blue, fin and sei whales. The methods used to kill whales have remained largely unchanged for the last 150 years. The age of "modern" industrial whaling was born.

MODERN AGE OF WHALING

Typically, many species of hunted whales were brought back to a shore-based whaling station where they were processed and the blubber was rendered. In 1925, another technological innovation, the invention of large, ocean-going factory ships, meant that whales could be processed at sea, and operations were no longer tied to shore bases. This opened up new regions for intensive exploitation, in particular the waters of the Southern Ocean around Antarctica. Other technological innovations such as larger vessels, spotter planes, and the use of sonar to detect whales and drive them to the surface increased the ability of whalers to catch animals.

By 1931, in recognition of the fact that some whale species were in decline and of the potential impacts that this might have on the whaling industry, the main whaling nations negotiated and signed the Convention for the Regulation of Whaling. Due to depletion of the species, bans on whaling were introduced for bowhead whales (1931), southern and northern right whales (1935), and Pacific gray whales (1937).

This convention eventually led to another agreement, the 1946 International Convention for the Regulation of Whaling, which formed the International Whaling Commission (IWC) in that same year. The IWC is now recognized internationally as the competent authority for the management of whale stocks. Under the IWC, more whaling bans were introduced for humpback and blue whales (1966) and sei whales (1979; except in Iceland). Finally, in 1982 the IWC voted to introduce a temporary moratorium on all commercial whaling, which came into effect in 1986. This moratorium was put in place to allow depleted whale stocks to recover and to allow the development of a better and more effective whaling quota system that would result in a sustainable whale catch. It is important to note that the IWC whaling ban only covers commercial hunting of baleen whales (except the pygmy right whale) and sperm whales. It does not stop scientific or subsistence whaling and hunting, commercial or otherwise, of all other cetaceans not controlled by the IWC.

CURRENT WORLD STATUS

Up until the date of the moratorium, over two million whales had been killed through commercial whaling, with many species such as the blue, fin, humpback, and sei whale becoming endangered. Even since the whaling moratorium came into effect, over 25,000 whales have still been killed. When the moratorium was enacted, Norway took a reservation on (opted out of) the ban and is not bound by the moratorium. It resumed commercial whaling in 1993, and in recent years Norwegian whalers have been taking approximately 550–700

The International Whaling Commission

The International Whaling Commission (IWC) was established on December 2, 1946. Since the 1980s it has been the primary mechanism for the ending of commercial whaling around the world. The IWC is a voluntary agreement with organizational headquarters in Cambridge, England, and has 70 member nations that meet annually to discuss limits on whaling. From the 1960s, it imposed quotas on the number and type of whales that could be caught with the aim of allowing the whale stocks to replenish—at the time some species were being hunted almost to extinction. Some countries, notably the Soviet Union, secretly flouted these quotas by massively under-reporting the number of whales killed. Gradually the main whaling nations of Japan, Norway, and Iceland found themselves outnumbered by the anti-whaling countries.

In the 1980s, the IWC voted to end commercial whaling, allowing it to take place on two grounds: Scientific whaling and whaling by aboriginal peoples. Norway started commercial whaling again in 1994, but at massively reduced levels, and Iceland started again in September 2006. The Japanese have never stopped whaling, claiming scientific research purposes. However, critics have seen the research as merely an excuse to continue operating whaling fleets while the meat goes to restaurants and retailers.

In recent years, the Japanese have been persuading Pacific and Caribbean countries to join the IWC and support their attempts to lift bans on commercial whaling. Conservation groups claim that Japanese overseas aid to poor countries in the Caribbean, the Pacific, and Africa has been directly tied to these countries' support in the IWC. There has also been criticism of the eight landlocked countries that are members of the IWC: Mali and Mongolia supporting the resumption of whaling, with Austria, the Czech Republic, Luxembourg, San Marino, Slovakia, and Switzerland opposing whaling. The IWC continues to maintain a moratorium on all commercial whaling.

northern minke whales a year, although a quota of over 1,000 animals was proposed for 2006.

Japan also hunts whales, even though its government agreed to the whaling moratorium. They do this by using a provision in the convention that allows whales to be killed for scientific research. After samples of blubber and stomach contents are taken from killed whales, meat is processed and sold in Japanese markets for human consumption. Japan currently hunts northern minke, Bryde's, sperm, and sei whales (151, 50, 10, and 50, respectively, in 2003 and 160, 51, three, and 100, respectively, in 2004) in the North Pacific and Antarctic minke whales (443 in 2003, 441 in 2004) in the Southern Ocean for scientific purposes. There are currently proposals to double the take of minke whales in the Southern Ocean and also to add fin whales, and eventually humpback whales, to the list of species being hunted in the Antarctic scientific whaling program. In 2003 Iceland also started a scientific whaling program, catching 37 animals in 2003 and 25 in 2004.

The sale of whale meat in Japan and Korea has some controversy attached; for example, genetic analyses have discovered the meat of endangered blue whale and protected J-stock minke whale being sold illegally. In addition, whale meat sales have provoked some environmental health concerns: Recent research has shown that meat being sold for human consumption in Japan had extremely high levels of mercury. Average contamination levels in meat were 22 and 18 times higher than health regulation limits permitted by the Japanese government, with some samples exceeding these limits by up to 200 times.

Another aspect of whaling is so-called aboriginal whaling. This is a type of hunt that is allowed by the IWC for aboriginal, indigenous, or native peoples that have a nutritional and cultural need for whale meat, with all products of the hunt to be consumed locally. Currently there are subsistence quotas allocated for Bering Sea bowhead whales (used by American and Russian natives), eastern Pacific gray whales (also used by American and Russian natives), Atlantic humpback whales (used in St. Vincent and the Grenadines), and north Atlantic fin and minke whales (used by Greenland natives). A hunt by the Makah Tribe of Washington State has not been conducted in recent years due to domestic legal issues. Although less controversial than commercial and scientific whaling, there are also some problematic issues with respect to aboriginal whaling in some areas; for example, the bowhead hunt by Alaskan natives occurs despite the bowhead whale being considered endangered under the U.S. Endangered Species Act.

Since the 1980s nations with a voting history of pro-conservation or antiwhaling tendencies, such as the United States, most European countries, New Zealand, and Australia, have been in the majority. However, in recent years the number of countries with a pro-commercial whaling stance has increased at the IWC, as have calls to lift the commercial whaling moratorium on populations that are considered to be showing signs of recovery. In the meantime, in Western countries there is strong and increasing societal opposition to a resumption of commercial whaling; in 1999, a survey found that less than one-fifth of Americans supported whaling of even abundant whale species, with 70 percent stating that they were opposed to the killing of whales on moral grounds. A similar survey in Scotland reported that 96 percent of the members of the public interviewed were opposed to whaling.

SEE ALSO: Endangered Species; Endangered Species Act (ESA); Indigenous Peoples; Mercury; Overfishing.

BIBLIOGRAPHY. T. Endo et al., "Mercury Contamination in the Red Meat of Whales and Dolphins Marketed for Human Consumption in Japan," *Environmental Science and Technology* (v.37, 2003); S.R. Kellert, *American Perceptions of Marine Mammals and Their Management* (School of Forestry and Environmental Studies, Yale University, 1999); William S. Perrin, Bernd Wursig, and J.G.M. Thewissen, eds., *Encyclopedia of Marine Mammals* (Academic Press, 2002); N. Scott and E.C.M. Parsons, "A Survey of Public Opinion in Southwest Scotland on Cetacean Conservation Issues," *Aquatic Conservation* (v.15, 2005); J.R. Twiss, Jr., and R.R. Reeves, eds., *Conservation and Management of Marine Mammals* (Smithsonian Institution Press, 1999).

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Wheat

WHEAT IS A cereal grass that is one of the most important sources of food in the world. Wheat belongs to the Poaceae family of the genus *Triticum*. Although wheat exists in numerous different species, it characteristically appears with long slender leaves, heads with a large number of small flowers that yield the seeds, and hollow stems. The most important varieties include *Triticum durum*, which is used to make various types of pasta, *Triticum aestivum*, which is used for bread, and *Triticum compactum*, which is used for baking cakes and biscuits.

Archaeological excavation reveals that wheat was first used in agriculture some 10,000 years ago. The first large-scale wheat farming took place in the Middle East and spread from there to Europe, northern Africa, and across Asia to China. It is not entirely clear whether migrants took the concept of farming wheat with them as they moved, or if the idea and necessary technology arose independently. Farmers developed new strains of wheat better adapted to local environmental conditions and tastes. In addition to crossbreeding, technological improvements included the seed drill, the animal-powered plough, and the use of fertilizers. However, it was not until the 20th century that large-scale, systematic attempts to improve wheat agriculture were made, specifically crossbreeding and the testing of environmental variables. The introduction of Japanese strains of wheat into the Americas is of particular significance, since these varieties helped to improve overall yield by a large amount. Also, attempts to reduce the effects of pests such as locusts, aphids, sawfly, and the wheat bug have improved wheat yields.

Moving into the 21st century, this type of research led to the creation of genetically modified (GM) wheat strains, notably by the American corporation Monsanto. The GM wheat products met with strong consumer resistance in Europe and Canada, although few regulations controlled their use in the United States. According to the Food and Agricultural Organization (FAO) of the United Nations, global wheat production in 2006 will reach 617 million tons, which is slightly below the record output of almost 632 million tons reached in 2004.

The introduction of Japanese strains of wheat into the Americas increased overall yield by a large amount.

The variation is attributed to the effect of weather, especially in important grain growing regions in Ukraine, Russia, and the United States. As climate change affects growing conditions and the increasing scarcity of water makes agriculture more difficult, it is expected that the variability in global yields will increase and the cost of crops will also increase. Approximately 70 percent of wheat supply is used for food, and another 18 percent for animal feed. Nearly every country in the world is involved in trading wheat, either by importing or exporting.

The wheat crop is harvested annually and the grains must be kept in suitable conditions to avoid excessive predation. The quality of the crop depends upon variables including the nature and purity of the soil and of the seeds used for sowing. The husks of the grains are threshed and used for different purposes. Many countries maintain specific guidelines with respect to the quality of different grades of wheat. Higher qualities of wheat are valued for nutritional and culinary purposes.

The inherited celiac disease, or gluten intolerance, can cause difficulty in digesting wheat. Gluten is a protein substance that is present in wheat and other cereal grains. People suffering from this disease are required to follow a particular diet to maintain good health. Such problems may increase in the future as the chemical composition of traditional foods is changed and as pollution increases.

SEE ALSO: Crops; Crossbreeding; Fertilizers; Food; Genetically Modified Organisms (GMOs).

BIBLIOGRAPHY. Derek Berwald, Colin A. Carter, and Guillaume P. Gruere, "Rejecting New Technology: The Case of Genetically Modified Wheat," *American Journal of Agricultural Economics* (v.88/2, 2006); Alain P. Bonjean and William J. Angus, eds., *The World Wheat Book: A History of Wheat Breeding* (Laviosier, 2001); Food and Agriculture Organization, "Global Market Analysis: Wheat," *Food Outlook* (v.1, 2006); Anne Underwood, "The Perils of Pasta," *Newsweek* (v.134/15, 1999).

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White, Gilbert (1720–93)

NATURALIST GILBERT WHITE was born on July 18, 1720, at a vicarage in Selborne, Hampshire, England, which his family lived in from 1728. Gilbert owned the house from 1763 and lived in it until his death. White graduated with a bachelor of arts from Oriel College, Oxford, in 1743. In 1744 he was elected fellow of Oriel, retaining his fellowship until his death; in the 1750s, he served as junior proctor of the University of Oxford and dean of his college. He was ordained successively deacon and priest in the Church of England and served as curate and vicar of various rural parishes in which his family or college had an interest, but did not seek preferments that would have prevented his living at Selborne.

On January 7, 1751, White began the record of the natural world on which his fame rests. His "Garden kalendar" records the cycle of growth and decay in his garden, with some wider references to natural history such as the migration of birds. From Benjamin Stillingfleet's *Miscellaneous Tracts* (1759) and especially from the "Calendar of flora" in the second edition (1762), White learned about the natural calendar, from which naturalists hoped that the observation of natural phenomena could guide the timing of sowing and reaping, ensuring reliable harvests for the benefit of all. Such a project required accurate identification of natural forms, and White's reading of William Hudson's *Flora Anglica* (1762) persuaded him to adopt Linnaean classification and nomenclature to aid rigorous and easily communicable identification of forms.

Through his brothers Thomas and Benjamin, White made important London scientific acquaintances, including Thomas Pennant. Pennant encouraged Daines Barrington to send White his *Naturalist's Journal* (1767), which was designed for the recording of meteorological phenomena and the behavior of flora and fauna: The correlation of these observations would lead to the discovery of the natural calendar. The idea of using his local knowledge for a general, disinterested purpose appealed to White, who in 1768 put aside the "Kalendar" in favor of the "Naturalist's Journal" of Barrington's design, which he kept until shortly before his death some 25 years later. Barrington's design required comprehensive, systematic, and precise observation and measurement. Barrington invited White to prepare for the Royal Society monographs on the house martin (*Delichon urbica*), swallow (*Hirundo rustica*), swift (*Apus apus*), and bank martin (*Hirundo riparia*); these were published in the *Philosophical Transactions of the Royal Society,* volumes 64 and 65. Barrington further encouraged White to prepare a work based on his journal for publication and suggested Samuel Hieronymus Grimm as illustrator. *The Natural History and Antiquities of Selborne* was published in 1789. White made his last journal entry on June 15, 1793, and died on June 26, 1793.

The Natural History of Selborne consists of three sequences of letters: The two to Pennant and Barrington concern natural history and the rest (unaddressed) concern parish antiquities. While his journals, published posthumously, offer a documentary record, *Selborne* is a literary work whose letters were considerably modified and extended for the press. Initially *Selborne* was valued as a new contribution to natural history, but, as its insights became part of general scientific knowledge, it was read more for the inspiration it gave to aspiring amateur naturalists. With numerous 19th- and 20th-century revised editions, *Selborne* entered the literary canon, a reassuring refuge for those troubled by Darwinism. White's exclusive focus on the local meant that his general discoveries and insights are few, but it enabled him to fulfill his main aim of encouraging readers to give "a more ready attention to wonders of the Creation." White's emphasis on what is accessible to the enquiring observer in any place or time, combined with his gracious style, give *Selborne* its continuing appeal.

SEE ALSO: Darwin, Charles; Linnaeus, Carl; Nature Writing.

BIBLIOGRAPHY. Paul G.M. Foster, *Gilbert White and His Records: A Scientific Biography* (Christopher Helm, 1988); Paul G.M. Foster, "Gilbert White," in H.C.G. Matthew and Brian Harrison, eds., *Oxford Dictionary of National Biography* (Oxford University Press, 2004); Gilbert White, *The Natural History and Antiquities of Selborne,* Paul G.M. Foster, ed. (Ray Society, 1993).

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White, Gilbert F. (1911–2006)

GILBERT FOWLER WHITE was born on November 26, 1911, in Chicago and died on October 5, 2006, in Boulder, Colorado. White earned his bachelor's degree in 1932 and his doctorate in 1942 at the University of Chicago. He served in the New Deal administration of Franklin D. Roosevelt as secretary to the Mississippi Valley Committee, National Resources Committee, and the National Resources Planning Board. From 1940–42, he worked in the Bureau of the Budget in the Executive Office of the President. White was a Quaker and a conscientious objector to military service who in 1942 joined the American Friends Service Committee (AFSC), which aided refugees in France. He was interned in Baden-Baden, Germany until 1944 when he was allowed to return to the United States; he continued working with the AFSC until 1946. White married Anne Underwood in 1944, with whom he frequently collaborated on problems of domestic water use in Africa, and they had three children. Underwood died in 1989 and White married Claire Sheridan in 2003.

From 1946–55, White served as president of Haverford College and then returned to the University of Chicago as a professor of geography until 1970 when he left in protest over the university's expulsion of students during anti–Vietnam War protests. White moved to the University of Colorado and from 1970 to 1978 he was a professor of geography, director of the Institute of Behavioral Science, founder and director of the university's Natural Hazards Research and Applications Information Center (from 1976 to 1984 and again from 1992 to 1994), and the Gustavson Distinguished Professor Emeritus of Geography from 1980 until his death in 2006.

Considered the "father of floodplain management," White emerged as a central figure in the field of natural hazards research. He was an established scholar recognized for his contribution to the study of flooding and general advocacy of sound water management; he pioneered the United States's system of identification and classification of adjustment mechanisms for flooding. These adjustments he termed *structural* or *nonstructural*. Structural adjustments were those mechanisms constructed by engineers designed to modify flooding hazards so that people could live comfortably in areas that were subject to periodic flooding. Nonstructural adjustments were those changes made by governments to restrict the use of areas susceptible to floods. White advocated whenever possible the accommodation of, or adaptation to, flood hazards rather than structural solutions, such as dams and levees, that had dominated thinking in the first half of the 20th century.

White promoted an integrated system of floodplain management that had at least seven constituent elements:

> (1) mapping the estimated frequency and magnitude of flooding, (2) planning and regulation of use of vulnerable areas and of areas contributing to flood flows, (3) government support of insurance against flood losses, (4) improvement of flood warning systems and advice and training as to how to respond effectively to warning, (5) research and education as to how to flood proof property against damage, (6) extending the federal program of financial assistance to victims of flood damage to include support for buying out damaged property to support abandonment of severely affected property and movement to

lands beyond the reach of floods, and (7) taking explicit account of the costs and benefits to ecosystems and human recreation of leaving a floodplain completely open to water and silt from natural overflow.

Throughout his career as a citizen-scientist, White's ideas had a tremendous impact on government policy at all levels. He used his mediation skills and position as chair of the University of Chicago's Department of Geography to bring members of the Army Corps of Engineers and the Tennessee Valley Authority together. He assisted the Lyndon B. Johnson administration's 1959 Senate Select Committee on National Water Resources, which led to the creation of the Flood Control Act of 1960 and eventually a Water Resources Council in 1965. In these years he chaired a Ford Foundation mission to advise the United Nations (UN) Mekong River Committee concerned with flood control in that region and later headed a UN task force that studied several major water storage projects in the Zambezi, Senegal, Volta, and Nile River drainages.

White's crowning achievement in these years came from his 1966 appointment as chair of the Task Force on Federal Flood Control Policy. His work resulted in the creation of Congressional House Document 465 and Executive Order 11296 that for the first time mandated that all federal agencies incorporate flood planning into their programs. The task force's broader aim was to create a unified national program for managing not only flood losses and flood control, but also floodplains as ecosystems, and it was slowly being achieved. When Congress established the National Flood Insurance Program (NFIP) in 1968 that created the Federal Insurance Administration—something White's 1966 task force and a parallel task force were largely responsible for—White emerged as both its champion and critic. In the late 1970s, White pushed for the transfer of the NFIP out of the Department of Housing and Urban Development to the new Federal Emergency Management Agency, which was established in 1978 by Congress during the James Carter administration.

Throughout his life, White worked to build communication bridges between various constituencies and served on numerous committees. A past president of the Association of American Geographers, he became involved with the International Geographical Union and Commission on Man and Environment (which he chaired from 1969–76) and the International Council of Scientific Unions's (for which he served as president from 1976–82) Scientific Committee on Problems of the Environment.

White also built institutions that survived. For example, as the chair of a Ford Foundation Resources for the Future institute in the 1970s, he spearheaded a successful multimillion dollar fundraising campaign to help ensure the institute's future in the 21st century. In 1974 he founded the Natural Hazards Research and Application Information Center and for decades worked there with students and colleagues producing a host of socially relevant master's theses and doctoral dissertations in a wide range of natural hazards research. Many of his students have gone on to become leading practitioners in the field. In a career that spanned seven decades, White produced over 400 scholarly papers and earned 50 degrees and honorary awards.

SEE ALSO: Dams; Floods and Flood Control; Hazards; Levees; Locks and Dams; Mekong River.

BIBLIOGRAPHY. Robert. E. Hinshaw, *Living with Nature's Extremes: The Life of Gilbert Fowler White* (Johnson Books, 2006); Robert W. Kates and Ian Burton, eds., *Geography, Resources, and Environment, Volume 1: Selected Writings of Gilbert F. White* and *Volume II: Themes from the Work of Gilbert F. White* (University of Chicago Press, 1986); Task Force on Federal Flood Control Policy, *A Unified National Program for Managing Flood Losses: Report by the Task Force on Federal Flood Control Policy* (House Doc. 465, U.S. Government Printing Office, 1966); Gilbert F. White, *Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States*, Ph.D. diss., (University of Chicago, 1942).

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Wilderness

WILDERNESS IS ONE of the most potent and contentious concepts in Western, particularly North

American, framings of society-nature relations. As a symbol of humankind's moral and spiritual condition, it is deeply imbedded in Western philosophy and religion. As an actual place, it lies at the heart of political-economic struggles over the future courses of development and biodiversity protection around the world. When wilderness is debated among scholars and scientists, it is more often about the idea of wilderness than actual wild places.

THE IDEA OF WILDERNESS

The idea of wilderness can be categorized into one of three roughly historical trends: Ancient, classical, and romantic. The origins of the ancient view are traceable to the Neolithic revolution in the Fertile Crescent of the ancient Mediterranean, according to Oelshlaeger. This region experienced the earliest transition of human culture from a reliance on hunting and gathering to the domestication of animals and permanent cultivation. This shift in material existence was accompanied by a shift in the cultural meanings of nature, including a move away from totemic rituals and myth, to animal idolatry and fertility cults, a greater sense of separation of humanity from the natural world, and the rise of the belief that nature could be manipulated to fit the designs and desires of humankind, according to Glacken and Oelshlaeger. The later emergence of monotheism, specifically Judaism, in this region marks a major shift in ancient ideas of nature, with the Hebrew's supreme being, Yahweh, believed to be not of nature, but above nature as its creator.

It is from the Hebrews' Old Testament, particularly as translated into English in the King James Version of the Bible, that some of the most influential and persistent ideas of wilderness are introduced into Western thought. Some historians have argued that the roots of modern environmental problems can be traced to the Old Testament and its negative portrayal of wilderness, as claimed by Nash and White. In particular, the metaphor of the garden as the site of God's grace and the wilderness, into which Adam and Eve are cast, as a spiritual wasteland is seen to have tainted Western attitudes toward nature for centuries. In addition, the Book of Genesis, which portrays people as having been created separate from and having dominion over the rest of God's creation, promotes a sense of nature as having no value or purpose beyond service to humankind. Some would argue, however, that the Hebrew Bible's portrayal of the wilderness is inconsistent and ambiguous and not reducible to either a positive or negative generalization, as claimed by Oelschlaeger. For example, the Old Testament also portrayed wilderness as a spiritual refuge, a place where the Hebrew prophets and their followers could come in more direct contact with their God, Yahweh.

The classical view of wilderness is rooted in the Greco-Roman civilizations, specifically in a blend of Greek rationalism, Roman pastoral aesthetic, and Christianity. Greek philosophers developed several key trends that continue today to influence Western conceptualizations of wilderness, particularly the idea of order, unity, and harmony in nature, a rational approach to observing and categorizing phenomena in nature, a homocentric understanding of the universe, and a strong distinction between the city and the county. According to Glacken, no earlier period in Western thought "revealed such strong, self-consciously expressed contrasts between the urban and the rural as did the Hellenistic." These trends were not formed in isolation, but were combined with elements of Hebrew and early Christian thought to create the "genesis of the idea of wilderness that has ruled Western civilization for these past two millennia," according to Oelschlaeger.

The classical view portrays wilderness as a condition of nature that awaits the transforming hand of civilization to make it productive and useful. This perspective is clear in the pastoral poetry of the 1st century B.C.E. poet Virgil, urging farmers to "mellow your harsh fruits by culture, nor suffer fields to lie idle," as quoted by Glacken. This drive to civilize wilderness takes on overt spiritual dimensions in early Christianity, when proselytizing monks set about converting pagan Europe. Paganism, built upon a reverence of nature and wild places, presented a challenge to early Christian missionaries who viewed pagans' sacred groves as the dwelling places of witches and other agents of the devil. Doing God's work meant simultaneously exercising dominion over nature and converting pagans to Christianity, both of which entailed cutting down the sacred groves and other places of nature worship and turning them into pasture and field, according to Nash and Oelschlaeger. There remained within Christian thought, however, the ideas of wilderness as a refuge from corrupt civilization, and of exposure to wild nature as a means to come into closer contact with God's creation, perspectives more commonly associated with the romantic view.

The romantic view of wilderness is best characterized as a reaction against modernity among Western artists, poets, writers, and philosophers. These cultural elites were generally situated far from the physical reality of wild nature. They lived in civilized Europe or the coastal cities of the Americas and admired wilderness from a comfortable distance, as noted by Nash.

The philosophical roots of the romantic view are found in the concept of the sublime, a term that until the 18th century was associated with the awesome, fearful, and majestic grandeur of God, explain Cronon and Cosgrove. As the industrial revolution transformed Europe, the sublime gradually came to be associated with remote mountain and rugged coastal landscapes, where the awesome display of wild nature's power could be experienced and contemplated. By the turn of the 19th century, genres of romantic poetry and landscape painting had emerged in which raw, untamed nature was celebrated for its very wildness. Wilderness, rather than being morally degenerate and economically unproductive, as in the classical view, became inspirational, even sacred, and deserving of protection and preservation. This romantic vision of wilderness experiences its fullest expression in the North American conservation movement of the 19th and 20th centuries.

AMERICAN WILDERNESS

The dominant conceptualization of wilderness today is most commonly associated with ideas that developed among North American conservationists. So pervasive is the wilderness idea in North American conservation thought that some have characterized it as an obsession that provides "the dominant ideological underpinning" for a wide range of environmental concerns, as stated by Cronon. To understand how the wilderness became so dominant in U.S. environmental thought, the idea has to be situated within the broader history of European conquest of North America, the role of the frontier in political culture and national identity, the encounter between Native Americans and Europeans, and the development of capitalist social relations in the United States, as pointed out by Cronon, Nash, and Cosgrove.

The Pilgrims and Puritans who spearheaded the European colonization of North America carried with them from Europe a classical perspective on wilderness. For the Puritans and the colonizers that followed in the 17th and 18th centuries, the continent's forests were obstacles to overcome, lands to be tamed, made productive, and civilized. Colonists described the lands beyond the meager coast-bound settlements as a "howling wilderness" that was dark, savage, and filled with dangers to both the physical and spiritual health of the colonizers. In various secular and sacred forms, this perspective remained dominant until the end of the 18th century.

By the latter half of the 19th century, there was a reversal in wilderness thought among cultural and political elites in the United States. Western North America, with its rugged and monumental mountain ranges and expansive deserts and forests, came to be viewed as a landscape of virtue and natural purity as opposed to the decadent and desecrated lands of Europe and North America's eastern seaboard. The writings of Henry David Thoreau, Walt

The history of wilderness is also a human history of conquest, colonization, and forced relocation.

Whitman, and John Muir gave shape to a new romantic vision of American wilderness.

A myth of national identity emerged that positioned Americans as different from European nationalities by virtue of their historical encounter with wilderness. Artists, writers, historians, and politicians began to celebrate North American wilderness as the source of personal characteristics of rugged individualism, self-reliance, and moral virtue, which were said to provide the core of American national identity. Something of a "wilderness cult," according to Nash, emerged that celebrated primitivism and noble savagery, suggesting that periodic wilderness encounters kept America vigorous by cultivating manliness and virility among its citizens. Among American political figures, Theodore Roosevelt is most closely identified with this perspective on wilderness through his many writings and his initiatives as president to establish national parks in the wildest areas of the U.S. West.

Among other historical developments, particularly the closing of the American frontier, the 19th-century cultural shift in the wilderness idea has been linked to new waves of immigrants coming to the United States. A nativist movement arose based on the belief that "since 1880 a new type of person had come to dominate movement into the United States … unskilled, transient young men, largely from southern and eastern Europe, entering urban industrial employment and keeping a distance from earlier settled Americans," as stated by Cosgrove. According to nativist logic, the new immigrants, having come from a different "racial stock" and never having experienced the transforming influences of the great American wilderness, could not be true Americans.

In combination, the wilderness cult and nativism gave the early conservation movement in the United States pervasive racist and masculine underpinnings. Early 20th-century conservationists were almost universally well-to-do, eastern-based, white males whose concerns about wilderness preservation, masculinity, racial purity, and immigration tended to bleed one into the other, an idea expounded upon by Haraway, Cosgrove, and Cronon.

A new political movement to protect what were widely viewed as the vestiges of a disappearing North American wilderness accompanied the cultural shift in American wilderness thought from a classical to a romantic perspective. Muir and Roosevelt were the primary catalysts for the movement, with Muir being the chief philosopher and promoter of the wilderness movement through his writings about Yosemite, and Roosevelt being the elected official most closely associated with early federal government initiatives to legally protect natural areas. Muir and Roosevelt, however, were on opposite sides of the plan to dam the Tuolumne River in Yosemite National Park and create the Hetch Hetchy Reservoir, an initiative that ultimately set the American wilderness movement on fire when Roosevelt approved the project in 1908. Hetch Hetchy became a rallying cry for conservationists.

A new generation of wilderness advocates arose, led by Aldo Leopold, a visionary forester with the U.S. Forest Service (USFS), and Robert Marshall, a professional forester from a wealthy New York family who also worked for a time with the USFS. Marshall made his principal mark on the movement when he founded the Wilderness Society in 1935, an organization specifically dedicated to promoting the permanent preservation of wilderness for wilderness' sake. In 1964, the movement achieved its goal of establishing a federally designated system of protected wilderness areas. The arguments for the U.S. Wilderness Act of 1964 reflected the romantic wilderness perspective developed in the writings of Thoreau, Muir, and Leopold. Today, there are over 106 million acres officially designated as wilderness under the act, more than half of which is in the state of Alaska.

THE NEW WILDERNESS DEBATE

Since the passage of the 1964 Wilderness Act, the wilderness idea has become more politically charged than ever, sparking what Calicott and Nelson identify as the "great new wilderness debate." The debate is not so much one between those that argue for and those that argue against wilderness preservation. Indeed, many of the critics of the wilderness idea make an effort to state their endorsement for the protection of wild areas, such as Cronon and Calicott. Rather, it is a debate about the idea of wilderness, as developed in the American and, now, the global conservation movement, the values that it reflects, and what it means for the ability to imagine models of sustainable society-nature relationships. Critics such as Calicott have labeled the writings of Thoreau, Muir, Leopold, Marshall, and the U.S. Congressional act that they inspired as the "received wilderness idea." The argument is that these writings provide the foundation for current Western conceptualizations of wilderness, yet they were shaped by ethnocentric, racist, and sexist ideologies and since-discredited scientific models of ecology.

At the heart of scholarly critiques of the wilderness idea is the proposition that wilderness is a social construction or, more specifically, that according to Calicott "the name wilderness socially constructs, as we now say, the landscape, in a way not shared by all social groups." The new wilderness debate is thus one aspect of a larger debate from the 1980s and 1990s surrounding the critiques of the philosophy and methodology of science by a broad range of social constructivists in the humanities and social sciences, subsequently labeled "science wars" by Ross. Among other claims, constructivists argued that nature, as an object of scientific study, is socially constructed. The social construction of nature is a phrase commonly employed to stress the role of representation, discourse, and imagery in defining and framing our knowledge of nature and the natural. As Bird argued, "scientific knowledge should not be regarded as a representation of nature, but rather a socially constructed interpretation of an already socially constructed natural-technical object of inquiry." Wilderness, it is argued, has become synonymous with a distinctly Western conceptualization of nature and so has been a central concept in scholarly debates over socially constructed nature, according to Proctor.

Perhaps the most notable critique of wilderness in the new debate is William Cronon's widely reprinted essay, "The Trouble with Wilderness." Cronon argues that nature in Western conservation thinking is idealized as an empty wilderness, clearly placing human society and nature in separate spheres and leading inevitably to the conclusion that human presence alone is enough to degrade nature. This dualistic vision of society-nature relations is for Cronon "the trouble with wilderness." His constructionist approach suggests two fundamental empirical and theoretical limitations of the wilderness model of nature. First, acceptance of this model would require ignoring the conclusions from the empirical findings of cultural geographers, environmental historians, and archeologists that people have manipulated and shaped nature "for as long as we have a record of their passing." In short, the physical actuality of nature as a vacant wilderness is not supported by geo-historical research. Second, the wilderness-humanity duality leaves no room for considering other, less environmentally destructive theories of human history and society. As Cronon explains the core paradox of wilderness, "if nature dies because we enter it, then the only way to save nature is to kill ourselves."

On the other side of the debate, Foreman has suggested that critics do not understand the science of biodiversity conservation and the importance of wilderness to the maintenance of global biodiversity. Another objection to social constructionist approaches is political. As Hayles asks, "If nature is only a social and discursive construction why fight hard to preserve it?" Soule argues that wilderness critics play into the hands of antienvironmental political initiatives. More generally, wilderness advocates have rejected the philosophical position of constructivism altogether and tried paint it as an extreme fringe perspective. Constructivist arguments have been characterized by Soule and Lease as "certain radical forms of 'postmodern deconstructivism'" that "asserts that all we ever perceive about the world are shadows" and so denies the external existence of nature. Foreman dismisses Cronon and others as "postmodern deconstructionist scholars" a label that, while inaccurate, effectively marginalizes those who may support wild land and biodiversity protection, but question the idea of wilderness. There is "real wilderness" in the world, so the argument goes, that is disappearing fast and is in desperate need of protection, according to Foreman.

THE POLITICAL ECOLOGY OF WILDERNESS

While the idea of wilderness, particularly in North America, continues to be debated, wilderness has become a dominant component of global biodiversity conservation strategies and the promotion of international ecotourism. The Convention on

Biological Diversity (CBD), which resulted from the 1992 Earth Summit, now provides the framework and rationale for international efforts to stem biodiversity loss, focusing on in situ conservation in the wilderness of national parks and protected areas. The international tourism industry uses the wilderness idea to sell ecotourism packages to third world settings, particularly sub-Saharan Africa. In short, the North American wilderness idea has been globalized as the dominant way of thinking about nature.

The transfer of the wilderness idea around the globe has raised questions about the political ecology of wilderness. These include how the relationship between society and nature is defined and conceptualized, how access to land and resources is controlled, and how environmental costs and benefits are distributed. For instance, many of the areas now designated as wilderness were only recently cleared of people who had occupied and transformed the environment over generations, sometimes millennia. Recent studies in North America report similar process of forced relocation, suggesting, "uninhabited wilderness had to be created before it could be preserved," according to Spence. More often than not, both in North America and around the world, the dislocations of resident populations were conducted as part of larger efforts by the state to control or eliminate some of its subjects. Thus the wilderness idea has been labeled "a tool of genocide," as stated by Calicott. Because the history of wilderness is a human history of conquest and colonization, wilderness areas have become enveloped in larger struggles for social justice, historical land claims, and self-determination among indigenous peoples and peasant communities around the world.

SEE ALSO: Conservation; Critical Environmental Theory (or Ecocriticism); Leopold, Aldo; Muir, John; National Parks; Nature, Social Construction of; Nature Writing; Political Ecology; Preservation; Pristine Myth; Religion; Restoration Ecology; Thoreau, Henry David; Wilderness Act (U.S. 1964); Wilderness Society; Wildlife.

BIBLIOGRAPHY. E. Bird, "The Social Construction of Nature: Theoretical Approaches to the History of Environmental Problems," *Environmental Review* (v.11/4, 1987); J.B. Calicott, "Contemporary Criticisms of the Received Wilderness Idea," *USDA Forest Service Proceedings* (v.15/1, 2000); J.B. Calicott and M. Nelson, eds., *The Great New Wilderness Debate: An Expansive Collection of Writings Defining Wilderness from John Muir to Gary Snyder* (University of Georgia Press, 1998); D. Cosgrove, "Habitable Earth: Wilderness, Empire, and Race in America," in D. Rothenberg, ed., *Wild Ideas* (University of Minnesota Press, 1995); D. Cosgrove, *Social Formation and Symbolic Landscape* (University of Wisconsin Press, 1998); W. Cronon, ed., *Uncommon Ground: Toward Reinventing Nature* (W.W. Norton, 1995); D. Foreman, "All Kinds of Wilderness Foes," *Wild Earth* (v.6, 1996); D. Foreman, "The Real Wilderness Idea," *USDA Forest Service Proceedings* (v.15/1, 2000); C. Glacken, *Traces on the Rhodian Shore* (University of California Press, 1967); R. Grove, "Environmental History," in P. Burke, ed., *New Perspectives on Historical Writing* (Penn State University Press, 2001); D. Haraway, "Teddy Bear Patriarchy: Taxidermy in the Garden of Eden, New York City, 1908–1936," *Social Text* (v.4, 1984); N. Hayles, "Searching for Common Ground," in M. Soulé, and G. Lease, eds., *Reinventing Nature? Responses to Postmodern Deconstruction* (Island Press, 1995); R. Nash, *Wilderness and the American Mind* (Yale University Press, 1982); R. Neumann, *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa* (University of California Press, 1998); R. Neumann, "Africa's 'Last Wilderness': Reordering Space for Political and Economic Control in Colonial Africa," *Africa* (v.71/4, 2001); R. Neumann, "Nature-State-Territory: Toward a Critical Theorization of Conservation Eenclosures," in R. Peet and M. Watts, eds., *Liberation Ecologies* (Routlege, 2004); M. Oelschlaeger, *The Idea of Wilderness: From Prehistory to the Age of Ecology* (Yale University Press, 1991); J. Proctor, "The Social Construction of Nature: Relativist Accusations, Pragmatist and Critical Realist Responses," *Annals of the Association of American Geographers* (v.88/3, 1998); A. Ross, ed., *Science Wars* (Duke University Press, 1996); M. Soule and G. Lease, eds., *Reinventing Nature? Responses to Postmodern Deconstruction* (Island Press, 1995); M. Spence, *Dispossessing the Wilderness: Indian Removal and the Making of the National Parks* (Oxford University Press, 1999); L. White, "The Historical Roots of Our Ecological Crisis," *Science* (March 10, 1967).

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Wilderness Act of 1964

THE WILDERNESS ACT of 1964 established the National Wilderness Preservation System in the United States, now comprising more than 680 units with a total of 106 million acres (42.8 million hectares). Federal lands protected under the Wilderness Act are defined as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Land designated by the U.S. Congress as wilderness areas are subjected to strict management regimes to provide the utmost protection for natural areas and the biological diversity they support. In recognizing the intrinsic value of ecosystems and their many components, Roderick Nash states that "[W]ilderness is not *for* humans at all, and wilderness preservation testifies to the human capacity for restraint."

The Wilderness Act excludes from those public lands designated as wilderness areas, such items as automobiles, motorcycles, bicycles, hang gliders, motorboats, and activities such as road and building construction. The act also excludes certain types of commercial activity such as logging and mining (the latter after 1984) but permits livestock grazing in certain locations. Lands protected under the Wilderness Act are usually at least 5,000 acres (2,023 hectares) and present recreational activities that offer "outstanding opportunities for solitude or a primitive and unconfined type of recreation."

Howard Zahnister, executive director of the Wilderness Society, and David Brower from the Sierra Club were two of the early advocates during the 1950s calling for a wilderness bill that would provide permanent Congressional protection for federal public lands. Zahnister eventually authored the Wilderness Act of 1964 out of concern that the United States lacked a comprehensive, permanent, and legally binding system to protect wilderness areas, thus leaving large tracts of public lands open to degradation: "Let us be done with a wilderness preservation program made up of a sequence of overlapping emergencies, threats, and defense campaigns."

Democratic Senator Hubert Humphrey from Minnesota introduced Zahnister's wilderness bill into Congress in 1956. Due to proposed restrictions on commercial resource extraction in wilderness areas, the original wilderness bill was heavily opposed by loggers, miners, and ranchers, as well as by U.S. federal agencies including the Forest Service and the National Park Service. The act was passed eight years later, though Zahnister died a few months before its signing. President Lyndon B. Johnson signed the Act on September 3, 1964, with 54 wilderness areas named (9.1 million acres [3.6 million hectares]) in 13 states.

The Wilderness Act is unique in that it represented an effort on the part of the conservation community as well as the U.S. Congress to preserve biological diversity, but also embodied, as Nash describes, the notion of wilderness preservation as a radical act: "It is indeed subversive to the forces that have accelerated modern civilization to power but now threaten its continuation: Materialism, utilitarianism, growth, domination, hierarchy, exploitation."

Wilderness Areas are managed by four federal agencies: the Bureau of Land Management, the Fish and Wildlife Service, the U.S. Forest Service, and the National Park Service. The first unofficial wilderness area was the 558,065-acre (225,841-hectare) Gila Wilderness in the Gila National Forest in New Mexico, created in June 1924 at the urging of conservation pioneer Aldo Leopold. The Gila Wilderness later received permanent protection under the Wilderness Act. There are now a total of 680 Wilderness Areas in the United States, the smallest being Pelican Island in Florida (6 acres [2 hectares]) and the largest being Wrangell–Saint Elias, in Alaska (9,078,675 acres [3,674,009 hectares]). The largest wilderness complex in the contiguous United States is the Frank Church–River of No Return and Gospel-Hump Wildernesses, Idaho (2,572,553 acres [1,041,075 hectares]).

States with the most Wilderness Areas include California (130 units), Arizona (90 units), Nevada (56 units), Alaska (48 units), and Colorado (41 units). States lacking lands with wilderness protection are Connecticut, Delaware, Iowa, Kansas, Maryland, and Rhode Island. Of the entire United States, 4.71 percent—about the size of California—is protected as Wilderness Areas; 54 percent of Wilderness Areas are found in Alaska, and only 2.58 percent of the continental United States is protected in this form.

Citizens have the ability to be influential in affecting which lands are designated for protection under the Wilderness Act by creating their own citizen wilderness proposals and submitting these plans to members of Congress. Citizen-supported nonprofit organizations such as the New Mexico Wilderness Alliance, the Sky Island Alliance, Southern Utah Wilderness Alliance, and the Wilderness Society are just a few of many wilderness advocacy groups that work for increased wilderness protection on public lands.

The National Wilderness Preservation System continues to grow. The Southern Utah Wilderness Alliance presented the most recent successful wilderness proposal when in 2006 legislation was granted providing lasting wilderness protection to 100,000 acres (40,469 hectares) in the Cedar Mountains of Utah.

SEE ALSO: Biodiversity; Conservation; Leopold, Aldo; Preservation; Public Land Management; Restoration Ecology; Wilderness; Wilderness Society.

BIBLIOGRAPHY. George Coggins, Charles Wilkinson, and John Leshy, *Federal Public Land and Resources Law* (Foundation Press, 1993); Dave Foreman and Howie Wolke, *The Big Outside* (Harmony 1992); Roderick Nash, *American Environmentalism: Readings in Conservation History* (McGraw-Hill, 1990); William Rodgers, "The Seven Statutory Wonders of U.S. Environmental Law," in Robert Fischman, Maxine Lipeles, and Mark Squillace, eds., *An Environmental Law Anthology* (Anderson Publishing Company, 1996); Southern Utah Wilderness Alliance, www.suwa.org (cited April 2006); Wilderness.net, www.wilderness.net (cited April 2006).

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Wilderness Society

THE WILDERNESS SOCIETY is a nonprofit environmental organization based in Washington, D.C., with 10 U.S. regional offices. Through science, economic analysis, advocacy, and education, it works to achieve wilderness designation on federal lands. Since its founding in 1935, it has helped add 105 million acres (42.4 million hectares) to the National Wilderness Preservation System.

The Wilderness Act of 1964 was written by former society president Howard Zahniser and signed into law by President Lyndon B. Johnson. The act defined wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." The act enables Congress to set aside select units in national forests, parks, wildlife refuges, and other federal lands as areas to be kept permanently unchanged by humans, meaning no roads, mechanized vehicles, resource extraction, or other significant impacts. To date, 106,619,208 acres (43,147,262 hectares) of land have been added to the National Wilderness Preservation System and the Wilderness Society is striving to protect an additional 100 million acres (40.4 million hectares).

The story of the society's founding is that foresters and friends Bob Marshall, Benton Mackaye, Bernard Frank, and Harvey Broome were in a heated debate over how to best save America's wilderness as they drove across the rolling hills of Tennessee. The men got out of the car, scrambled up an embankment, and argued over the philosophy and definition of the new organization that they eventually called the Wilderness Society.

The Wilderness Society's work is guided by a "land ethic," a philosophy of the relationship between people and the land based on the work of Aldo Leopold, one of the society's founding members. Leopold, who believed in preserving the integrity, stability, and beauty of ecosystems, envisioned that the society would help form the cornerstone for the movement needed to save America's vanishing wilderness.

Public support for wilderness has fluctuated over the past century. However, wilderness will always have an unmistakable lure to the human psyche because it provides release for our basic need for creativity, self-sufficiency, and freedom, all that civilization precludes. In Roderick Nash's classic *Wilderness and the American Mind,* he suggests that wilderness itself is a large part of American identity. Wilderness provides an escape from the noise and pollution of urban areas and opportunities for spiritual renewal. Environmentally, tracts of wilderness land provide a safe haven for wildlife, protect watersheds, and improve air quality. Wilderness Areas also offer amazing vistas and opportunities for outdoor recreation.

The Wilderness Society's current campaigns are to protect the Arctic National Wildlife Refuge and other wildernesses from oil and gas drilling, to stop road building and logging on 58 million acres (23,471,767 million hectares) of forest lands, and to reduce the destruction caused by off-road vehicle use. As urban areas continue to sprawl in an ever-increasing network of roads, traffic, and shopping malls, the value of wilderness to society will increase. The Wilderness Society's long-term mission is to ensure that wild areas will remain preserved and protected for future generations.

SEE ALSO: Arctic National Wildlife Refuge; Land Ethic; Leopold, Aldo; Preservation; Wilderness; Wilderness Act of 1964.

BIBLIOGRAPHY. Aldo Leopold, *A Sand County Almanac* (Oxford University Press, 1968); Roderick Nash, *Wilderness and the American Mind,* 4th ed. (Yale University Press, 2001); The Wilderness Society, www.wilderness.org (cited April 2006); Dyan Zaslowsky and the Wilderness Society, *These American Lands* (Henry Holt, 1986).

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Wild Horses

WILD HORSES ARE horses that roam in wilderness areas of the world. Wild horses, strictly speaking, are horses descended from horses that have never been domesticated. More broadly, horses that have escaped into the wilds or that have been born wild are feral horses. The only remaining wild horse is the Asian wild horse, also known as the dun-colored, black-maned equids of Mongolia, which are a national symbol. The wild Mongolian horse is called *Takhi* in Mongolian, meaning "spirit" or "spiritual." Russian General Nikolai Przhevalsky (1839–88) first identified the Mongolian wild horse as unique, and he went to Mongolia in the 1880s to search for the horse because it was so rare. In 1900 Carl Hagenbeck captured some, which were put into zoos. Some of these reproduced and their stock was re-introduced into the wilds of Mongolia in 1992 after repeated attempts to locate wild stocks from 1960 onward failed. In 2006 the wild population was around 1,500; they were all descended from animals bred in zoos. Przewalski's (from the Polish spelling of Przhevalsky) horses are about the size of large ponies, are muscular in body, and have a heavy head. Their color is usually light brown, with a black tail, mane, and lower legs, but a white muzzle.

All the other horses in the world that are called wild horses are actually feral horses. That is, they are domesticated horses that have escaped into the wilds, or they are descended from horses that were originally domesticated, but which were either abandoned or escaped into wild areas. Christopher Columbus brought horses with him on his second voyage (1493–96) to the New World. By 1600 a number of Spanish horses had escaped into the great open spaces of the sparsely settled America. They soon grew into great herds, which transformed the lifestyle of the Plains Indians into a horse culture. Descendants of some of these horses still roam wilderness areas of the American West. They are often called *mustangs*, which is an English pronunciation of the Spanish word *mesteno* for "stray" or "wild." Many Americans view mustangs as a symbol of America's frontier heritage. Before passage of the Wild Free-Roaming Horse and Burro Act (1971), Western ranchers killed great numbers as nuisances. In 2004, Senator Conrad Burns (Montana) was able to attach a rider to a much larger bill that effectively gutted the 1971 act. Today many environmental, humane, and historical organizations are campaigning for a restoration of full protection for American wild horses.

In Canada few, if any, wild horses are true mustangs. Most are a mixture of feral English breeds including Suffield, Shire, and Clydesdales. Most are located in Alberta. Attempts to reduce or eliminate them have been opposed by numerous animal rights groups or individuals. Australia also has wild or feral horses that are called Brumby horses. By the early 1800s, there were a number of them in the mountains of eastern Australia, and today they also live in the west and other areas of Australia.

Wild horses on the barrier islands of Chesapeake Bay and of North Carolina's Outer Banks were probably originally from Spanish galleons. Others were strays that went feral. In North Carolina the barrier island of Corolla has become home for a few wild horses. The Corolla Wild Horse Fund was formed in 1989 and works to protect them. In Maryland, Assateague Island has a wild horse population that is separated from Virginia's by fences. Because of poor diet in the salt marshes they are about the size of ponies. The same is true for the wild horses of Chincoteague Island (Virginia) National Wildlife Refuge. Both Assateague and Chincoteague Islands have roundups to manage the population.

SEE ALSO: Mongolia; Ranchers; Wild versus Tame.

BIBLIOGRAPHY. Joel Berger, *Wild Horses of the Great Basin: Social Competition and Population Size* (The University of Chicago Press, 1986); Jay Featherly, *Mustangs: Wild Horses of the American West* (Carolrhoda Books, 1986); Ann Weiss, *Save the Mustangs! How a Federal Law Is Passed* (Simon and Schuster, 1974).

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Wildlife

ACCORDING TO THE *Oxford English Dictionary* (OED), the usage of *wild*, meaning "of an animal; living in a state of nature; not tame, not domesticated," can be traced back to 725 C.E. By 1440 C.E., the word *wildness*, meaning "the state or character of being wild" or "undomesticated," referred to a particular way of being—a category of behaviors and attributes, but not Kingdom or Phylum-specific ones. The word *wildlife* (or *wild life*), meaning "native flora and fauna of a particular region," dates back only to 1879 C.E., and popular usage of its attributive form (e.g., wildlife conservation) and combinative form (e.g., wildlife park, wildlife sanctuary), began in the mid-1930s and 1960s, respectively (OED). Wildlife, then, originated as a category inclusive of animals *and* plants. As such, wildlife together comprise biodiversity.

Although *wildlife* was meant to refer to the native flora and fauna of a particular region, for nearly half a century, television, film, and a number of prominent organizations have privileged fauna. Wildlife as animals dominates National Geographic documentaries, Marlin Perkins's *Wild Kingdom*, more recent shows on the Discovery Channel and Animal Planet. The U.S. Department of Agriculture describes wildlife as "any living creature, wild by nature, endowed with sensation and power of voluntary motion and including mammals, birds, amphibians and reptiles, which spend a majority of their life cycle on land." The Natural Resources Defense Council describes wildlife as "animals living in the wilderness without human intervention," while the standard forestry glossary describes wildlife as "a broad term that includes nondomesticated vertebrates, especially mammals, birds, and fish."

Humans are not counted among wildlife, although anthropogenic processes certainly impact the life forms that are. Prior to the Neolithic Revolution, all human beings relied on undomesticated plants and animals for survival. Thus, for most of human history, all plants and animals would have been considered "wild" by today's standards. With the advent of agriculture, many species of "wild" plants and animals were domesticated. Over time and through human selection, plants and animals of today's farmlands and pet shops have become quite different from their ancestors. This contrast between domesticated species and their increasingly distant relatives contributed to the creation of the word *wildlife*.

More recently, interest in wildlife and wildlife conservation has increased because many species of wildlife have been driven to extinction or near-extinction due to rapid human growth rates and their concomitant ecological pressures. Non-human species have suffered habitat loss and other threats due to agricultural and urban expansion, deforestation, desertification, pollution, and the introduction of exotic species, also called biopollution.

WILDLIFE CONSERVATION

Wildlife conservation describes various practices to regulate certain species to guarantee their abilities to reproduce and remain plentiful. Conservation goals may be based on ideals of wildlife's intrinsic value, wildlife's utility in providing goods and services, or some combination thereof. Wildlife has featured prominently in worldviews, or life-ways, since time immemorial. The majority of the world's religions—including major faiths such as Buddhism, Hinduism, Jainism, and Islam, as well as thousands of small-scale, so-called indigenous religions—support spiritual interrelationships among all living beings. An ethic of stewardship obligates many religious practitioners to care for other species, as conveyed through stories, customary laws, rituals, and religious figures. Examples include portrayals of Noah's Ark replete with breeding pairs of all of the world's animals (Book of Genesis, chapters 6–9; also featured in the Torah and the Koran); the Seventh Generation precept of the Haudenosaunee (Six Nations Iroquois Confederacy), which requires that chiefs consider the impacts their decisions will have on the seventh subsequent generation of living beings; the Tsembaga ritual of *kaiko*, described in Roy Rappaport's *Pigs for the Ancestors*, as a homeostatic process, regulating ecological relationships; and the Roman Catholic St. Francis of Assisi, patron saint of animals and environment.

Across the globe, wildlife products have been exchanged within and between communities as parts of tribute and bartering systems. Hunting reserves are a particular form of utilitarian wildlife conservation and date back millennia. As Mulder and Coppolillio describe, historical records indicate that Assyrians had set aside land for hunting reserves by 700 B.C.E. Reserves in India emerged by 500 B.C.E. to provide not only exclusive areas for royal hunts, but also to protect elephants, which served important roles in the war efforts of state expansion. Such reserves connote a utilitarian approach to managing wildlife to ensure the reproduction of certain species desired for elite use and to restrict nonelites' access to the flora and fauna in those reserves. Furthermore, the species within these "protected areas" became what today would be called natural resources—things to be managed and commodified.

The term *wildlife* was preceded by *game*, defined as "the object of the chase; the animal and animals hunted" (traced to 1400 C.E.) or a collective form defined as "wild animals or birds such as are pursued, caught or killed in the chase" (traced to the late 1200s), and later still "the flesh of such animals used for food" (traced to the mid-1800s) (OED). British colonial discourse in Asia and Africa favored *game* well into the 20th century. There were colonial game reserves by the end of the 19th century, game departments shortly thereafter, and game feasts. As Gibson describes with respect to Africa, meat from wild animals and ivory supported early European explorers and colonial troops, as well as comprised a significant portion of the household budget for colonial administrators and early settlers. More recently, fortress conservation (the locking up of land for the preservation of wildlife) and community-based conservation (attempts to implement utilitarian agendas that permit human habitation in and use of biodiverse regions) have been posed as solutions to the ecological "problem" of wildlife management. Particularly with regard to community-based conservation, wildlife conservation programs fit within the nebulous realm of sustainable development.

WILDLIFE CONSERVATION INSTITUTIONS

Conservation efforts began with the creation of protected areas. The formal gazetting of land—and thus wildlife—dates back to hunting reserves and royal forests. The dominance of Western conservation can be traced predominantly to British and U.S. models. The English enclosure movement beginning in the 16th century reached its peak in the 18th and 19th centuries through various Acts of Parliament. Communally-held and open lands were reconfigured by a system of private land management, and the landscape was literally divided by fences, hedges, and walls into units of production and residence, while separate areas existed for "nature." Such divisions of landscape overlapped with 19th-century U.S. westward expansion and its repercussions.

The establishment of Yellowstone National Park in 1872 inspired a sweeping fortress conservation movement based on the national park model to "protect" indigenous flora and fauna. As noted above, the late 19th and early 20th century efforts at wildlife preservation in British colonially-held territories were often oriented toward protecting certain game species for elite hunters and from indigenous hunters, the latter of whom would be accused of poaching for pursuing those "protected" species.

Wildlife conservation *seems* to stem from the idea that people destroy nature (i.e., wildlife and their habitat in this case) because economic activity has appeared to be incompatible with conservation goals, and yet people are by default the stewards of wildlife and work to save "it" by making it economically productive. The challenge of defining and overseeing wildlife conservation has led to the creation of a variety of institutions, including game and then wildlife departments, government ministries or "parastatals" to manage parks and reserves, and a rapidly growing number of nongovernmental organizations (NGOs). Regulating wildlife internationally has proven particularly difficult.

The Convention for the Preservation of Animals, Birds, and Fish in Africa was the first international conservation treaty. Signed in London in 1900, it served as the foundation for wildlife policies in British colonial Africa, and it was subsequently adopted elsewhere in the world for large-scale conservation efforts. It provided for the gazetting of lands into parks and reserves, and allowed for spin-off legislation regarding trespassing, poaching of protected flora and fauna, and the manners in which natural resources could be exploited—and by whom. By the time the first World Parks Congress convened in 1962, the majority of 10,000 protected areas were in Africa and North America and totaled two million square kilometers of surface area. By the fifth World Parks Congress held in 2003, there were over 100,000 protected areas, totaling over 18 million square kilometers. Those areas include Biosphere Reserves, World Heritage Sites, and other sanctuaries.

The term *wildlife* is often deployed by international conservation organizations and legislation to draw attention to issues of biodiversity and the protection of endangered species. The aforementioned World Parks Congress is a regular gathering sponsored by IUCN, the World Conservation Union, formerly the International Union for the Conservation of Nature and Natural Resources, founded in 1948. IUCN works with representatives from 82 states, 111 government agencies, over 800 nongovernmental organizations, and approximately 10,000 scientists to oversee wildlife management and to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable."

Perhaps the best known international wildlife treaty, CITES, or the "Washington" Convention on International Trade in Endangered Species of Wild Fauna and Flora, endeavors to protect certain plants and animals by regulating and monitoring their international trade to prevent such trade from reaching unsustainable levels. The Convention entered into force in 1975, and there are now over 160 parties. The United Nations Environment Program (UNEP) administers CITES. Plants and animals are classified as endangered, vulnerable, or lower risk species, and monitored accordingly. The World Wildlife Fund lists its primary conservation goals as "saving endangered species, protecting endangered habitats and addressing global threats such as toxic pollution, over-fishing and climate change." WWF, in conjunction with IUCN, also enforces CITES through TRAFFIC, the world's largest trade monitoring network.

Another significant international treaty, the Convention on Biological Diversity (CBD) was signed by 150 government leaders at the 1992 Earth Summit. The Convention promotes sustainable development while protecting biodiversity, which it describes as "the fruit of billions of years of evolution, shaped by natural processes and, increasingly, by the influence of humans." The agreement serves as a basis through which to regulate all species, ecosystems, and genetic resources, and it also covers the field of biotechnology. CBD objectives are implemented within the signatory nations through a variety of mechanisms, such as required implementation of national parks and protected areas systems to protect wildlife; green taxes, tax deductions, and/or severe economic penalties for habitat destruction or wildlife poaching; and expansion of the nonprofit sector.

Some indigenous groups have founded explicitly environmental institutions. For example, the First Nations Environmental Network is a national organization of individuals, nonprofit agencies, green technologies and corporations, and Nations working together on environmental issues. FNEN describes itself as "a circle of First Nations people committed to protecting, defending, and restoring the balance of all life by honoring traditional Indigenous values and the path of our ancestors."

The definition of *wildlife* as "native flora and fauna of a particular region" does not preclude the possibility that the animals that qualify as "wildlife" can also be domesticated for profit (e.g., ranching, sport-hunting) or pleasure (e.g., zoos, private, or pet ownership). Following this logic, if we understand the definition of *wild* as "living in a state of nature; not tame, not domesticated," then the phrase *wild animals* can have an entirely different meaning from *wildlife*, even though members of the same species may comprise each category.

For example, ostriches—which live in an east African national park and have not been intentionally tamed by humans—may be considered as both wild animals and wildlife; but, given the above definitions, ostriches raised and tamed by humans, such as those at various ostrich farms throughout east Africa, qualify as wildlife but not as wild animals. The phrase *wildlife domestication* may sound like an oxymoron, but it is both an implicit characteristic and process of "wildlife conservation" and its conceptual sibling "wildlife resource management"—both of which bear the hallmark of colonial and neo-colonial interests.

SEE ALSO: Animals; Conservation; Convention on International Trade in Species of Wild Fauna and Flora (CITES); Environmental Organizations; Movements, Environmental; National Parks; Poaching; Safaris; Wild versus Tame.

BIBLIOGRAPHY. Raymond Bonner, *At the Hand of Man: Peril and Hope for Africa's Wildlife* (Knopf, 1993); Dan Brockington, *Fortress Conservation: The Preservation of the Mkomazi Game Reserve, Tanzania* (Indiana University Press, 2002); Jennifer Coffman, "The Invention of Wildlife: Managing a Natural Resource in Colonial and Post-Colonial Kenya," in Clark Gibson, ed., *Politicians and Poachers: The Political Economy of Wildlife Policy in Africa* (Cambridge University Press, 1999); John MacKenzie, *The Empire of Nature: Hunting, Conservation, and British Imperialism* (Manchester University Press, 1988); Monique Borgerhoff Mulder and Peter Coppolillo, *Conservation: Linking Ecology, Economics, and Culture* (Princeton University Press, 2005); Roderick Neumann, *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa* (University of California Press, 1988); James O'Connor, *Natural Causes: Essays in Ecological Marxism* (Guilford Press, 1998); David Western and Michael Wright, eds., *Natural Connections: Perspectives in Community-based Conservation* (Island Press, 1994).

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Wild versus Tame

THE WORDS *wild* and *tame* go back to ancient Germanic roots, and perhaps earlier still, if they are—respectively—cognate with Latin *ferus* "wild" and *domare* "dominate," as suggested by the *Oxford English Dictionary*. They always had the meanings they have now, and they also were always opposed. The first English reference to *tame*, an Anglo-Saxon gloss of 888 C.E., explicitly opposes them. They are defined in relation to each other. A wolf is wilder than a bad or willful dog, but the latter is wilder than a thoroughly subjugated one; the cur is tame relative to the wolf, wild relative to the good pet. Jasper National Park is wilder than Yosemite, and Yosemite is wilder than Times Square. Naturally occurring species of roses are wilder than hybrid single roses, but the latter, even when they are modern hybrids, seem wilder to gardeners than the huge multi-petaled florists' roses. Formerly cultivated land reverts slowly and gradually to the wild. Tame animals can go wild or feral.

Wild has always had its present double or extended meaning: Natural as opposed to human-managed, and uncontrolled or hyper-reactive as opposed to tranquil and calm. A wild person can be violently emotional or somehow remote mentally from ordinary people. Latin *ferus* has similar extended meanings. *Tame* means controlled by humans; its secondary meaning of dull and ordinary is not attested before 1600. *Wilderness* is a derivative of *wild*, with attributive suffixes. Other languages have equivalent, but not always exactly equivalent, words. Chinese *ye* implies not only "wild" and "wilderness," but also "abandoned land." Romance languages usually use words derived not from *ferus*, but from Latin *sylvaticus*, "of the forest," such as: *sauvage* (French), and *selvatico* (Italian). These usually have a negative, even violent connotation, as in the English derivative savage (from the French). Yucatec Maya parallels Latin: *k'aaxil* "of the forest" and *baalche'* "things of the trees" are the nearest equivalent to "wild things." However, in Maya the connotation is good: The Maya love the forest and have strong positive associations with its inhabitants. Tame in Yucatec Maya is *alakbil*, "raised by humans," a close parallel with English.

In short, wild and tame are concepts that are broadly held—every culture feels the need to contrast the home-reared with the natural and uncontrolled, but culture and tradition powerfully influence their connotations. People understand them differently at different times and places. *Wild* and *wilderness* had broadly negative connotations through much of history. Conversely, wildness can be so valued that it is imitated. English landscape architects of the 17th–19th centuries laid out artificial wildernesses, and saw nothing oxymoronic about this. Today, restoration ecologists recreate the wild or the wilderness. In most countries, opinions range from strongly pro-wild (as in the John Muir tradition of conservation), to strongly antiwild. This leads to political debates that often become impassioned. The United States, home of the ideas of conservation, national parks, and national wilderness areas, is also home to a powerful pro-development ethic that defines progress as increasingly radical transformation of natural resources into commodities. Holders of these views come into conflict. The concept of tame inspires less emotion, but it too has positive and negative connotations.

From the ancient Chinese (such as Chuang Tzu and Han Shan) and the Desert Fathers of early Christianity to modern conservationists like John Muir and Edward Abbey, many people have found wild areas to be desirable, or even necessary, for personal renewal and contemplation, and have lived in the wild when possible. Conversely, others have found fulfillment only in destroying the wild to produce a tame world of houses, lawns, and factories. Many appreciate both types of landscapes, and are fulfilled only when they can move from one to the other with some ease. This attitude is now often identified with young educated urbanites, but is by no means confined to them, in the Western world or elsewhere. The Maya, and other Native Americans of Mexico, regard the balance of town and wild as essential to the world—a religious or cosmological necessity. Medieval India had almost the same view, widely expressed in Sanskrit and Tamil poetry. The ancient Celtic peoples idealized the wild more than perhaps any other culture on earth, but they usually (though not always) preferred to live in villages and castles.

It is often said today that there is no real wild or wilderness, because all parts of the planet are affected by humanity. However, this claim ignores the relative nature of the world. The usage of *wild* to mean totally unaffected by human action has never been standard. *Wilderness* has recently been widely used to mean areas thus unaffected, but this is a rather specialized and recent usage. The French philosopher Bruno Latour has argued that we should speak of natures rather than nature in recognition of these considerations, and the same might be argued for wild had not wilds long been used to mean wild places. Tame contrasts in scientific usage with domesticated. Domesticated, formally, refers to organisms that have been significantly changed by human breeding, such that they are genetically different from any population not managed and bred by humans. Wild animals can be tamed, but are not automatically domesticated. The elephants used so widely in ancient and modern times in Africa and Asia, for war and draught, have never been truly domesticated. Many cultivated tree crops are barely, if at all, domesticated, in spite of long histories of orchard use. Usually these are minor, or new crops such as macadamia nuts, but even such ancient crops as commercial olive varieties may have been propagated from naturally occurring trees rather than deliberately bred.

Wild and domestic forms of a given crop routinely interbreed. This introduces valuable new genes, especially for disease and pest resistance, to the domestic stock. For millennia, people have known this, and deliberately let their crops breed with wild relatives. The search for valuable genes in wild populations of wheat, barley, potatoes, and other major crops is a major research industry. Since pests and diseases quickly home in on particular domesticated varieties, plant breeders must constantly find new resistance genes in wild populations, and also in local landraces developed by small traditional communities in isolated areas. Loss of wild and landrace strains would be devastating to world food security. This is a most immediate and urgent practical reason to preserve wild and non-modernized landscapes. Moreover, domesticated forms can escape from tameness and go wild. If they are animals, they are said to be feral; if plants, volunteer. So an organism can be domesticated without being tame. Such organisms, having been bred to flourish among humans, can become pests. The common dandelion owes much of its success as a weed to a long history of being bred as a garden crop.

SEE ALSO: Domestication; Domination of Nature; Landrace; Wilderness; Wilderness Act (U.S. 1964); Wilderness Society; Wildlife.

BIBLIOGRAPHY. E.N. Anderson, *The Political Ecology of a Yucatec Maya Community* (University of Arizona Press, 2005); A.C. Graham, *Chuang Tzu: The Inner Chapters* (George Allen and Unwin, 1981); B. Latour, *Politics of Nature: How to Bring the Sciences into Democracy*, trans. by Catherine Porter (Harvard University Press, 2004); Han Shan, *The Collected Songs of Cold Mountain*, trans. by Red Pine, also known as Bill Porter (Copper Canyon Press, 2000); R. Torrance, ed., *Encompassing Nature* (Counterpoint, 1998).

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Wind Energy

THE KINETIC ENERGY in wind can be converted into mechanical or electrical power. For centuries, windmills have converted wind energy into mechanical power to grind wheat into flour. Now, improved turbine technology allows wind generators to affordably produce electricity. Electricity is produced when an electrical conductor moves perpendicularly to a magnetic field. Generators have a conductor (or rotor) that spins inside a magnetic field (or stator). The challenge is to find abundant, low-cost energy to spin the rotor.

Wind generates less than 1 percent of the world's electricity, but is its fastest-growing energy source.

Hydroelectricity is a renewable energy source that uses the potential energy of falling water to turn the rotor. Wind is also a renewable energy source because its supply is not depleted after being used. Generators also use nuclear or fossil fuels to convert water into steam pressure, which turns the rotor. Fossil fuels like coal are essentially nonrenewable because they form over millions of years. Although wind is renewable, it is not always reliable. Wind velocity may fluctuate or fall below the minimum annual average velocity of 13 miles per hour needed to generate electricity.

Wind is created when solar radiation interacts differentially with clouds, vegetation, and water bodies to unevenly heat the earth's surface. Resulting atmospheric pressure differences force air from high to low pressure areas. Wind velocity, density, and temperature determine wind quality. Winds aloft are better than surface winds. Hills, valleys, and other geomorphic features can locally increase or decrease the relative velocity.

Wind energy potential depends on the area swept by the wind, its density, and velocity. Blade length and rotor design define the area component for a turbine. Denser air will also have an impact by generating more momentum. Velocity is the primary factor in wind power generation because changes in velocity have a cubed effect on power.

PRACTICAL ASPECTS OF WIND POWER

Wind generates less than 1 percent of the world's electricity, but is the world's fastest-growing energy source, with an installed turbine capacity of 58,982 megawatts. Environmental and human factors, however, affect the global and regional patterns of where wind is used to generate electricity. The production of wind energy is still centered in Western Europe but is increasing in developing countries with rapidly-growing economies, such as India.

In the United States, wind energy development is dependent on adequate wind resources, the availability of transmission lines, and federal and state policies and incentives. The potential amount of electricity available from wind is measured by the installed capacity of the turbines. For example, North Dakota is ranked highest in the United States for wind potential, but lacks the transmission lines to move electricity on a large scale to population centers.

Wind energy advocates tout its reduction of greenhouse gas emissions and the income it generates as wind farm operators pay property taxes and rent for the use of local land. Opponents argue that large wind farms are a visual blight and that rotating blades can be noisy and endanger bats and migratory birds. These concerns are like those associated with other large industrial developments.

All energy sources, including wind, affect the environment when they are harnessed for human uses. Consequently, in the current energy policy debate there are no easy answers about which energy source is the best. For the time being, wind energy comprises only a small portion of the American energy portfolio. Its expanded use depends upon continuing technological improvements and public acceptance of its net benefits.

SEE ALSO: Fossil Fuels; Hydropower; Renewable Energy; Solar Energy.

BIBLIOGRAPHY. American Wind Energy Association, *Wind Energy Projects throughout the United States of America*, www.awea.org (cited April 2006); L. Daniels, S. Johnson, and W. Slaymaker, *Harvest the Wind*, www.iira.org (cited April 2006); U.S. Department of Energy, *Wind and Hydropower Technologies Program*, www1 .eere.energy.gov (cited April 2006); World Wind Energy Association, *Worldwide Wind Energy Boom in 2005*, www.wwindea.org (cited April 2006).

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Wine

WINE IS AN alcoholic beverage made of grape juice through fermentation. A few dozen grape types produced by the vine plant *Vitis vinifera* are of particular interest to wine experts. Popular varieties include cabernet sauvignon, chardonnay, merlot, pinot noir, and zinfandel. Where these grapes grow determines much of a wine's character. Differences in weather and lighting conditions, soil, and temperature are distinguishable in the taste of wine so that the same grapes result in different wines in different regions. Details of the fermentation process and aging further profile the end product—be it red, white, rosé (blush), sparkling, sweet, or dry.

The history of wine is a history of global trade by powerful economic actors. The story begins in Mesopotamia and Caucasia roughly 8,000 years ago. The know-how traveled to Egypt in 3,000 years and reached Greece 1,000 years later. Greek colonizers and merchants introduced wine to the Mediterranean sphere: To present-day Italy, France, Spain, and northern Africa. Imperial Romans then domesticated wine further north, in today's Britain, Germany, and northern France. When the Romans left these areas by the 5th century, the seeds of contemporary vineyards had been planted. These were typically located along rivers, the most important channels of transportation in this era. By the Middle Ages the Christian Church had emerged as the most powerful producer and trader of wine, with monasteries as the most important centers of innovation. Wine dominated the European beverage market until the 18th century, when imports from the colonies (chocolate, coffee, and tea) gained popularity, distilling and preservation techniques of other alcoholic beverages developed, and water in European cities became safer to drink. Competition encouraged innovation, creating the foundations of modern wine. Wine clearly is a culturally specific (Western) product with origins in particular climatic, historical-cultural, and economic conditions.

Over the past century the wine business has industrialized in form and become global in scale. Most of the production still comes from Europe, although the New World has gained power in the market. The leading wine producing countries are France, Italy, Spain, the United States, and Argentina. In each country wines have intensely local and regional roots. The production comes from strictly defined regions that only use certain methods and varieties of grapes. Famous wine regions include Bordeaux in France, La Rioja in Spain, and Napa Valley in California.

The legal definition of these regions, their maximum annual crops, and the alcohol contents of their products exemplify the detailed controls and regulations applied to wine by authorities and specific regulatory bodies. Producers, their organizations, and national governments use regulation to control the quality of wines, to protect their reputation, and to improve their sales. Local and national governments may tax the licensed producers, distributors, retailers, and consumers of wine. This revenue is typically used to cover social costs related to alcohol consumption. International tariffs may apply to the import and export of wine for reasons of market protection and revenue.

Some regulations connect to cultural, social, and moral values, which often dictate where, when, and by whom wine can be purchased and consumed. Many countries have set legal age limits to the consumption of wine and prohibit driving under its influence, but how young is too young, how much is too much, or how strictly the control is enforced varies from one society to another. Social tolerance for visible intoxication also varies significantly both at the level of societies and socioeconomic class, so that one can speak of "drinking cultures." Some religious communities consider the consumption of all alcoholic beverages unacceptable, whereas others shun intoxication but find deep symbolic or metaphorical meaning in wine consumed in sacred rituals. The importance of wine to human social life is reflected in artistic representation—in paintings, literature, and various forms of contemporary popular culture.

Wine thus connects to identity in multiple ways. A globally famous wine is a source of local, regional, or national pride and influences the identity and landscapes of the place associated with the wine. Wine tasters and other specialists have professional group identities supported by expert vocabularies and know-how. Wines profile their consumers: What wine is served, in what situation, to whom, and how may function as a powerful indicator of socioeconomic status, cultural knowledge or background, and lifestyle.

Over the course of tough competition small family-owned wineries have merged into multinational production companies with complex ownership structures. The distance between the producer and the consumer, and between the botanical and the chemical, has grown: Wine is still an agricultural product, but it is increasingly produced under strict technological control and consumed in urban, post-industrial environments far from the original production region. Because of their reputation, consumer identities, and available profit, there is demand for wines to routinely travel over long distances. This movement of trendy consumables may be criticized from a perspective of environmental sustainability. On the other hand, environmentally-aware wine drinkers have grown increasingly interested in the sustainability of production. Interest in local produce and urbanites' recreational needs have reconnected wine consumers and producers through sustainable, moderately scaled forms of wine tourism.

The delicate relationship between wine production and the natural environment shapes the future of the business. Unexpected side effects of global exchange have been well-traveling plant diseases and pests, which have seriously damaged wine production in Europe (especially in the 1870s), the United States (contemporary California), and New Zealand. In some areas, methods of biological or chemical pest control have created further problems by damaging soils and water supplies or by altering the balance of species. At worst, these problems may threaten entire regions and their wine-dependent economies.

SEE ALSO: Cacao; Coffee; Drugs; Green Consumerism; Religion; Soils.

BIBLIOGRAPHY. H. J. de Blij, "Viticulture and Viniculture in the Southeastern United States," *Southeastern Geographer* (v.27, 1987); J. P. Dickenson and J. Salt, "In Vino Veritas: An Introduction to the Geography of Wine," *Progress in Human Geography* (v.6, 1982); Daniel W. Gade, "Tradition, Territory, and Terroir in French Viniculture: Cassis, France, and Appellation Contrôlée," *Annals of the Association of American Geographers* (v.94, 2004); Hugh Johnson, *World Atlas of Wine,* 4th ed. (Chancellor Press, 2002); Tim Unwin, *Wine and the Vine* (Routledge, 1991).

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Winters Doctrine

WINTERS DOCTRINE IS a legal principle announced by the U.S. Supreme Court in the case of *Winters v. United States* 207 U.S. 564 (1908). The doctrine created a different legal rule for the distribution of water in the arid western states. The rule is that water rights have been reserved to Indian reservations and public lands in order to make sure that there will be enough water to achieve their assigned purposes. The Winters Doctrine contradicts the law of water rights in the western United States that is applied to privately held lands. The rule generally followed in the west is the "state-based appropriative rights" rule. It is the principle that the rights to water derive from the first time that they were put to beneficial use. The federal rule, however, begins its allocation of water based on the date on which the lands in question were reserved for a dedicated purpose. The federal rule means that a rancher may have been using water for years that was not called upon by an Indian reservation or a federal land management project. The rancher or a farm may therefore have been applying the water to beneficial use long before federal claimants began to seek to use the limited water supplies.

The Winters doctrine developed from a case brought by the U.S. government against Henry Winters, John W. Acker, Chris Cruse, Agnes Downs, and others. Winters and his associates were constructing and maintaining dams on the Milk River in the State of Montana. Their upstream activities impeded and reduced the riparian flow downstream to the Fort Belknap Indian Reservation. Winters and his associates lost the case in the federal district court. They were ordered to not interfere in any manner whatsoever with the flow of 5,000 inches of the water of the Milk River. The Circuit Court of Appeals (74 C. C. A. 666, 143 Fed 740) affirmed the decision. In response, Winters, et al., appealed to the U.S. Supreme Court.

The opinion delivered by the Supreme Court noted that the Fort Belknap Indian Reservation had been established on May 1, 1888, when property of the U.S. government was set aside for the Gros Ventre and Assiniboing tribes as an abiding dwelling place. The Court accepted the fact that Winters, et al., had a right to the water under Montana law; it ruled that the federal government had a prior and a different claim that superseded the otherwise lawful state claim. The federal claim to the water was established when Congress created federal lands for special purposes. It did so with the reservation that water is always reserved for the use of the federal facility despite claims of others at a later time.

The Winters decision has meant that all public lands of the federal government are first in line for water uses. This includes national parks, wildlife refuges, national forests, military bases, wilderness areas, or other public purpose areas. Later court cases expanded the rule to include lands set aside by treaty, executive orders, or by federal statutes.

SEE ALSO: Native Americans; Riparian Rights; United States, Mountain West; Water Law.

BIBLIOGRAPHY. Reid Peyton Chambers, *Implementing Winters Doctrine Indian Reserved Water Rights: Producing Indian Water and Economic Development without Injuring Non-Indian Water Users?* (University of Colorado School of Law, 1991); Michael C. Nelson and Bradley L. Booke, *The Winters Doctrine: Seventy Years of Application of Reserved Water Rights to Indian Reservations* (Office of Arid Land Studies, 1977); Jeffrey M. John Shurts, *Indian Reserved Water Rights: The Winters*

Doctrine in its Social and Legal Context, 1880s–1930s (University of Oklahoma Press, 2000).

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Wise Use Movement

THE WISE USE movement is a conglomeration of grassroots activists and organizations presenting an alternative philosophy regarding resource extraction and access on U.S. public lands. The movement started in the late 1980s by a handful of influentials such as Ron Arnold, Chuck "Rent-a-Riot" Cushman, and Allan Gottlieb. Arnold has been Executive Vice President of the Center for the Defense of Free Enterprise since 1984, and was honored as the "Father of the Wise Use movement." His blatant and harsh criticism of environmentalists has made him a veritable spokesperson for the movement.

The authors (Maughan & Nilson) identified the seven predominant strategies of the movement:

(1) bills itself as the "true" environmental movement; (2) tries to marginalize environmental groups by highlighting the views and actions of the radical fringe of environmentalism, and in other ways promote the perception that environmentalists are atypical of the public; (3) downplays threats to the environment; (4) tries to form coalitions with interests who perceive they have been harmed or are threatened with harm from environmental policies; (5) forms coalitions with groups that share part of the Old West ideology; (6) stresses the economic costs of environmental policy; and (7) creates the perception that the real goal of environmentalists is attainment of authoritarian power.

Overall, the Wise Use movement is regarded by many in and outside of the movement as "anti-environmental." A quick look at the Wise Use Agenda reveals a philosophy that is in many regards contrary to the policies advocated by environmentalists, conservation organizations, and U.S. federal agencies.

Since there are numerous Wise Use organizations that focus on a myriad of specific issues, the goals stated below are not supported by every Wise Use group. However, at a Multiple Use Strategy Conference in Reno, Nevada in August 1988 sponsored by Ron Arnold's Center for the Defense of Free Enterprise, Wise Use organizations collaborated on their mutual concerns about resource management. As a result of the conference, Alan Gottlieb compiled *The Wise Use Agenda*, a book detailing the goals of the movement. Note that many of the policies presented were subsequently adopted by the George W. Bush administration. The first 10 goals are stated below:

1. Initiation of a Wise Use public education project by the U.S. Forest Service explaining the wise commodity use of the national forests and all federal lands (to reduce the federal deficit).
2. Immediate wise development of the petroleum resources of the Arctic National Wildlife Refuge in Alaska.
3. Advocate the passage of an Inholders Protection Act, giving broader property rights to inholders (persons who own land within the borders or tangent to federal or state lands).
4. Passage of the Global Warming Protection Act that works to remove all decaying matter from national forests to be replaced by young stands of carbon-dioxide absorbing trees.
5. Designate 3 million acres in the Tongass National Forest in Alaska for timber harvest.
6. Open all public lands (including wilderness areas and national parks) to mining and energy production.
7. Assert states' sovereign rights in matters pertaining to water distribution and regulation.
8. Commemorate the one hundredth anniversary of the founding of the Forest Service by calling attention to the commodity use of forests and the homestead settlement of these areas.
9. Increase harvesting of trees in national forests to promote "rural, timber-dependent community stability" through the Rural Community Stability Act. These sales will be exempt from administrative appeal.
10. Create a national timber harvesting system that allows for greater harvesting of timber on public lands.

Many of the individual groups within the Wise Use movement were at one time funded in part by the oil, off-road (recreation), timber, mining, and ranching industries, as well as anti-environmental politicians. In 2001 the Sierra Club reported that Boise Cascade Company (timber company), DuPont (chemical manufacturers), and Chevron (gas and oil company), at one time funded Wise Use movement conferences. However, many of the corporate interests quickly soured on the wise-use groups' overheated rhetoric (and sometimes aggressive tactics) and pulled their funding.

The Blue Ribbon Coalition, the Mountain States Legal Foundation, and the Center for the Defense of Free Enterprise are among the more prominent Wise Use groups in the United States

The Mountain States Legal Foundation was founded in 1987 by Clark Collins to advocate for motorized access for off-road vehicles on U.S. public lands. Of note, the Coalition joined in a lawsuit against the U.S. Forest Service over the 2001 Roadless Area Conservation Rule. The rule was developed following years of scientific evidence, hundreds of public meetings across the country and 1.6 million public comments. Since 2006 the Forest Service has received more than four million comments on the rule, 95 percent in favor. The rule received the largest turnout of public comments in U.S. Forest Service history.

According to their website, the Center for the Defense of Free Enterprise (CDFE) is highly interested in environmental issues and "was founded by a group of distinguished businessmen, educators, legislators and students who were deeply concerned about the rollback of 200 years of individual rights and the multitude of restrictions being imposed on America's free enterprise system by big government."

SEE ALSO: Bush, George W. Administration; Industry; Timber Industry.

BIBLIOGRAPHY. Ron Arnold, www.cdfe.org (cited April 2006); The Blue Ribbon Coalition, www.sharetrails.org (cited April 2006); Alan Gottlieb, *The Wise Use Agenda: The Citizen's Guide to Environmental Resource Issues* (Free Enterprise Press, 1989); Jennifer Hattam, "Wise-Use movement, R.I.P.?: Friends in the White House, But Few Foot Soldiers," *Sierra* Magazine (May/June 2001); David Helvarg, "Wise Use in the White House," *Sierra* Magazine (September/October 2004); The Heritage Forest Campaign, "Roadless Area Protection Act," www.ourforests.org (cited April 2006); Scott Silver, www.wildwilderness.org (cited April 2006);

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Wittfogel, Karl A. (1896–1988)

KARL A. WITTFOGEL, a German historian and prominent sinologist, is most noted for his theory of the hydraulic civilization. Applied by Wittfogel primarily to ancient Egypt, Mesopotamia, China, the Indus Valley, and regions in pre-Columbian Latin America, he contended that the strong central political control was necessary to control the source and disposition of water. The degree of centralization within these civilizations was extreme to the point of being despotic. All of the civilizations noted in Wittfogel's studies existed in arid regions, where vast irrigation systems supported extensive agricultural operations, with the exception of China. It is on this point that his theory has been sternly criticized. The prominent China scholar, Joseph Needham, argued that early Chinese governments, although exercising central control, were not despotic. Needham, along with other scholars, also correctly pointed out that the most productive agricultural regions in China are not arid, sources of water are widespread, and water control measures are locally administered.

Wittfogel moved to the United States and became a naturalized citizen in 1939, after enduring two years in a Nazi concentration camp for his vocal attacks on fascism in Germany. He served on the faculty at Columbia University before joining the Far Eastern and Russian Institute at the University of Washington in 1947. It was here that Wittfogel completed his most important book, *Oriental Despotism: A Comparative Study of Total Power* (1957), which laid out his schema for the origins of bureaucratic totalitarianism based on the control of a society's water supply.

Wittfogel drew heavily on the works of Karl Marx, Friedrich Engels, and Max Weber in developing his ideas about early non-European societies and their governmental structure. Weber, in particular, was most influential and is credited with introducing Wittfogel to the unique hydraulic-bureaucratic societal structures in South Asia and East Asia.

In his book, *Rivers of Empire: Water, Aridity, and Growth of the American West,* environmentalist Donald Forster invokes Wittfogel's thesis and applies it to the American southwest, a region of aridity and closely managed water sullies. Forster strenuously argues that a true hydraulic society emerged in the southwest as population increased and demands on a limited water supply rapidly increased. In his scenario, a mega-bureaucracy emerged, which included large land-holding agriculturalist and governmental officials who concentrated water rights in the hands of a relatively small number of influential individuals. Forster considers the National Reclamation Act (1902) and the Bureau of Reclamation to be the primary instruments in the creation of the southwest's hydraulic society.

SEE ALSO: Marx, Karl; Socialism; Water; Water Demand.

BIBLIOGRAPHY. Karl A. Wittfogel, *Oriental Despotism: A Comparative Study of Total Power* (Yale University Press, 1957); Orlan Lee, *Bureaucratic Despotism and Reactionary Revolution: The Wittfogel Theory and the Chinese Revolution* (Chinese Materials Center, 1982); G. L. Ulman, *Society and History: Essays in Honor of Karl August Wittfogel* (Mouton, 1978); Donald Worster, *Rivers of Empire: Water, Aridity, and Growth of the American West* (Pantheon Books, 1985).

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Wolves

WOLVES (*CANIS LUPUS*) are mammals of the order Carnivora and belong to the same family (Canidae) of carnivores as coyotes, doges, foxes and jackals. They are digitigrades like other Canidae family members. Wolves are social animals that live in packs with a dominance hierarchy. The members of the pack include wolf pups, several nonbreeding adults, the dominant male (alpha) and his mate (fae). They mate in January and usually have five or six pups about six weeks later. The pups are fed by the pack until they become young adults.

Wolves are keystone predators. What they leave behind feeds other animals such as scavengers. They also keep the populations of ungulates such as bison, caribou, Dall sheep, elk, moose, mountain goats, and musk-oxen at healthy levels. However, many ranchers and sports hunters view the wolf as a menace that should be exterminated.

The gray wolf (timber wolf) is found across the Northern Hemispheres in North America, Europe, and Asia. There were five subspecies, but several have become extinct because of habitat destruction and hunting encouraged by fear of wolves. The Mexican gray wolf (*Canis lupus baileyi)* is a subspecies hunted to near extinction in the last 50 years. The South American maned wolf *(Chrysocyon brachyurus)* resembles a dog with reddish fur.

In the American West, wolves were hunted to extinction partly because of traditional fears of wolves.

Called a *lobo* in Spanish and Portuguese, it is not actually a wolf. It lives in Paraguay, Southern Brazil, and Bolivia east of the Andes.

The Arctic wolf (*Canis lupus arctos*) is a subspecies of the gray wolf. Also called the white wolf or the polar wolf, they range across the Canadian Arctic and Greenland. They are different from the tundra wolf (*Canis lupus albus*) that ranges across the tundra of the northern European and Asian Arctic.

The largest subspecies of the gray wolf is the Russian wolf (*Canis lupis communis*). Its range is north-central Russia where it is hunted legally. In Europe wolves have been nearly driven to extinction. Small numbers exist in the mountains of Italy, Spain, Portugal, Norway, Sweden, and Finland. Larger numbers survive in the Carpathian Mountains.

Africa's only species of wolf is the Ethiopian wolf (*Canis simenis)*. Only a few hundred individuals survive in the alpine ecosystem of the Ethiopian highlands. The Arabian wolf (*Canis lupus Arabia*) is a subspecies of the gray wolf. Numbers have increased in the United Arab Emirates since hunting was banned. The dire wolf was common in North America during the Pleistocene era but is now extinct. It disappeared with other mega-fauna at the end of the last ice age. Specimens have been found in tar pits and fossil beds. The North American red wolf (*Canis rufus*) may have been a descendant of the dire wolf. It was hunted nearly to extinction and was declared biologically extinct in the wild in 1980, but it has since been reintroduced to the wild in the southern Appalachian Mountains.

SEE ALSO: Conservation; Habitat Protection; Native Species; Nature, Social Construction of; Predator/Prey Relations; Public Land Management; Yellowstone National Park.

BIBLIOGRAPHY. John Elder, *The Return of the Wolf: Reflections on the Future of Wolves in the Northeast* (Middlebury College Press, 2000); Thomas McNamee, *The Return of the Wolf to Yellowstone* (Owl Books, 1998); Chris Whit, *Wolves: Life in the Pack* (Main Street Press, 2004); Daniel Wood, *Wolves* (Whitecap Books, 2005).

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WEDO: Women's Environment and Development Organization

THE WOMEN'S ENVIRONMENT and Development Organization (WEDO) was founded in 1990 by the late Bella Abzug (former Democratic U.S. congresswoman; 1920–98), and Mim Kelber (1922–2004), a well-known women's rights and peace activist. As noted in their mission statement, the international organization "advocates for women's equality in global policy. It seeks to empower women as decision makers to achieve economic, social and gender justice, a healthy, peaceful planet and human rights for all."

WEDO was inspired by an earlier movement, women in development (WID), which began in the 1970s and was a shift in international aid development policies to emphasize the importance of women's roles in economic development. The WID approach was later institutionalized by aid organizations such as the U.S. Agency for International Development (USAID), and served as impetus for the First United Nations (UN) Conference on Women and Development in Mexico City in 1975. WID was an important foundation for the feminist movement of its time and it helped make women's voices heard in international development projects and policies. It also helped set in motion the concept of ecofeminism, a belief that the connection of women with nature is so strong that it "called upon women to lead an ecological revolution to save the planet."

As women's voices from Northern and Southern countries became heard regarding topics of environment and development (including not just those of well-educated and upper- or middle-class backgrounds—but also women from farming, fishing, and indigenous communities), world leaders and nongovernmental organizations began preparations for the 1992 UN Conference on Environment and Development (UNCED) held at Rio de Janiero, also known as the Earth Summit. Abzug and Kelber, influenced by the infamous Bruntland Report, were concerned that even after two decades of WID policies and discourse, few women occupied positions associated with global policy formulation. As a strategy to attract attention from the global community and those creating the UNCED agenda, Azbug and Kelber created WEDO to formally organize a conference called the World Congress for a Healthy Planet in Miami in 1991. The 1,500 women there agreed to demand press leaders at UNCED for an equal say in governmental policies created by local and global governments or institutions. They believed that "male-led technologies, wars, and industries are killing people and the planet." Their vision was that more women must be involved in designing policies that linked environment with issues of poverty and social justice and that this would be an important advance toward bringing the "earth's political, economic, social and spiritual systems into healthy balance."

The Healthy Planet conference, as intended, was instrumental in leveraging women's influence on UNCED and ultimately increased women's visibility in decision making regarding policy issues that link environment with issues of poverty, social justice, free trade and international debt. The mechanism that was used to gain influence in UNCED and produced by WEDO, as a result of the Healthy Planet conference, was called "Women's Action Agenda 21," referencing Agenda 21 because this was the title of the document that governments from participating countries at UNCED planned to produce at Rio de Janeiro.

Action Agenda 21 contained a list of specific demands regarding topics of: Democratic rights, diversity, environmental ethics, women and militarism, foreign debt, trade, poverty, land rights, food security, population and women's rights, biotechnology and biodiversity, alternative energy and nuclear power, technology and science, consumer power of women, education, and information. The document also challenged the UN for its lack of gender balance in the organization itself. The WEDO lobbying efforts using Action Agenda 21 were successful in positioning women's issues in Agenda 21 in a majority of the chapters in the document, as well as one chapter specifically dedicated to women's roles in globally sustainable and equitable development.

WEDO continues to stay active in pressing the UN for a "wider gender lens" in all of its activities and policies, particularly the UN Millennium Declaration, a 2000 Declaration agreed upon by 191 governments at the largest gathering ever of world leaders. The organization campaigns for women's rights throughout the world. Its recent activities include: Beijing +10, a 2005 campaign to reaffirm the Original Action Plan of the 1995 Fourth Conference on Women held in Beijing, China; and a global campaign: "Plant a Tree for Peace," commemorating Nobel Laureate Wangari Maathai and connecting environment, human rights, peace and gender equity.

SEE ALSO: Agenda 21; Brundtland Report; Ecofeminism; Gender; Justice; United Nations Conference on Environment and Development (Earth Summit 1992).

BIBLIOGRAPHY. B. Abzug, "The Century of the Woman," *Social Policy* (v.28, 1998); E. Boserup, *Woman's Role in Economic Development* (St. Martin's Press, 1970); R. Langara, "How Beijing Has Been Betrayed: WEDO's New Book Carries Women's Reports on How Governments Have Failed to Act on the BPFA," *Women in Action* (v.1, 2005); C. Merchant, *Radical Ecology: The Search for a Livable World* (Rosenberg, 1992); Women's Environment and Development Organization, www.wedo.org (cited April 2006).

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Wood (as energy source)

BIOMASS RECEIVES AND stores energy from the sun. When burned, this energy is released as heat. Wood fuel (commonly referred to as fuelwood) serves a variety of heating purposes although the most common fuelwood-based practices around the world cooking and heating—especially in developing nations.

Calculating how much wood is harvested and burned each year is difficult to determine because fuelwood collection and use occurs predominantly through informal practices. As a result there is a dearth of precise data on wood energy use. This stands in contrast to non-biomass energy sources such as oil and natural gas, which have been subject to more in-depth analysis.

According to the United Nations Food and Agricultural Organization (FAO), biomass accounts for roughly 30 percent of the total energy consumed in developing nations- with fuelwood accounting for approximately half of this amount or 15 percent of the total energy. Other common types of biomass include agricultural matter and animal dung. In some countries, dependence on fuelwood is much higher. For example in Nepal and countries in Sub-Saharan Africa, fuelwood accounts for roughly 80 percent of the total energy requirements.

Developed nations use fuelwood to a much lesser extent, although fuelwood contributes to between 12 to 18 percent of total energy needs in Scandinavian and Central and East European countries primarily because of heating practices during cold winters. Still, dependence on fuelwood is most common in developing nations with the FAO estimating in 1998 that 50 percent of the world's fuelwood was consumed in five countries: Brazil, China, India, Indonesia and Nigeria.

Wood as a source of energy varies in its heating potential. Two major factors determining heat potential are wood density and dryness. Density is determined by tree species type. The potential heat content per kilogram is roughly equal between all types of wood so it is the density of that wood which influences its heat producing capacity. Broadly speaking, wood either comes from softwood or hardwood varieties. Softwood tree species include many conifers while hardwood species are typically broadleaf trees. Softwood trees are typically less dense than slower growing hardwood tree species and are therefore less desirable for fuelwood. There are some hardwoods such as Aspen or Poplar with lower density wood and some softwood trees like Western Larch and Yew with higher density fuelwood. Dryness is another important factor influencing the heating potential of fuelwood. Efficient combustion is greatest in wood that is well dried.

There are many benefits and conveniences associated with fuelwood that make it an optimal fuel choice for rural communities worldwide. In many regions, the most obvious benefit is that wood is free and readily available for individuals to collect. A renewable energy source, fuelwood can be managed in ways that replenish tree stocks and maintain a consistent local supply.

This is a claim that other common domestic fuel types such as kerosene, Liquid Petroleum Gasoline (LPG) and coal cannot easily make. Wood fuel is also a desirable form of household energy because it produces smoke that can serve practical purposes. For example, many households use wood smoke to cure meats while other homes with thatched roofing and siding find smoke a useful mechanism for repelling pests and insects.

Despite the many benefits and conveniences of wood, indoor air pollution from cooking and heating remains a serious global health problem. According to reports by Practical Action, the indoor burning of solid fuels kills 1.6 million people each year. The affected population is comprised predominantly of women and children who usually partake in cooking and heating practices. In India alone, the World Health Organization (WHO) concluded in 2002 that exposure to indoor air pollution contributes to 500,000 deaths and 500 million cases of illness among women and children each year. According to the United Nations Development Program, this places India alongside China as one of the two countries in the world to experience the highest levels of indoor air pollution. Indoor air pollution from wood and other biomass fuels has been described as the "Silent Killer" by a number of international NGOs because for many years, little attention was given to the problem by governments around the world. It is argued by some that the main explanations for such low attention is the politically marginal position of the main victims-third world, rural, poor, women.

With a heavy reliance on fuelwood to satisfy household energy needs, many regions of the world have suffered from a perceived "fuelwood crisis." These concerns were legitimized largely by a series of influential reports during the 1970s and early 1980s by the World Bank, United Nations Development Program, and the FAO. These reports explained how fuelwood shortages were a result of heavy deforestation in developing nations. The fuelwood crisis was predicated on the fuelwood gap theory stating simply that tree removal was outpacing tree regeneration resulting in a fuelwood "deficit."

The basic premise of the theory stated that fuelwood collection was the principal driver of rapid tree removal and the fuelwood deficit. A number of subsequent studies revealed the fuelwood crisis to be misdiagnosed and largely overstated. In terms of the so-called fuelwood gap, many of the regional studies failed to include trees outside of forests including trees in villages, along roads and in agricultural areas. These studies also overlooked other forms of biomass which constitute fuelwood such as farm-derived woody biomass. As far as blaming heavy deforestation on fuelwood collection, these studies failed to identify a significant underlying factor—large-scale forest clearing for agricultural purposes.

During this time period, community forests were established to ameliorate the fuelwood crisis. The historically inadequate policies of top-down, state-led forest management programs led to the formation of community forestry programs during the 1970s. "Forests for the People" programs were established to cater specifically to the needs of the energy consumers. These programs included the establishment of woodlots in tree deficient regions and cash crop capabilities for local residents. Ultimately many of these projects failed due to inappropriate, persistent top-down 'expert' management, and corruption at the micro politics scale- including community level exclusionary practices.

Despite the alarmist and sweeping inaccuracy of the fuelwood crisis, today there remains ample evidence of localized fuelwood supply irregularities. For example, fuelwood shortages are increasingly common around urban areas. Commonly referred to as treeless halos, fuelwood shortages occur as urban residents and their wood foraging activities are pushed to settlements along the margins of urban areas. In response to local fuelwood shortages, both supply-side and demand-side measures have been implemented worldwide to ensure sustainable fuelwood resources.

From a supply standpoint, participatory forest management, or joint forest management programs have been established in many countries to provide reliable fuelwood resources to local communities. The basic philosophy guiding these programs is to give joint control over forest stewardship and revenue generating potential to the government and communities. Demand side regulation occurs principally through improved cookstove programs. The goal of these programs is to increase the wood burning efficiency of cookstoves by replacing old, inefficient stoves with new models.

SEE ALSO: Energy; Forests; Underdeveloped ("Third") World.

BIBLIOGRAPHY. B. Agrawal, *Cold Hearths and Barren Slopes: The Woodfuel Crisis in the Third World* (Riverdale Company, 1986); G. Leach and R. Mearns, *Beyond the Woodfuel Crisis: People, Land and Trees in Africa* (Earthscan Publications, 1988); D. Pandey. *Fuelwood Studies in India: Myth and Reality* (Center for International Forestry Research, 2002); World Energy Council, *The Challenge of Rural Energy Poverty in Developing Nations* (1999).

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Workplace Hazards

WORKPLACE HAZARDS ARE the possible causes of physical or mental problems for people working in any particular place. They range from exposure to hazardous chemicals, excessively loud noise, psychological stress, and workplace violence or discrimination. Workplace hazards cause large numbers of deaths and injuries every year. It is estimated that some two million people die from workplace-caused hazards annually, and another 160 million become subject to a disease stemming from their work. Since prevention of accidents and risk generally comes at the initial expense of lowered productivity, employers have a strong disincentive to provide safety systems. Consequently, workers with less power or representation are generally more at risk from workplace hazards. Women, migrants, and temporary workers are some of the groups most likely to be put at risk of workplace hazards.

The nature and severity of workplace hazards varies depending on the type of work, the regulations in force in the geographic area in which the work takes place, the state of new scientific understanding, and the industry concerned. New forms of occupation and working activity, based more on sedentary work with computers, has brought about the risk of repetitive strain injuries, for example. Previously, hazards would be more likely to be working with dangerous machinery or with chemicals or other materials that lead to negative health outcomes. Some industrial activities, such as mining or deep-sea fishing, are inherently dangerous and even more so when proper regulations of activities are not enforced and policed.

In February 2005, 203 miners were killed in an explosion in China, part of the approximately 6,000 people killed in that industry annually, most of whom worked in poorly-regulated private sector mines. In addition to the possibility of accidents and explosions, miners also face the problem of inhaling dangerous substances leading to disease. Exposure to coal dust, for example, can lead to the lung disease pneumoconiosis, which has claimed thousands of lives and destroyed the health of thousands more. The period between exposure and development of the disease can be around 10 years, which means that it has been very difficult to demonstrate causal links and therefore obtain either better safety equipment or compensation. Figures from the United Kingdom reveal that identification of new cases of the disease continues to run at nearly 1,200 per year, despite the closure of much of the country's coal mining industry.

Other forms of hazard include bloodborne pathogens, HIV/AIDS, exposure to toxic animal droppings, and deliberate attack by terrorists. The extent to which people may be protected from these hazards depends on national-level legislation and the ability and will to enforce those laws, together with the willingness of state governments to enforce international-level safety standards, for example those promoted by the International Labor Organization (ILO). As understanding of mental health develops, so too has the understanding of what workplace conditions can cause mental health problems. Forcing this to happen requires lengthy and often difficult attempts to bring civil or criminal actions against employers who may have much more power to withstand such attempts.

Workers, especially those in vulnerable situations, are often unwilling or scarcely capable of participating in such cases. However, when precedents are set, then it is much more possible for subsequent cases to be prosecuted, when employers may prefer to settle out of court rather than fight a losing battle. Since the majority of the world's population either depends on agriculture or else lives and works in poor urban conditions, it is considered important by many that international rights-based organizations focus on those hazards which are broadly applicable rather than focusing too much on those which are more contentious and expensive to implement.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Coal; Disease; Fisheries; Hazards; Mining.

BIBLIOGRAPHY. "Chinese Mine Explosion Kills 203," *BBC News* (February 15, 2005); Health and Safety Executive, "Coalworkers' Pneumoconiosis and Silicosis, Chronic Bronchitis and Emphysema," www.hse.gov.uk (cited July 2006); New York Committee for Occupational Safety and Health, www.nycosh.org (cited July 2006).

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World Bank

THE WORLD BANK is not a single institution but a group of five international finance and regulatory bodies that function to provide financial services and advice to governments around the world. While the bank initially was designed to provide reconstruction loans in the wake of WWII, the primary aims of the group today are economic development, poverty reduction, and the protection of the international investment market.

The motto of the World Bank Group is "a dream of a world without poverty," but historically the goals of the institution were the physical reconstruction of war-devastated countries after World War II. However, by the 1960s these reconstruction efforts were effectively complete and economic development and poverty reduction in poor countries became the primary focus for the Bank's efforts. Today the mission of the Bank is to improve the living standards of people in the developing world through the provision of long-term loans, grants, and technical assistance designed to help developing countries implement their own poverty reduction strategies. World Bank assistance is evident in everything from broad economic planning to infrastructure development, health and education reforms, and environmental projects.

HISTORY AND OPERATIONAL STRUCTURE

The initial institution in the World Bank Group was the International Bank for Reconstruction and Development (IBRD) which, along with the International Monetary Fund (IMF), was created during the United Nations (UN) Monetary and Financial Conference which took place on July 1–22, 1944, at Bretton Woods in New Hampshire. The Bank formally came into existence on December 27, 1944, commenced operations on June 25, 1946, and made its first loan ($250 million to France) on May 9, 1947.

The primary function of the bank was intended to be the reconstruction of the physical infrastructure of the world after the devastation of World War II. However, the presence of several Latin American countries among the 44 representatives of the UN ensured that the bank's mission statement would include language allowing for future economic development. The articles of membership in the IBRD were ratified by 28 countries on December 27, 1945, and since then the membership of the bank has grown to 184 countries. In subsequent years the IBRD was joined by a series of affiliate agencies, the International Finance Corporation (1956), the International Development Association (1960), the International Center for Settlement of Investment Disputes (1966), and the Multilateral Investment Guarantee Agency (1988).

The headquarters of the World Bank Group (WBG) is in Washington, D.C., and the organization maintains field offices in all the countries in which it operates. Each of the five agencies is an independent entity (although they are all part of the UN system) and is owned by the countries that make up its membership. Each country subscribes to the Bank's basic capital share and while some voting rights are equal for all member countries, others are determined by the financial contribution of the member. Consequently, decisions within the WBG tend to be made by developed countries, while loans and grants are made for projects primarily in developing countries. The primary share holders are the United States (16 percent), Japan (8 percent), Germany, France, and the United Kingdom (4.5 percent each). As any decision requires an 85 percent majority, it is possible for the United States to use veto power to control the decisions of the board.

Each agency in the WBG has different membership, the IBRD is the largest (184 members); and the others have between 140 and 175 members. The group is run by a Board of Directors made up of 24 executive directors representing either a single large country or a group of smaller countries.

By tradition, the president of the World Bank is always a U.S. citizen (while the managing director of the IMF is always a European). Presidents serve for five-year renewable terms. Former Secretary of Defense Robert McNamara was one of the longest-serving directors of the World Bank (1968–81) and initiated a major shift in World Bank priorities toward poverty reduction and the support of developing government efforts to regulate and strengthen local markets. The appointment of William Clausen in 1981 shifted the focus once again, toward free market economics and the removal of government protections for developing economies.

Since the 1980s, both the IMF and the World Bank have maintained this focus on opening developing economies to free market forces and many economists contend that this emphasis has increased the rapid and often inappropriate globalization of third world economies and has benefited the governments and industries of the primary world bank shareholders, rather than of the client states. A final shift in World Bank priorities was signaled during the Clinton administration when James Wolfensohn became president and indicated a new emphasis on battling corruption in client state governments.

CURRENT ACTIVITIES AND PROJECTS

In recent years, the World Bank has moved from general economic development and large scale infrastructure projects toward specific poverty reduction efforts and has increased its efforts to support sustainable development, and small local enterprises that are appropriate to the scale of economic activity in the client countries. Examples of recent project approvals include a water supply and sanitation program for low-income communities in Indonesia; an assessment of labor market conditions in Argentina; and a project to rehabilitate the watershed of the Changjiang and Pearl Rivers in China.

After a series of controversial projects in the 1970s and 1980s, the World Bank has set in place a series of Safeguard Policies which require the Bank to assess the environmental, social, economic, and demographic consequences of each project before it can proceed. In addition, there is an independent institution within the bank, the Independent Evaluation Group, which assesses the impacts and effectiveness of projects once they have been completed. The IEG reports directly to the board and is designed to ensure that the World Bank is accountable to its member governments.

CRITICISMS

One reason for the creation of both the Safeguard Policies and the IEG is long-standing criticism of the World Bank from nongovernmental organizations, member governments, and even from within the institution itself. Early criticisms focused on the lack of environmental and social accountability of bank projects, which, in projects like the Indonesian Transmigration Project of the early 1970s, led to major abuses of both the environment and of local populations. The most frequent recent criticisms however, have emphasized the role of the World Bank in opening up client state economies to the global economy, often to the detriment of local business and governments. These Western-centric practices are often part of "structural adjustment" programs that force free-market liberalization on economies that may not be stable or robust enough to sustain external competition. In addition, such programs often force reductions in public services and increases in external control of the economy. In addition, "structural adjustment" is often undertaken to salvage unpayable loans from developed nations, thereby shifting the burden of risk from the lender to the populations of developing countries. Finally the recent shift to combating corruption in recipient countries has led to a charge that the World Bank has abandoned its traditional non-political stance. However, the bank has countered that reducing corruption is an economic rather than a political goal.

Despite theses criticisms, many of which are valid, the ability of the World Bank to provide below-market rate loans to member countries, many of whom do not have access to traditional global capital markets, can be extremely beneficial when the projects are appropriate and carefully monitored.

SEE ALSO: Debt; Globalization; International Monetary Fund; Underdeveloped (Third) World; World Trade Organization.

BIBLIOGRAPHY. Bahram Ghazi, *The IMF, the World Bank Group, and the Question of Human Rights* (Transnational, 2005); Amy L.S. Staples, *The Birth of Development: How the World Bank, Food And Agriculture Organization, and World Health Organization Have Changed the World 1945–1965* (Kent State University Press, 2006).

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World Conservation Union (IUCN)

THE INTERNATIONAL UNION for the Conservation of Nature and Natural Resources (IUCN) was founded in 1948 following an international conference in France (Fontainebleau) under the name International Union for Protection of Nature (IUPN). However, the name was changed to IUCN in 1956. The name was once again changed to World Conservation Union in 1990, but it is still called by its old name and acronym. It is still known as the Union or IUCN. The Union's mission is "to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable."

The World Conservation Union has its headquarter in Gland, Switzerland, and is headed by a director general. The IUCN has offices in 62 different countries with a staff of 1,000. As a result, it brings together 82 states, 111 governmental agencies, more than 800 nongovernmental organizations (NGOs), and some 10,000 scientists and experts from 181 countries in a unique worldwide partnership, making the IUCN the world's most important conservation network. Aside from a director general in Switzerland, there are three directors who look after global operations, global programs, and global strategies, respectively. There are eight regional directors, each responsible for Meso-America, west/central Asia and north Africa, south America, Asia, eastern Africa, Europe, south Africa, and central Africa. The one in the United States has the designation of executive director. Members within a country or region often organize themselves into national and regional committees to facilitate cooperation and help coordinate the work of the Union. Networks of volunteer scientists and experts are principal sources of guidance on conservation knowledge, policy, and technical advice, and implement parts of the Union's work program. They are divided into the following six commissions:

1. Ecosystem Management: The purpose of the Commission on Ecosystems Management is to ensure the sustainable and efficient management of ecosystems, integrating social, economic, and environmental aims at local, national, and transboundary levels. It consists of almost 500 volunteer ecosystem management experts from around the world.
2. Education and Communication: The Commission on Education and Communication is IUCN's knowledge network concerned with ways to involve people in learning and changes toward more sustainable development through biodiversity and natural resources management. It consists of a network of almost 600 volunteers who are experts in learning, education, communication, capacity building, and change management.
3. Environmental, Economic, and Social Policy: The Commission on Environmental, Economic, and Social Policy consists of professionals who are experts in environmental, economic, social, and cultural factors that affect natural resources and biological diversity. The group of experts provides guidance and support toward effective policies and practices in environmental conservation and sustainable development.
4. Environmental Law: The Commission on Environmental Law consists of volunteers who are experts in environmental law and policy from all over the world. It acts as the principal source of legal technical advice to the Union on all aspects of environmental law.
5. Protected Areas: The Commission on Protected Areas consists of almost 1,200 volunteers involved in promoting the establishment and effective management of a worldwide representative network of terrestrial and marine protected areas. It provides strategic advice to policy makers; helps strengthen capacity and investment in protected areas; and gathers the diverse constituency of protected area stakeholders to address challenging issues.
6. Species Survival: The Commission on Species Survival consists of almost 7,000 volunteers who are experts on plants, birds, mammals, fish, amphibians, reptiles, and invertebrates and are interested in the conservation of biodiversity in plants and animals. The commission provides information on biodiversity conservation, the inherent value of species, their role in ecosystem health and functioning, the provision of ecosystem services, and their support to human livelihoods.

The priorities and work of the commissions are set every four years at the World Conservation Congress, where the members of the Union also elect each 32-member council together with a president, treasurer, and three representatives from each of the eight regions of the Union. The council also includes the chairs of the six commissions. The council operates like a board of directors meeting once or twice a year to direct Union policy, approve finances, and decide on strategy. The council may appoint up to six additional councilors. Accountable to the council, the secretariat is led by a director general and has a decentralized structure with regional, outpost, and country offices around the world.

The IUCN has been criticized in recent years for its slowness in coming to understand the relationship of indigenous rights, environmental justice, and political ecology to successfully implementing conservation efforts. Associated with sometimes-draconian conservation efforts (somewhat unfairly), the IUCN has made recent efforts to broaden its investigation into, and support of, participatory and justice-oriented efforts in conservation. By maintaining databases, assessments, guidelines, and case studies on all environmental issues, and providing scientific understanding of what natural ecosystems provide to humans, the IUCN brings together scientists, policy makers, business leaders and NGOs in ways that increasingly acknowledge the complex social and economic issues that surround conservation problems. The Union is actively engaged in managing and restoring ecosystems, but also is increasingly geared toward improving human lives, economies, and societies where the interests of conservation coincide with the interests of protecting human resources and the rights of local people.

SEE ALSO: Conservation; Environmental Organizations; Extinction of Species; Sustainability.

BIBLIOGRAPHY. P.R. Gil et al., *The Red Book: The Extinction Crisis Face to Face* (Agrupacion Sierra Madre, 2001); Kenton R. Miller and W.V. Reid, *Conserving the World's Biological Diversity* (World Bank, 1990); World Conservation Union, www.iucn.org (cited November 2006).

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World Health Organization (WHO)

THE WORLD HEALTH Organization (WHO), established in 1948 and with headquarters in Geneva, Switzerland, is the United Nations (UN) specialized agency for health. The organization is perhaps best known for its work to prevent and control epidemics like polio, tuberculosis, malaria, and other diseases. Its constitutional objective is the attainment, for all peoples of the world, of the highest possible level of health. The WHO does not supply health services directly, but rather provides research, advice, training, and funding to assist mainly developing countries to promote health and fight disease.

In terms of structure and processes, the WHO member states appoint delegations to the WHO's supreme decision-making body, the World Health Assembly. This meets once a year, and as well as appointing the director general, supervises the financial policies of the organization and reviews and approves the proposed global budget. The assembly elects 32 members for three-year terms to an executive board. The main functions of the board are to give effect to the decisions and policies of the assembly, to advise it, and generally to facilitate its work. The day-to-day groundwork of WHO is carried out by its secretariat, which is staffed by many thousands of health experts and support staff working in the Geneva headquarters and in the six regional offices.

The WHO member states are grouped into six regions: Africa, the Americas, southeast Asia, Europe and the western Pacific. Each of the six regional offices have a degree of independence. Each is headed by a regional director, while a regional committee for each region sets guidelines for the implementation of all the Health and other policies adopted by the World Health Assembly. The WHO also operates more than 100 country and liaison offices. Each country office includes several health and other experts, as well as various administration staff. The primary functions of WHO country offices include providing leadership and coordination for disaster efforts and being the primary advisor to that country's government in international health issues.

In addition to coordinating international efforts to monitor outbreaks of infectious disease, the WHO organizes specific and focused programs to combat diseases, such as developing and distributing vaccines. Some have been very successful. In 1979, the WHO was able to declare that, due to its activities, smallpox had been eradicated from the world. This was the first disease in history to be completely eliminated by deliberate human design.

Despite the expertise of its public health professionals, however, the WHO has had the unfortunate reputation of being among the UN's worst-run institutions. Its medical and financial policies, notably in relation to HIV/AIDS, have been criticized.

In response, WHO has attempted to make its corporate structure more responsive and flexible. It has also revised its health strategy, adopting an expanded and more-inclusive approach to health within the context of human development, humanitarian activities, gender equality, and human rights. In the context of the UN Millennium Goals, it has placed a renewed emphasis on the relationships between poverty reduction and health. The WHO failed, however, to meet its "3 by 5" target—a plan to put 3 million AIDS sufferers on antiretroviral treatment by the end of 2005. Progress in meeting its targets within the UN Millennium Goals—notably child mortality and maternal health—have been problematic, mostly in sub-Saharan Africa where public health systems are severely under-resourced or nonexistent.

The WHO publishes statistics and holds comprehensive databases on population health. It also publishes the International Classification of Diseases, which clarifies and universalizes the understanding of disease globally. With regard to research, as well as working with academic collaborating centers based in universities, it both funds and promotes research studies. Meanwhile, it connects with the public through good will ambassadors, the provision of international health information and advice, and events such as World Health Day. As pandemics continue to sweep the developing world and noncommunicable diseases continue to affect the global population, the critical significance of the WHO's original mission continues to be matched by the challenges it faces.

SEE ALSO: Disease; Health; Smallpox; United Nations.

BIBLIOGRAPHY. Gian Luca Burci and Claude-Henri Vignes, *World Health Organization* (Kluwer Law, 2004); M.D. Siddiqi Javed, *World Health and World Politics: The World Health Organization and the UN System* (University of South Carolina Press, 1995).

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World Heritage Sites

AN INTERNATIONAL MOVEMENT for the protection of heritage emerged after World War II, following the decision to build the Aswan High Dam in Egypt. The dam would have flooded the valley containing the ancient Abu Simbel temples. To prevent this, the United Nations Educational, Scientific and Cultural Organization (UNESCO) launched a campaign in 1959 resulting in the successful relocation of the temples. A draft convention on the protection of cultural heritage was subsequently initiated by UNESCO in collaboration with the International Council on Monuments and Sites (ICOMOS). In 1965, a conference at the White House in Washington, D.C., for the first time proposed the linking of cultural and natural heritage, calling for a "World Heritage Trust" that would stimulate international cooperation to protect "the world's superb natural and scenic areas and historic sites for the present and the future of the entire world citizenry." In 1972, a similar proposal from the International Union for Conservation of Nature and Natural Resources (IUCN), also known as The World Conservation Union, was presented to the United Nations (UN) Conference on Human Environment in Stockholm.

Also known as the Convention Concerning the Protection of the World Cultural and Natural Heritage, the World Heritage Convention was adopted by the General Conference of UNESCO in 1972. It came into force on December 17, 1975, as one of the first international conservation conventions and took effect as the World Heritage List. Countries that accept and adhere to the Convention are called State Parties. In all, 181 countries have ratified the Convention or are at various stages of ratification. The Convention is implemented by the World Heritage Committee, which meets once a year and consists of representatives from 21 of the States Parties elected for terms up to six years. The Committee guides the use of the World Heritage Fund and makes the final decision on the inscription of properties in the list. In 2006, the list had 812 properties of cultural and natural heritage, which the World Heritage Committee considers to be of "outstanding universal value." These include 628 cultural, 160 natural, and 24 mixed properties in 137 State Parties. Mixed properties have both cultural and natural attributes, e.g., the Laponian Area in Sweden. The Great Wall in China, Angkor in Cambodia, and the Acropolis in Greece are examples of cultural properties.

The Roman ruins of Volubilis in Morocco are one of many World Heritage Sites on the African continent.

Proposals for the inclusion of properties in the list can only be submitted by signatories to the Convention. In the nomination process, the first step a country takes is to prepare an inventory of important natural and cultural sites, known as the Tentative List. The State Party then selects sites from the Tentative List, collects exhaustive documentation and maps on the sites and prepares a nomination file. The file is evaluated by two Advisory Bodies mandated by the Convention, i.e., ICOMOS and IUCN, the latter providing evaluations of the nominated natural sites. Following nomination and evaluation, the Committee meets once a year and decides which sites are inscribed. Properties listed are considered to be the "common heritage of mankind" and are thus of universal interest and paramount value, the protection of which is the responsibility of all humanity. The Convention calls for such sites to possess "outstanding universal value." A site must also fulfill requirements collectively termed the "conditions of integrity" listed in the Committee's operational guidelines, essentially specifying the long-term conditions a site must meet. To be listed as a natural area, proposed sites must be globally significant and be ecologically viable and protected. Additional criteria that determine a natural site's importance include: Distinctiveness, integrity, naturalness, dependency, and diversity. In the case of cultural sites, significance is determined according to a different set of criteria.

Unfortunately, in times of conflict or war, or due to lack of proper oversight, the basis of the criteria for a site's inscription becomes threatened. Such sites may then be inscribed on the World Heritage in Danger List. As of 2006, 34 properties were in danger from among the 812 properties on the List. These 34 properties include 15 protected areas, e.g., Everglades National Park in the United States; Manas Wildlife Sanctuary in India; and four national parks in the Democratic Republic of the Congo.

In 1994, over two decades after the historic adoption of the Convention, it became apparent that the composition of the list was skewed. There were only 90 natural properties and 304 cultural properties. To rectify this imbalance and to overhaul the framework and methods for defining "World Heritage" and implementing the Convention, the Committee launched the Global Strategy for a Balanced, Representative and Credible World Heritage List. Countries were encouraged to become State Parties in order to ensure geographical representation. Emphasis was placed on nominating and inscribing sites showing coexistence of humans with land, among other attributes. The Committee, at its 28th Session in 2004, reviewed IUCN's assessment that a relatively balanced distribution of regions and wildlife habitats had been achieved. Major gaps remained, however, in the representation of tropical/temperate grasslands, savannas, lakes, tundra and polar systems, and cold winter deserts.

In 2004, IUCN's Review of the World Heritage Network (Review) described the natural and mixed World Heritage Sites as "jewels in the crown" of the world's protected area network. It also laid out the most useful classification and prioritization schemes for revising the Tentative Lists of the State Parties. The schemes are IUCN/Species Survival Commission's habitat analysis, the Udvardy Biogeographic System, WWF Global 200 Ecoregions, and Conservational International's Biodiversity Hotspots. In this Review, the Udvardy biome criteria highlighted cold winter deserts, and tundra and polar systems. The WWF Global 220 Ecoregions approach identified terrestrial ecoregions, e.g., Arctic tundra and western Ghats, and marine ecoregions, e.g., the Andaman Islands and Tahiti. The IUCN/SSC analysis identified many potential sites around the world, including several grasslands and savanna sites in Africa; subtropical and tropical montane moist forests in India; montane rain forests in New Caledonia and Polynesia (Oceania/Australasia region); the Central Mexican desert areas; desert and coastal areas of Chile and Peru in South America; and the coastal saline wetlands of Europe.

According to the Review, the continent of Africa had the highest number of natural World Heritage Sites (33), followed by Asia (31) and South America (28); Oceania/Australasia, however, had the highest density of World Heritage Sites, approximately one site per 440,000 square kilometers. Of the 126 natural and mixed World Heritage Sites in 2004, 73 had no resident human population, e.g., Kaziranga and Manas in India. Given the widespread presence and dependence of humans on their immediate environment, however, many World Heritage Sites do not preclude human use and are not strict nature reserves, allowing a range of extractive activities. The 2003 World Parks Congress in Durban clearly recognized the interconnectedness of parks and the people living nearby. Among the largest World Heritage Sites with resident human populations are Lake Baikal (88,000 square kilometers) in the Russian Federation, Manu (15,328 square kilometers) in Peru, and the Canadian Rocky Mountain Parks (23,068 square kilometers) in the Provinces of British Columbia and Alberta.

SEE ALSO: Conservation; National Parks; Protected Areas.

BIBLIOGRAPHY. International Union for Conservation of Nature, *Benefits Beyond Boundaries* (IUCN, Gland Switzerland and Cambridge, UK, 2005); Chris Magin and Stuart Chape, *Review of the World Heritage Network. Biogeography, Habitats and Biodiversity* (UNEP World Conservation Monitoring Centre and IUCN, 2004); Jeffrey Sayer, Natarajan Ishwaran, James Thorsell, and Todd Sigaty, "Tropical Forest Biodiversity and the World Heritage Convention," *Ambio: A Journal of the Human Environment* (v.29, 2000); Rahul J. Shrivastava, *Natural Resource Use and Park-People Relations at Kaziranga National Park and World Heritage Site, India* (Florida International University, 2002); Jim Thorsell and Todd Sigaty, *Human Use of World Heritage Natural Sites: A Global Overview* (IUCN: Natural Heritage Program, 1998); United Nations Educational, Scientific and Cultural Organization, "About World Heritage," whc.unesco.org (cited April 2006); Graeme L. Worboys, Michael Lockwood, and Terry D. Lacy, *Protected Area Management: Principles and Practice* (Oxford University Press, 2005).

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World Systems Theory (WST)

WORLD SYSTEMS THEORY (WST) provides a holistic perspective to understand human interaction within a global political economic framework. Though largely heralded by academics in the global South, over the years WST has come under scathing critique by Western social scientists declaring that it is inherently deterministic and overly simplifies human interactions. The theory argues that since the early 19th century, all of humankind has been encompassed within one world system—the capitalist world-economy.

WST espouses that human activities can only be examined within this global system, and that parceled examinations of human political economic and social activity at more focused scales are inherently flawed, because they fail to recognize human processes within their broader context. Thus, WST completely dispels the central role that states, nations, and territorially based political entities (e.g., empires) broadly maintain in the social sciences. The importance of understanding and explaining processes within the capitalist world-system can only be done at the global scale—states, nations, classes, and races are merely the social constructs of systemic, capitalist processes. Different systems come and go, but they are always a product of history. Three different systems have existed—mini-systems, world empires, and the capitalist world system (the latter so called because it is the first system to encompass the entire world's population).

ORIGINS AND DEVELOPMENT

WST originated with, and is still largely associated with, the sociologist Immanuel Wallerstein, who published his seminal work in 1974—*The Modern World System: Capitalist Agriculture and the Origins on the European World-Economy in the Sixteenth Century*. Wallerstein was not the first to argue that state-centric analysis was shortsighted and failed to envelop the true extent of human interaction, but he pioneered synergizing of two disparate, yet intricately congruent, theoretical views of world politics. First, he borrowed heavily from the Annales School of history in France—in particular from the work of Fernand Braudel. Historians of this school were dismayed with 20th-century historians' fetish on the particular details of intra- and interstate political processes and diplomacy. They argued that a holistic approach analyzing political figures within the history of ordinary people was necessary for historical analysis and would be far more useful than case-specific analyses of important events throughout history. The Annales School argued that history operated through *longue durée*—long periods of materialist and economic production that survived regardless of political crises and change.

The second theoretical background interwoven within WST is Marxist theory. In essence, WST is a revision of Marxism itself, attempting to move beyond Marxism's fixation on state economies and its unconvincing portrayal of nationalism in comparison to class. Wallerstein borrows heavily from neo-Marxist critiques of development theories in modern social science. Development theories are state-centric theories that argue states can and do develop linearly. In development theories, all states are provided equal footing, but some states are "behind," "backward," or need to "catch up."

WST arose largely out of Wallerstein's contempt for modernization and development theories that espouse that economic processes operate the same way in all places. WST's counter is that for every state's or region's development, another state or region experiences "underdevelopment." Thus, WST's main critique of such theories is that they are inherently deterministic and fail to take into consideration the context of the greater global economy.

The essence of WST is that since 1800 human interaction—political, economic, and social—has occurred within a global economy—the capitalist system. States are not the containers of human politics, and they are anything but equal. State interactions, as well as the interactions of numerous other political institutions occurring across a variety of geographic scales (i.e., the household, gender, class, race, nation, religion, and transnational institutions such as the United Nations), are all processes occurring within the capitalist world economy. The economy is the structure—everything else is ephemeral.

Among these institutions exist relationships between institutions of the "core" and "periphery." Institutions belonging to the "core" produce high-value goods that can be traded for surplus to "peripheral" institutions producing cheaper, low value goods. This setup creates an inherently unequal system of trade, enlightening what Wallerstein sees as faults in modernization theory. The concept of core and periphery was not originally Wallerstein's, but to these two classes Wallerstein adds the concept of the "semi-periphery." Unlike other social theorists at the time, who largely argued that states and institutions were not mobile between core and periphery, Wallerstein argues that states can move between these positions, albeit rarely. Moreover, he argues that many states belong to the semi-periphery—they are exploited by core states but are often exploiters of peripheral states in the world economy.

Traditionally, most World Systems studies have utilized a quantitative approach. Wallerstein incorporated economic cycles into his theory and often used quantitative analysis of production, trade, and financial statistics to solidify his theory. However, in recent years, WST has increasingly incorporated qualitative analysis—particularly in the disciplines of geography and history.

WST AND THE ENVIRONMENT

WST has increasingly been used to analyze environmental issues by a variety of scientists across numerous disciplines. Arguing that capitalist processes have fended off the major 20th-century resistance to the capitalist system (i.e., global communism), several theorists are now hypothesizing that the capitalist system may be precipitating its own systemic decline through the ecological ruin resulting from its excesses. For example, World Systems theorists Andrew Jorgenson and Edward L. Kick argue that what is "lacking in the environmental literature … is a mature long-term historical approach" that only WST can provide.

WST, with its emphasis on core-periphery relationships, has been increasingly used to help explain the roots of environmental degradation. Increasingly, carbon emissions, fossil fuel efficiency, pollution control, and corporate production have been quantitatively analyzed within the capitalist world system context to help understand why peripheral states have continually seen an increase in environmental degradation. World Systems theorists argue that much environmentalist literature fails to see the whole picture—that is, environmental pollution is an outcome of the perpetual quest for more profit in the capitalist world-system, and that pollution affects peripheral states more than the core states due to their poor position within the capitalist economy.

WST rejects the widely accepted notion that "globalization" is characterized by distinct, interacting networks (e.g., political, economic, social, and cultural globalizations) that should be studied individually as additive pieces of a global process. Though the analysis of networks may be useful to distinguish between different types of globalization to better assess different impacts on the environment, WST researchers argue that any such case analysis must be brought back into the broader context of the world system.

As pertains to political and sociological theory, WST has largely passed its peak in academic reverence. Though still used by political geographers, sociologists, and historians, it has been harshly criticized by numerous academics of good repute. In recent decades, Wallerstein has increasingly moved away from analysis of the world-system to focus on philosophies of social science. However, the theory is increasingly being integrated and used as a lens for the analysis of environmental justice, particularly at the global scale. Articles dealing with the environment and capitalism regularly appear in the *Journal of World-Systems Research* and *Review*—the two flagship journals of world-systems research. Edited books using WST to analyze climate and greenhouse gases are a common occurrence as well.

SEE ALSO: Braudel, Fernand; Capitalism; Globalization; Justice; Markets; Marx, Karl.

BIBLIOGRAPHY. Giovanni Arrighi, *The Long Twentieth Century* (Verso, 1994); David Harvey, "The World Systems Theory Trap," *Studies in Comparative International Development* (v.22/1, 1987); Andrew Jorgenson and Edward L. Kick, "Globalization and the Environment," *Journal of World-Systems Research* (v.9/2, 2003); Theda Skocpol, "Wallerstein's World Capitalist System: A Theoretical and Historical Critique," *American Journal of Sociology* (v.82/5, 2003); Peter J. Taylor and Colin Flint, *Political Geography: World-Economy, Nation-State, and Locality*, 4th ed. (Prentice Hall, 2000); Immanuel Wallerstein, *The Modern World System: Capitalist Agriculture and the Origins of the European World-Economy in the Sixteenth Century* (Academic Press, 1974); Immanuel Wallerstein, "The Rise and Future Demise of the Capitalist World System: Concepts for Comparative Analysis," *Comparative Studies in Society and History* (v.16, 1974); Immanuel Wallerstein, *Unthinking Social Science* (Polity Press, 1991).

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World Trade Court

THE WORLD TRADE Court is an appellate court of the World Trade Organization (WTO). However, the term is not accurate, because the World Trade Court is more like an arbitration body than a typical criminal or civil court. Also, the term *World Trade Court* has not yet come into common currency. There has been resistance in some quarters to using the term because it implies a move toward permanent institutionalization and because it cannot issue decisions that are enforceable legal opinions like those in domestic legal systems. The appellate body of the WTO was created to serve as a world trade court in order to aid the WTO in fulfilling its mission—to help producers of goods and services, traders, exporters, and importers conduct their business. This means that its goal is to ensure just and equitable settlement to all disagreements on trade issues. The work of the appellate body is focused on facilitating the flow of trade between nations. Its major responsibility is to administer WTO trade agreements.

The WTO is headquartered in Geneva, Switzerland. It was created during the Uruguay Round (1986–94) of negotiations on global trade. It began operations on January 1, 1995. As of December 11, 2005, it had a membership of 149 countries. The WTO is the only global organization that applies the rules of trade between nations. It does this on the basis of WTO agreements that have been negotiated and signed as accepted agreements between the major trading nations of the world. The WTO's agreements have all been ratified by its member nations.

The WTO provides a forum for conducting trade negotiations. It handles trade disputes and monitors national trade policies. It also provides technical assistance and training for people from developing countries. Finally, it cooperates with other international organizations. In April of 1994 at Marrakech, Morocco, the Marrakech Agreement (often referred to as the WTO's founding charter) was signed establishing the WTO. The agreement created a mechanism for resolving international trade disputes.

A Dispute Settlement Body (DBS) composed of representatives from all member governments was created. The DBS administers the Understanding on Rules and Procedures Governing Settlement of Disputes (DSU). If a member state believes that another state is engaging in unfair trade practices, then it can bring the dispute to the DBS. A dispute settlement panel composed of three persons who are trade officials will hear a dispute. They meet in secret to avoid political pressures, and their decisions are binding. A state that chooses can appeal a ruling of a panel to the World Trade Court. If a member state appeals to the World Trade Court, then it must do so on the basis of points of law and not on the basis of new evidence or over a dispute about findings of the dispute settlement panel.

The World Trade Court was established by Article 17 of the DSU. It is a permanent body composed of seven persons. They hear appeals from reports issued by the dispute settlement panels. The appellate body can, after reviewing the case, confirm the decision of the original dispute settlement panel, modify its report, or even reverse it. After the appellate body has issued its decision it will be reviewed by the dispute settlement body. The DSB has to accept or reject the appellate body's decision, which will then be binding upon all parties to the case. While binding upon the parties to the case, the WTO does not have an enforcement mechanism. Compliance is voluntary or and requires moral or political persuasion by the parties concerned or by the international community. The appellate body is a standing body also of seven persons and has a permanent seat in Geneva, Switzerland. Members serve four-year terms. The members are chosen for their recognized expertise in law and international trade. They may not be official members in service of any government.

The challenges of free trade for environmental regulation are myriad and many cases heard by the World Trade Court pertain to ecological problems associated with the production of certain traded commodities. In a landmark case, the U.S. federal regulation against the import of shrimp from countries where they are caught with nets that endangered sea turtle populations came under scrutiny. Viewed as an unfair trade restriction by other nations (including India, Malaysia, Pakistan and Thailand), a case was brought before the WTC. In May 1998, the court ruled that the U.S. restrictions represented an embargo that violated free trade agreements. In the aftermath of the decision, U.S. policy was altered so that shrimp imports were handled on shipment-by-shipment basis, rather than a nation-by-nation basis. The compromise, and its implications for national sovereignty in environmental issues, is still being considered by the international business and environmental communities.

Thus, while environmental concerns were important parts of the WTO in its preamble—citing environmental protection, conservation of scarce resources, and sustainable development as WTO goals—the role of the court in adjudicating environmental disputes as trade disputes is somewhat awkward. The DSB has addressed hundreds of cases since 1995. The appellate body has also heard several hundred cases. Among those involving controversial ecological issues was a dispute between the United States and the European Union. The European Union had adopted a number of laws banning genetically modified foods. In 2003, the United States had disputed the laws with a challenge before the WTO. The appellate body's decision in 2006 was complicated. It agreed with the United States that the banning of American genetically modified food was discriminatory. It also dismissed a number of the United States's complaints. Nationalist groups and ecological groups like Green Peace attacked the appellate body's ruling and threatened civil disobedience.

Pesticides used on foods sent into the international market have been inspected with increasing care for food safety. Health-threatening agents such as pesticides, animal and plant diseases, bacterial contaminants, or invasive pests are treated under the SPS Agreement. The SPS agreement puts limits on the food safety policies of member-states in an attempt to prevent them from gaining a competitive edge under the guise of protecting public health. The future of the WTO with regards to environmental policy, therefore, remains important however unclear.

SEE ALSO: Genetically Modified Organisms (GMOs); Trade, Fair; Trade, Free; World Trade Organization.

BIBLIOGRAPHY. Thomas Cottier and Petros C. Mavroidis, eds., *The Role of the Judge in International Trade Regulation: Experience and Lessons for the WTO* (The University of Michigan Press, 2003); Claus-Dieter Ehlermann, "Six Years on the Bench of the 'World Trade Court': Some Personal Experiences as Member of the Appellate Body of the World Trade Organization," *Journal of World Trade* (v.36/4, 2002); Peter Van den Boosche, "From Afterthought to Centerpiece: The WTO Appellate Body and its Rise to Prominence in the World Trading System" (Working Papers, University of Maastricht, Faculty of Law, 2005).

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World Trade Organization (WTO)

THE WORLD TRADE Organization (WTO) is an international body responsible for the negotiation, implementation, and enforcement of trade rules. Established in 1995, it presides over a multilateral trading system of which the core international treaty is the General Agreement on Tariffs and Trade (GATT), as legally consolidated in 1994. GATT obligations are informed by a political and ideological commitment to free trade: At the heart of the GATT treaty are the so-called nondiscrimination principles of most-favored-nation status (Article 1) and national treatment (Article 3). Their combined effect is legally to prescribe equality of treatment for imports and exports, such that WTO contracting states subscribe to open, predictable rules of trade.

There are 149 members in the WTO, accounting for over 97 percent of world trade. Meeting at least once every two years, the Ministerial Conference is the governing body of the WTO: conferences have taken place in Singapore (1996), Geneva (1998), Seattle (1999), Doha (2001), Cancun (2003), and Hong Kong (2005). Between ministerial sessions, the WTO General Council—located in Geneva, Switzerland—undertakes key executive functions, including meeting as the organization's Trade Policy Review Body and Dispute Settlement Body. Reporting to the General Council is a council triumvirate addressing goods, services, and intellectual property. There are also numerous specialist committees and working groups dealing individual agreements and thematic areas. One of these is the Committee on Trade and Environment (CTE), which serves as a forum for member states to examine the relationship between trade and environmental protection, with a view to determining whether changes are required in trade rules to enhance their positive interaction. As with all WTO bodies, decision making within the CTE is consensus-based.

The protection and preservation of the environment is embraced as an objective in the Marrakesh Agreement Establishing the World Trade Organization. However, its most important manifestation in international trade rules is still the "general exceptions" clause of GATT first articulated in 1947: under Article 20, trade-restrictive measures may be undertaken for reasons including the protection of human, animal, or plant health and the conservation of exhaustible natural resources. Similar environmental exceptions are also found in specialist WTO agreements, such as those on food safety and product standards. Not until a 2000 ruling on asbestos products did the WTO Dispute Settlement Body uphold a trade restriction under Article 20 on environment-related grounds. A more significant precedent was set in 2001 when, in its ruling on a U.S. ban of Asian shrimp imports, the Dispute Settlement Body stated that there were circumstances in which WTO members could employ trade restrictive measures under Article 20 in order to prevent serious environmental harm outside their national jurisdiction.

Under the Doha Development Agenda of trade negotiations, launched at the 2001 WTO Ministerial Conference, the CTE was charged with clarifying the relationship between WTO rules and international environmental agreements containing trade measures. There remain legal uncertainties over the rule compatibilities between WTO law and specific trade obligations in international environmental agreements, including those within the 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, the 2000 Cartagena Protocol on Biosafety, and the 2001 Stockholm Convention of Persistent Organic Pollutants. While there has not yet been a conflict, the CTE has struggled to improve coordination in this area. It has been suggested by some academic commentators that the robustness of international environmental agreements with specific trade obligations would be strengthened by an amendment to GATT exempting them from WTO rules.

Many environmentalists have campaigned against the WTO, claiming that it is not addressing the harmful ecological effects of its rule making and enforcement. Along with other sections of the global justice movement, they have also leveled the charge that the WTO is undemocratic, with closed negotiations and judicial deliberations dominated by the most powerful states. This is a criticism strongly resisted by the organization, which argues that all its decisions are reached by consensus and ratified in the parliaments of member states. In recent years there have been moves to increase transparency within the WTO, such as improved access to information and meetings with transnational nongovernmental organizations (NGOs). However, member states have resisted proposals to grant transnational NGOs access—as observers—to negotiating forums and dispute settlement hearings. The WTO maintains that the national political processes of member states are the appropriate arenas for NGOs to communicate trade-related environmental concerns, not its own intergovernmental decision making.

There are deep divisions within the WTO over the incorporation of environmental concerns into its negotiations and rulings. Developing countries now constitute two-thirds of the membership of the organization and are generally unsympathetic to the concerns of environmental NGOs, who are perceived as advancing global Northern interests. Indeed, the existence of an environmental protection agenda in the WTO rests on the lobbying of European member states, and developing countries remain fearful of a discriminatory "green protectionism" excluding their exports from European and North American markets. The slow progress of CTE negotiations reflects these divergent positions, as well as the increasing political clout of member states from the global South. Only systemic revisions in trade rule making and interpretation will ensure a more effective consideration of environmental protection issues. Yet, unless environmental protection is linked more directly to the development priorities of developing countries, the scope for advancing these reforms in the WTO will be narrow.

SEE ALSO: Developed (First) World; General Agreement on Tariffs and Trade; Globalization; Justice; Montreal Protocol; Nongovernmental Organizations; Trade, Fair; Trade, Free; Underdeveloped (Third) World.

BIBLIOGRAPHY. Robyn Eckersley, "The Big Chill: The WTO and Multilateral Environmental Agreements," *Global Environmental Politics* (v.4/2, 2004); Michael Mason, *The New Accountability: Environmental Responsibility across Borders* (Earthscan, 2005); Eric Neumayer, "The WTO and the Environment: Its Past Record Is Better Than Critics Believe, but the Future Outlook Is Bleak," *Global Environmental Politics* (v.4/3, 2004); World Trade Organization, www.wto.org (cited April 2006).

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Worldwatch Institute

THE WORLDWATCH INSTITUTE is a nonprofit independent research organization focusing on environmental and social policy. Lester Brown founded the Worldwatch Institute in 1974 with a grant from the Rockefeller Brothers Fund and funding from the United Nations Environment Programme (UNEP). Christopher Flavin has been president since 2001, and Oystein Dahle is chair of the board of directors. Worldwatch Institute has an annual budget of approximately $4 million. Major support comes from foundation grants, the sale of publications, and individual donations. The institute has around 28 full- and part-time staff. An academic advisory panel advises Worldwatch on how it can serve professors and students.

One guiding vision of the institute is to find ways to meet the needs of people without endangering the natural environment or the welfare of future generations. An institute hallmark is to use fact-based and accessible analysis to address key global issues with environmental and development consequences and inform individuals and public officials worldwide about the underlying causes of complex and interconnected problems; the focus is on practical solutions to guide citizens and policy makers.

Four main research areas of the institute are: people, nature, energy, and economy. The institute addresses these areas through a wide range of perspectives (ecology, public health, political science, and economics) to address problems from an interdisciplinary perspective. Unlike related organizations, the Worldwatch Institute has continued to serve as a research institute rather than an interest group.

This agenda follows directly from the long-term leadership of Brown. Brown, a former staffer at the U.S. Department of Agriculture and developer of the Overseas Development Council, has long seen his role as a "synthesizer" of insights drawn from academic disciplines for solving the world's food, population, and economic problems. Early driving forces at the Institute included Eric Eckholm, Jim Fallows, Orville Freeman, and Denis Hayes (coordinator of Earth Day). The institute's founding was part of the third wave of growth in the American public policy research sector.

The Worldwatch Institute disseminates its analysis and viewpoints through three primary and high profile annual publications: *State of the World*, *Vital Signs,* and *World Watch,* a bimonthly magazine, along with other papers and books. *State of the World* was first published in 1984, and has since been translated into over 25 languages worldwide. It is widely read by policy analysts, legislators, world leaders, students, and citizens. Its central purpose is to provide accessible summaries of issues related to the global environment; in recent years each issue has focused on specific topics such as "Redefining Global Security," "The Consumer Society," and "China and India." *Vital Signs* was first published in 1992 and provides analysis of key global trends using graphs and charts to offer visual references; recent topics include energy and climate, resource economics, agricultural resources, and transportation.

World Watch started in 1988. One recent addition to the *World Watch* portfolio of information sources includes Eye on Earth, a new endeavor in partnership with Blue Moon Fund to provide the institute's perspective on current events and global trends. All Worldwatch Institute publications use environmentally sound paper supplies, and the organization pursues other measures to promote sustainability in the office environment.

Central to the current Worldwatch Institute agenda is the analysis of the relationships between environmental degradation, disasters, conflict, and peacemaking. China Watch is a joint initiative of Worldwatch Institute and Beijing-based Global Environmental Initiative (GEI) that reports on agriculture, energy, health, population, water, and the environment. The institute also supports Worldwatch University (for students and teachers), *Environmental Milestones*, a library, online discussions, and a network of global partners.

Critics have charged that though the Worldwatch Institute addresses a vast range of important environmental topics, it remains largely neo-Malthusian in outlook, consistently holding population as the most important driving problem in global ecological degradation, rather than affluence, under-regulation, market failure, capital accumulation, or other global forces. Nevertheless, the institute is powerful in Washington debates because it defines, creates, and enforces the meaning of "truth" on these core developmental problems. It is an agenda-setter.

SEE ALSO: Nongovernmental Organizations; Policy, Environmental; United Nations Environment Programme.

BIBLIOGRAPHY. C.H., "Briefing," *Science* (v.187/4181, 1975); Timothy W. Luke, "On Environmentality: Geo-Power and Eco-Knowledge in the Discourses of Contemporary Environmentalism," *Cultural Critique* (v.31, 1995); James G. McGann, "Academics to Ideologues: A Brief History of the Public Policy Research Industry," *PS: Political Science and Politics* (v. 25/4, 1992); Public Broadcasting Service, NOVA, "Voices of Concern: Lester Brown," (2003), www.pbs.org (cited January 2007).

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World Wildlife Fund

THE WORLD WILDLIFE Fund is a global conservation network with offices in more than one hundred countries around the world. Scientists, such as Sir Julian Huxley, and political leaders, such as the Duke of Edinburgh, started WWF in Switzerland in 1961. The organization's initial goal was to raise money for conservation. WWF developed slowly for the first two decades. Then, in the 1980s, it grew to become the world's largest private international conservation organization. While many offices were initially started in industrialized states, branches are now located in places such as Bhutan, Malaysia, Pakistan, and Central America. The organization's environment work is not just focused on policy change; WWF runs more than 1,000 field projects annually around the globe.

WWF has identified 200 ecoregions deemed the most critical for conservation, called the Global 200. WWF is an example of international environmental cooperation, but there have been instances of internal conflict within the network. As a result, in 1986, WWF-International changed its name to the World Wide Fund for Nature. The U.S. and Canadian branches continued with the original name. However, all branches continue to use the acronym WWF and the panda symbol, which can contribute to confusion over which branch is behind specific activities. Although many environmental priorities are shared by the larger network there are strategic differences among the offices.

WWF's transnational network involves many important partnerships. WWF and the World Conservation Union cooperate on several campaigns, including efforts to improve co-management with indigenous and traditional peoples in protected areas. Both groups also support an organization called TRAFFIC (Trade Record Analysis of Flora and Fauna in Commerce) that monitors illegal wildlife trade.

Since 1998 the WWF has shared a forest campaign with the World Bank. The Alliance for Forest Conservation and Sustainable Use employs a market-oriented approach that focuses on the promotion of internationally certified sustainable forest extraction. Both groups also seek to remove perverse incentives leading to ecological degradation that frequently exist in policies, institutions, and markets. They highlight poverty reduction as a major environmental concern. They propose solutions based on positive incentives, created through market mechanisms, to support conservation, and finance sustainable local resource extraction. Following this paradigm, WWF has shifted from a nearly exclusive focus on protected areas to eco-friendly production.

WWF's conservation approaches are popular with bilateral and multilateral aid agencies and the private sector. While two decades ago private foundations and individuals provided the majority of funding for WWF, a growing portion of funds currently originate from private firms.

A major focus area for the World Wildlife Fund is sustainable forest management. In the 1980s WWF was a major advocate of Integrated Conservation with Development Programs, which aimed to better involve local populations in protected area initiatives. WWF helped to initiate the Forest Stewardship Council in the early 1990s and has been a key player in the transition from conventional to certified forestry. One of the greatest challenges for forest certification is strengthening consumer demand, so the WWF started the Global Forest Trade Network (GFTN). GFTN is an independent network, made up of more than 500 companies, including some of the biggest lumber suppliers, forest owners, furniture makers, architects, construction companies, retailers, and investors. Campaigns such as this fit with WWF's focus on sustainable consumption, an strategy that has received criticism from environmental groups that promote less market-oriented approaches to conservation and development.

SEE ALSO: Forests; Sustainable Development; Wilderness; Wildlife.

BIBLIOGRAPHY. Mac Chapin, "A Challenge to Conservationists," *World Watch* (November/December 2004); Fred Pearce, "A Greyer Shade of Green," *New Scientist* (June 21, 2003); Paul Wapner, "World Wildlife Fund and Political Localism," *Environmental Activism and World Civic Politics* (1996, State University of New York Press); WWF Global Network, www.wwf.org (cited March 2006).

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Worster, Donald

DONALD E. WORSTER is a professor of U.S. History and Environmentalism (among other duties and honorary positions) at Kansas University, which is located in the region where he was born. His work has primarily focused on the link between the economic development of the western and southern United States, changes in the physical environment, and the implications arising from this interaction. His general conclusion has been that economic development has resulted in a set of enormous and significant changes in the environment and in the relation between it and the people who determine its uses. The management of water resources in the expansion of American interests into the western portion of the continent led to, among other things, transfer of control over those resources to political and economic elites who retain control into the modern world. As the public sector took over the role of controlling and manipulating the water resources of the West, the seat of American power shifted from the original colony regions to imperially dominated and environmentally transformed virgin lands, from which indigenous peoples were removed. This method of imperial expansion is essentially similar to that previously followed by European powers and has been replicated in the overseas possessions brought into American possession. Ideologically, therefore, the basis of the American state and the wealth that it has brought to its people is based on the presumed right to seize and transform the physical land and the creatures that depend on it.

Ownership and control over the resources of the environment has been customarily accompanied by the professed belief that the land is a resource to be exploited to its maximum economic value with little, if any, consideration for the sustainability of that form of use. This was seen in the Dust Bowl tragedy of the 1930s, when inappropriate use of fertilizers and other chemicals led to the destruction of farmable land and caused widespread hunger and forcible migration. Worster's argument is that insufficient lessons have been learned from the past and that there are real dangers of similar events being repeated in the future. This method of viewing history, which is typically deployed by Professor Worster, helps to highlight lessons for the present and the future.

The models of ecology used by Worster in his work have been faulted by critics, who point to their somewhat over-simplistic qualities. Specifically, the complex ecological dynamics of most ecosystems over time and the complex interactions and responses between human and non-human systems make the straight-forward narratives of books like his *Dust Bowl* less compelling in light of contemporary disequilibrium ecological theory. Nevertheless, Worster has blazed a trail for work in the humanities, uniting history and ecology in a new way.

SEE ALSO: Development; Dust Bowl, U.S.; Environmentalism; Policy, Environmental.

BIBLIOGRAPHY. Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (Oxford University Press, 1992); Donald Worster, *Nature's Economy: A History of Ecological Ideas*, (Cambridge University Press, 1994); Donald Worster, *Dust Bowl: The Southern Plains in the 1930s* (Oxford University Press, 2004).

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Wright, Frank Lloyd (1867–1959)

FRANK LLOYD WRIGHT (1867–1959) was perhaps the most celebrated U.S. architect and designer, famous for his original concept of houses built in harmony with nature. In the 1930s, Wright defined his concept of "organic architecture" as a respectful interaction and simple reinterpretation of nature, instead of a mere reproduction of it. For instance, natural materials like wood or stone used in houses should look as such, without being transformed or painted. Wright often declared, "Form and function are one," which means, for instance, that a museum should look like a museum and not like a Greek temple.

Among many notable buildings, Wright's Fallingwater in the Laurel Highlands of southwest Pennsylvania illustrates his ecological approach to architecture: In this case, a unique house built in 1939 on a cascade that goes inside the building and crosses the living room. This synthesis of the architecture with the environment is not just decorative; it is the symbol of the integration of nature that feeds the harmony of the life style, the furnishings, and the indoor design. In this case, instead of having a nice view of the outside waterfalls though a window, inhabitants lived in a house that rose over the unchanged cascade. Unlike some of Wright's projects, Fallingwater, also known as the Edgar J. Kaufmann House, still remains with its original furnishings; it has been open to visitors since the Kaufmann family left it in 1964.

Between 1900 and 1919, Wright also introduced the Prairie style, which was later known as the Prairie School, a design approach that was shared with other U.S. architects and followers. Instead of building houses that looked like boxes, the Prairie style favored unity, open plans, and low, horizontal lines that would seem to blend with the flat landscape, with broad open spaces instead of a group of strictly defined rooms. Perhaps influenced by his trip to Japan in 1916, Wright wanted to design

Wright's Prairie style favored open plans, low, horizontal lines, and blending the building with the surrounding landscape. Perhaps the perfect example of the Prairie style is the Robie House in Chicago, built in 1909.

every house as a unified environment in which the interior would be coherent with the natural landscape instead of being similar to the surrounding buildings. Wright recommended the use of natural materials and natural light. Perhaps the perfect example of the Prairie style would be the Robie House in Chicago, built in 1909.

Wright believed that "better homes would create better people." During more than half a century, Wright conceived more than 400 houses, bungalows, factories, theaters, civic centers, and office buildings, mostly in the United States, but also created a few projects in Canada and Japan, like the Imperial Hotel in Tokyo (1922) and the E. H. Pitkin Cottage (1900) on Sapper Island in Desbardts, Ontario. Some of these houses have been remodeled or even demolished. Other houses built by Wright, like the Louis Sullivan Bungalow and the James Charnley Bungalow (both in Ocean Springs, Mississippi), were destroyed by Hurricane Katrina in 2005.

Conceived as a spiral structure that looks like a work of art in itself, the Solomon R. Guggenheim Museum in New York City remains perhaps the most famous building created by Frank Lloyd Wright (between 1943 and 1957). Here, the concept was to allow the visitor to take the elevator to the top of the building and then proceed slowly down the spiral walkway to view the artwork, in order to avoid fatigue.

A prolific writer, and on occasion a teacher and lecturer, Frank Lloyd Wright also published many books and essays: *An Organic Architecture* (1939), *The Natural House* (1954), *A Testament* (1957), and *The Living City* (1958). Already a celebrity before his death at 91, Frank Lloyd Wright has become an American icon.

SEE ALSO: Design (and Ecodesign); Development; Landscape Architecture; Urban Planning.

BIBLIOGRAPHY. Jackie Craven, "Frank Lloyd Wright Buildings Index," architecture.about.com (cited December 2006); Kaufmann Conservation on Bear Run, "Frank Lloyd Wright's Fallingwater, in the Laurel Highlands, Pennsylvania," www.fay-west.com (cited December 2006); Organic Architect, www.organicarchitect.com (cited December 2006); William Allin Storrer, ed., *The Frank Lloyd Wright Companion* (University of Chicago Press, 2006); William Allin Storrer, "The Frank Lloyd Wright Update," www.franklloydwrightinfo.com (cited December 2006); Frank Lloyd Wright, *Frank Lloyd Wright Collected Writings* (Rizzoli, 1994); Frank Lloyd Wright, *Frank Lloyd Wright. An Autobiography* (Pomegranate, 2005); Frank Lloyd Wright and Mike Wallace, *Frank Lloyd Wright. The Mike Wallace Interviews,* audiocassette (HighBridge Company, 1996); Frank Lloyd Wright Foundation, www.franklloydwright.org (cited December 2006); Frank Lloyd Wright Preservation Trust, wrightcatalog.stores.yahoo.net (cited December 2006).

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Xeriscape

A XERISCAPE (PRONOUNCED "z-ri-scape") is a landscape that has been developed to maximize water conservation. "Xeriscape" is a compound of the Greek word *xeros* ("dry") and *scape* to express the idea of developing a landform that is manageable in a drought-prone area or a dry landscape. Xeriscaping is a creative form of landscaping that uses plants that can derive the maximum benefit possible from the available water.

A xeriscape is not limited to desert plants or to desert or semi-arid regions. Xeriscaping can be used in urban areas; an unusual dry spell will then not kill the plants because they are immune to small droughts, nor will they require watering. The term *xeriscape* was originally coined by Denver Water, a municipal utility that continues to hold the trademark, but it has since become a generically used term for all forms of sustainable, water-conserving landscaping.

In 1977, a severe drought in the western United States made water usage a public and financial issue. Homeowners, landscapers, and others realized that turf grass lawns and other water-intensive plantings were expensive and impractical. However, sand, gravel, and plastic yard coverings were not the answer—xeriscaping was.

Development of a xeriscape takes planning, as does the development of any landscape. But, with a xeriscape the plan seeks to maximize the use of water, including finding ways to retain water and curb runoff. In addition, because water loss due to evaporation is usually greatest in areas with a southern or western exposure, plants used in these areas should be those that need lesser amounts of water and that can withstand higher temperatures. These areas may be appropriate for a drought resistant ground cover, which, if the slope of the area is steep, will retain more moisture and moderate ground temperatures. Another important change in implementing a xeriscape is to replace turf grasses with drought-resistant grasses. Some areas can also be planted with drought-resistant wildflowers.

Success in creating a xeriscape is influenced by good soil preparation. Sandy or heavy clay soils will not retain water as well as a more balanced soil. Modification of the soil so that there are increased pore spaces can be accomplished with mixtures of organic materials, silt, sand, and clays. Since plant roots usually need oxidation, increasing pore spaces will aid plants to grow and withstand drought.

Landscaping with desert plants is one way to create a xeriscape. Cacti are an obvious choice, but to

After cacti, there are many other plant choices for xeriscaping—even drought-resistant wildflowers.

cacti can be added a great number of xerophytes, or plants from arid regions. Xerophytes are a class of plants that have adapted to desert environments by some mechanism to prevent water loss or to store water in their leaves. Many Mediterranean plants are xerophytic adaptations that survive summer dryness. Some, like the live oak, have hard, thick, leathery leaves while others have waxy leaf coatings that do not release water easily. Others are succulents, which store water in their leaves.

Some xerophytes can be found in salt marshes, saline soils, or in acid bogs where they have adapted to chemically hostile wet environments. Other xerophytes have evolved at beaches, in sand dunes, and on bare rock surfaces, even in wet regions where local conditions leave some spots dry.

Another way to practice xeriscaping is to reuse water. In California, some cities such as Santa Monica are reusing both treated sewage water and storm runoff. Water from urban runoff is not potable, but it can be used to water plants. A xeriscape can use water that is not potable at a reduced cost compared to using treated water. Besides being a sound horticultural practice, xeriscaping is often cheaper and more environmentally responsible.

SEE ALSO: Gardens; Groundwater; Landscape Architecture; Landscape Ecology; Recycling; Runoff.

BIBLIOGRAPHY. Connie Lockhart Ellefson, *Xeriscape Colorado: The Complete Guide* (Westcliffe Publishers, 2004); Rob Proctor, *Xeriscape Plant Guide: 100 Water-Wise Plants for Gardens and Landscapes* (Fulcrum Publishing, 1999); Gayle Weinstein, *Xeriscape Handbook: A How-to-Guide to Natural, Resource-Wise Gardening* (Fulcrum Publishing, 1999).

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Yellow Fever

YELLOW FEVER IS a disease of the flavivirus family affecting humans and monkeys that is transmitted by mosquitoes of the genus *Aedes*. Yellow fever has long been associated with human-created ecological change, both in urban areas and, more recently, in areas of the tropics experiencing rapid deforestation and urbanization. Victims first develop fever, chills, and vomiting followed by internal bleeding and jaundice; the illness may lead to death within two weeks.

Medical historians believe that *Aedes* mosquitoes are native to West Africa and arrived in the Americas via slave ships beginning in the 16th century. The mosquito and the virus spread throughout North and South America, though in temperate regions *Aedes* could not overwinter but was frequently reintroduced through trade. *Aedes* is well adapted to urban environments, breeding in standing water as found in cisterns or tires. The virus exacted high mortality rates and caused social dislocation and economic isolation in the temperate-zone cities where it occurred periodically until 1905.

In the tropical regions where yellow fever was endemic, many experienced moderate cases as children and survived with immunity. Lack of immunity among Europeans and North Americans limited colonial activities in West Africa, foiled French plans to build a canal in Panama, and inhibited U.S. expansion in the Caribbean. These and similar frustrations inspired the development of the field of tropical medicine as an aid to the colonial project. Physicians Walter Reed and Carlos Finley in 1901 discerned that yellow fever was mosquito-borne, and the U.S. Army soon enforced mosquito control measures in Havana and other areas of interest. The same control methods allowed the United States to construct and defend the Panama Canal and brought an end to epidemics in North America.

Yellow fever has been largely eradicated in temperate regions and industrialized countries through quarantine, environmental control, mosquito eradication and, after 1937, vaccination. The Rockefeller Foundation implemented mosquito control measures worldwide in the interwar period, but vaccination delivered the final blow in many areas. Between World War II and the 1960s, public health and military campaigns worldwide used DDT to control *Aedes*. The Pan-American Health Organization attempted to eradicate one *Aedes* species throughout the Americas in the mid-20th century, but lack of U.S. support, and U.S. concern over DDT exposure, doomed the effort.

Yellow fever has reemerged as a threat in tropical regions of Africa and South America and now occurs there as epidemics as well as endemically. Comprehensive vaccination campaigns have protected regions such as The Gambia, but few states have achieved widespread vaccination. Infections have been increasing since the 1980s, with 200,000 cases and 30,000 deaths in 2000. Because several different *Aedes* species can transmit the virus, the disease can move among forest, savanna, village, and city environments. Timber workers have been exposed to the sylvatic form of yellow fever through mosquitoes that feed on forest-dwelling populations of several monkey species. Epidemiologists suspect that rapid, human-caused ecological change has resulted in outbreaks of an intermediate form of the disease at the edge of savannas and forests, and that the growth of cities in Africa and South America will increase epidemics of the urban form. Disease ecology experts in temperate regions fear that global warming will expand the range of *Aedes* mosquitoes and thereby yellow fever.

SEE ALSO: Colonialism; DDT; Disease; Global Warming; Malaria; Mosquitoes.

BIBLIOGRAPHY. Laurie Garrett, *The Coming Plague* (Penguin, 1996); Andrew Learmonth, *Disease Ecology* (Blackwell, 1988); William H. McNeill, *Plagues and Peoples* (Random House, 1976); World Health Organization, "Yellow Fever" (December 2001), www.who.int (cited April 2006).

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Yellowstone National Park

ESTABLISHED IN 1872, Yellowstone National Park is now known as the world's first national park. The park's boundaries were set in the northwest corner of Wyoming and narrow portions of southeast Idaho as well as south-central Montana. Famous for spectacular scenery— the Rocky Mountains, explosive active geysers, crystal clear rivers and springs, still-abundant buffalo, elk, eagles, and other wildlife—the mention of Yellowstone invokes an image of pristine nature, unspoiled by humans. However, Native Americans occupied the area as long as 11,000 years ago.

Some of the first European explorers, including members of the Lewis and Clark expeditions in the early 1800s, encountered Native Americans—called the Shoshone—in the area now known as Yellowstone. A member of their expedition, John Colter, remained in the region and documented his winter journey in the mountains. During the first half of the 1800s, aside from the Lewis and Clark expeditions, the territory remained largely unexplored by anyone other than fur traders and Native Americans.

By the 1850s, a few missionaries had begun to explore the area and made detailed records of what they saw; at that time politicians in the east were still in disbelief about the descriptions they had heard of the Yellowstone region. Military excursions into the region were rare, but not unheard of, and no systematic efforts had been made to validate the claims of those who had seen the area. Gold strikes in Idaho in the 1860s brought prospectors and engineers deep into the area.

Finally, a series of formal explorations of the Yellowstone region took place (the Folsom, Washburn, Hayden, and Barlow parties consecutively from 1869 to 1871) supported by the U.S. government, private donors, and the Northern Pacific railway. Explorers, soldiers, and skilled technicians of all kinds—cartographers, zoologists, botanists, artists, and photographers—were sent out to map, record, and photograph the entire region that had been described by early adventurers and missionaries. Even the U.S. Geological Service sent explorers to document the Yellowstone region for its mining potential—as of this time, lawmakers in the east thought of the vast open spaces of the west as resources that could be used for economic advancement of the country.

By the time of the Hadyen and Barlow parties of 1871, photographs and records of the region had stimulated the interest of scientists from the Smithsonian Institution and other prestigious organizations. The country's leaders had become aware of the wonders of the area, then referred to as Great Geyser Basin, and had intended to build a railroad

Nathaniel "National Park" Langford

Nathaniel Pitt Langford, the first superintendent of Yellowstone National Park, became known as "National Park" Langford because of his role in the early establishment of the park.

Langford was born in 1832 at Westmoreland, New York, and moved to Oregon in 1862 after gold was found there. He made his camp on Grasshopper Creek, now in Montana (but then in Dakota). When Montana was organized as a territory, he was appointed collector for internal revenue, a post he held until 1868. In January 1869 President Andrew Johnson nominated him governor of Montana but this was never confirmed by the Senate. In 1870, as a member of the Washburn party, he discovered geysers, or hot springs, in what would become Yellowstone National Park.

Langford became the superintendent of Yellowstone National Park in 1872. There was no money provided to run the park, however, and Langford had no salary. Therefore, he had to spend much of his time working as National Bank Examiner for the Pacific Coast from 1872 until 1884. For this reason he only entered the park twice during his superintendency. On the first occasion, it was during the Second Hayden Expedition in 1872; the second time was two years later, when he had to evict Matthew McGuirk, who claimed to have the rights to the park's hot springs. Eventually Langford was accused of neglecting the welfare of the park; he was removed as superintendent in 1877. He moved to St. Paul, Minnesota, and was director of the Board of Control there. He died in 1911.

into the region. Ironically, it was an employee of Northern Pacific Railroad, Jay Cooke, who promoted the idea of setting aside a reservation or a park for the enjoyment of the public and for its aesthetic and geologic value. In 1872 the U.S. Congress established Yellowstone as the first national park of the country and of the world, setting precedent for human perceptions of nature as wild and uninhabited places.

Unfortunately, the area was not uninhabited, and with the creation of Yellowstone, Native American tribes such as the Shoshone, Blackfoot, and Crow were forcibly evicted from the area or killed. Today, Native Americans who have cultural ties with the park (as with other U.S. national parks) may utilize the park's resources for traditional practices through agreements with Yellowstone Park and the National Park Service Ethnography Program and as protected by the National Historic Preservation Act and the Native American Free Exercise of Religion Act.

Other current issues affecting the park include a variety of scientific and recreational problems, such as fire management, reintroduction of the wolf, and banning of snowmobiles and other motorized vehicles. In 1988, half of Yellowstone National Park was burned by wildfires. Ecologists who criticize the Park Service's forest suppression policies have noted that fires are a natural part of ecosystems and should be allowed to burn naturally because they help regenerate plant life and clear natural fire hazards. The 1988 fires led park managers to reevaluate their fire management policies and some "let burn" policies have been implemented.

Beginning in 1995 wildlife conservationists reintroduced gray wolves into the area known as the Greater Yellowstone Ecosystem (GYE), which extends beyond the boundaries of the national park. A great deal of controversy preceded the release of the wolves because people feared they would damage livestock or even pose a danger to humans. Objectives of the wolf reintroduction were to "restore natural ecological processes" and reduce prey, as well as help control populations of elk and moose that had grown to exceed the capacity of the land to support them. Although access to park areas has traditionally restricted snowmobiles, recent policies—mandated by Congress—have allowed snowmobiles into some areas of the park. Many national and local environmental organizations, such as the Sierra Club and the Greater Yellowstone Coalition, have continued to fight those policies.

SEE ALSO: Fire; National Parks; National Parks Service (U.S.); Native Americans; Preservation; Wolves.

BIBLIOGRAPHY. American Park Network, "Yellowstone: History," www.americanparknetwork.com (cited May 2006); M. Colchester, "Salvaging Nature: Indigenous Peoples and Protected Areas," in K.B. Ghimire and M.P. Pimbert, eds., *Social Change and Conservation* (Earthscan Publications Limited, 1997); A.L. Haines, *Yellowstone National Park: Its Exploration and Establishment* (National Park Service, 1974); G.K. Meffe and C.R. Carroll, *Principles of Conservation Biology* (Sinauer Associates, 1994); D.W. Smith, R.O. Peterson, and D.B. Houston, "Yellowstone After Wolves," *BioScience* (v.53, 2002); L. Smith, "The Contested Landscape of Early Yellowstone," *Journal of Cultural Geography* (v.22, 2004).

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Yemen

WHEN THE END of World War I signaled the breakup of the Ottoman Empire, North Yemen became independent. South Yemen, a British protectorate since the 19th century, did not achieve independence until 1967. When South Yemen adopted Marxism in 1970, hundreds of Yemenis fled to the north, setting the stage for dissension that ended only with the unification of the two countries as the Republic of Yemen in 1990. A border dispute with Saudi Arabia was peacefully settled in 2000. However, internal strife in Yemen continued, due in large part to a stagnant economy, ultimately leading to a crisis of debt payments. Following loan rescheduling by the International Monetary Fund, by the end of 2002 Yemen's external debt was 47.9 percent of its GDP, down from 52 percent the previous year.

Yemen is the 14th-poorest nation in the world, with a per capita income of only $800. Over 45 percent of Yemenis live below the national poverty line. More than a third of the labor force is unemployed, and the majority of workers are engaged in subsistence agriculture and herding. Barely a fourth of Yemenis live in urban areas.

A number of social indicators mirror Yemen's status as one of the world's poorest nations, preventing the government from focusing attention on environmental issues. Life expectancy is only 61.5 years for the population of 20,727,063. The combination of an infant mortality rate of 61.5 deaths per 1,000 live births, a fertility rate of 6.67 children per female, an HIV/AIDS rate of 0.1 percent, and exposure to diseases that are common among poor nations produces additional environmental burdens. The low literacy rate (70.5 percent overall and 30 percent for females) makes the dissemination of health and environmental information extremely difficult. The United Nations Development Programme Human Development Reports rank Yemen 151st of 232 nations on overall quality-of-life issues.

Bordering on the Arabian and Red Seas and the Gulf of Aden, Yemen has a coastline of 1,182 miles (1,906 kilometers). The country is located on Bab el Mandeb, the strait that links the Red Sea with the Gulf of Aden and is one of the most active shipping lanes in the world. The Yemeni terrain is composed of narrow coastal plains flanked by mountains and flat-topped hills, with the Arabian Peninsula dissecting the desert plains of the uplands. At least 90 percent of the land area has an arid or hyper-arid climate with high rainfall evaporation rates. Sand and dust storms are frequent in the hot summers. Along the western coast, temperatures tend to be hot and humid. In the mountains of the west, seasonal monsoons occur in direct contrast to the harsh desert conditions of the east. Natural resources include petroleum, fish, rock salt, marble, and small deposits of coal, gold, lead, nickel, and copper. With less than 3 percent arable land, the only fertile soils of Yemen are found in the west.

A study by scientists at Yale University in 2005 ranked Yemen 11th from the bottom in environmental performance, far below the comparable income and geographic groups. Scores were particularly low in the categories of biodiversity and habitat, air quality, and environmental health. Barely a fourth of rural Yemenis have access to safe drinking water, and only 14 percent of this group have access to improved sanitation. In contrast, 68 percent of urban residents have access to safe drinking water, and 76 percent have access to improved sanitation.

Environmental issues arise in Yemen from overexploitation, depletion, and pollution of valuable resources. The lack of freshwater sources, which has created a shortage of potable water, is Yemen's major environmental problem. This shortage has been accelerated by the practice of pumping groundwater beyond the sustainable level. Scientists have estimated that without intensive water conservation, existing water basins will disappear by the mid-21st century. There is particular concern over the practice of using scarce water to grow gat, an amphetamine-like narcotic, because it prevents farmers from growing essential food products. The food supply is further threatened by extensive coastal degradation and the loss of fisheries.

Overgrazing and soil erosion are a result of desertification that occurs from the combination of agricultural mismanagement and climatic conditions. Forests are being depleted at a rate of 1.8 percent each year, with each family using an estimated one to two tons of wood a year. Deforestation is accompanied by a loss of biodiversity and habits. Of 66 endemic mammal species, five are endangered, as are 12 of 93 endemic bird species. The government has made some progress in this area by protecting the Socotra archipelago, which is known as the Galapagos of the Indian Ocean.

The Environmental Protection Council is the Yemeni agency charged with promoting environmentalism through the implementation of the National Action Plan, which focuses on strengthening water management, curbing soil degradation, creating sanctuaries, and regulating waste management. Yemen participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Kyoto Protocol, Law of the Sea, and Ozone Layer Protection.

SEE ALSO: Deforestation; Endangered Species; Fisheries; Land Degradation; Life Expectancy; Overgrazing; Poverty; Soil Erosion; Water Demand.

BIBLIOGRAPHY. Central Intelligence Agency, "Yemen," *The World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Ministry of Planning and International Cooperation, "Environment and Bio-Diversity," www .mpic-yemen.org (cited April 2006); One World, "Yemen: Environment," uk.oneworld.net (cited April 2006); United Nations Development Programme (UNDP), "Human Development Report: Yemen," hdr.undp.org (cited April 2006); UNDP, "Yemen: Natural Resources" www .undp.org (cited April 2006); World Bank, "Yemen," *Little Green Data Book,* lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Yosemite National Park

YOSEMITE NATIONAL PARK is located along the western slopes of California's Sierra Nevada mountain range. Falling under the jurisdiction of the U.S. Department of the Interior, Yosemite spans over 1,158 square miles (3,000 square kilometers) and ranges in elevation from 2,000 to over 13,000 feet (610 to 3,962 meters) above sea level. Though Yosemite is a land of superlatives—containing sheer 3,500-foot (1,067-meter) cliffs, the highest waterfall in North America (Yosemite Falls), and the largest living tree species in the world (the giant sequoia)—it is perhaps most notable for being an icon of the U.S. environmental movement.

In 1864 Abraham Lincoln passed a landmark bill called the Yosemite Grant, which ceded Yosemite Valley and the Mariposa Sequoia Grove to California as a state park. During the late 19th and early 20th centuries, Yosemite National Park became ground zero for a monumental debate between preservationists and conservationists over how to plan for the park's future. During the late 1800s John Muir helped draw the public's attention to Yosemite through his influential writings and environmental activism—including the formation of the Sierra Club.

In response to heavy sheep grazing and the logging of giant sequoia, John Muir and other preservationists advocated for the preservation of Yosemite in its natural state by granting the area federal

Yosemite's status as a national park has led to 89 percent of the park being designated wilderness area, but also to annual tourist visitation rates that exceed three million.

protection. In 1890 his efforts were rewarded when Yosemite was declared a national park. Meanwhile, Gifford Pinchot, the first chief of the National Forest Service and an important political figure in the conservation movement, had been lobbying to manage Yosemite's natural resources scientifically for productive purposes.

Today, Yosemite can be viewed as a mosaic of compromises between preservationists and conservationists. For example, though a national park, Yosemite contains within its park boundaries a large dam and reservoir in Hetch Hetchy Valley. A conservationist achievement, the O'Shaughnessy Dam at Hetch Hetchy quenched the water needs of the San Francisco Bay Area for many years. The preservationist movement also had notable achievements. With its designation as a national park, approximately 89 percent of the park is designated wilderness area. Yosemite is also home to the headwaters for two designated wild and scenic rivers—the Merced and Tuolumne.

In 1984, the park's federal status expanded when Yosemite was named a world heritage site because of its perceived contribution to California's cultural heritage including the California Gold rush; the broader U.S. National Park movement; and the cultural legacy of over 8,000 years of Native American settlement in the Yosemite region, including by the Miwok and Paiute tribes.

Annual visitation rates in Yosemite exceed three million, with the vast majority of these guests visiting Yosemite Valley. As a result, the Park Service has seen a number of environmental challenges arise. These challenges include: (1) air pollution in the Yosemite Valley from high levels of car and tour bus congestion; (2) the interruption of natural fire regimes and forest regeneration due to heavy fire suppression practices; (3) persistent interaction between black bears and humans as bears began to rely on human food, causing damage to visitor property and ultimately costing the lives of black bears; (4) the introduction of invasive species bringing significant changes to Yosemite's fragile alpine ecosystems; and (5) habitat fragmentation, especially along the valley floor as roads and buildings are built to accommodate millions of Yosemite sightseers every year.

In 2000, the Yosemite Valley Plan was produced under the guidelines of the National Environmental Policy Act to supplement and modify the goals and proposed strategies found in the 1980 General Management Plan for Yosemite. Aimed at preserving the natural and cultural resources of Yosemite Valley for the use and enjoyment of visitors, the Yosemite Plan is a management response to the park's paradoxical position as a sanctuary for unique wildlife species and fragile habitats and as an overwhelmingly popular tourist destination.

SEE ALSO: Muir, John; National Forest Service (U.S.); National Parks; Pinchot, Gifford; Sierra Club; Tourism; World Heritage Sites.

BIBLIOGRAPHY. John Muir, *My First Summer in the Sierra* (Houghton Mifflin, 1998); Alfred Runte, *Yosemite the Embattled Wilderness* (University of Nebraska Press, 1990); U.S. Department of the Interior, Yosemite National Park, www.nps.gov/yose (cited April 2006).

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Yucca Mountain

YUCCA MOUNTAIN IS the site of a proposed repository for spent nuclear fuel and other radioactive waste material. Yucca Mountain is located in Nye County, Nevada, approximately 100 miles northwest of Las Vegas. The land is under the joint control of the U.S. Department of Energy (DOE), the U.S. Air Force, and the Bureau of Land Management. The proposed repository would occupy 230 square miles of high desert with no permanent settlements within 15 miles. Yucca Mountain was formed by several layers of volcanic rock deposited over 12 million years ago. The rock is identified as "tuff," which is formed ash deposited from volcanic eruptions.

Yucca Mountain has been considered as a potential permanent nuclear waste repository since 1978 when the DOE began studying the geologic character of the site. The DOE received authority to search for a suitable repository under the Nuclear Waste Policy Act. An earlier precedent for the search came from a recommendation by the National Academy of Science in 1957 that suggested that burial of nuclear wastes in deep underground sites would protect the environment and ensure the health and safety of humans. The proposals to use underground burial in general and Yucca Mountain specifically have both met with significant resistance from the outset.

Despite repeated objections to the proposals by politicians and environmentalists alike, repository planning continued into the 21st century and has yet to be finally resolved. In 1983, the DOE studied nine possible sites for the repository and two years later President Ronald Reagan called for further in-depth analysis of three of those sites: Hanford, Washington; Deaf Smith County, Texas; and Yucca Mountain. A congressional amendment to the Nuclear Waste Policy Act in 1987 specified that the DOE would consider only Yucca Mountain. Further progress on the program was made on July 23, 2002, when President George W. Bush authorized the DOE to make formal application to the Nuclear Regulatory Commission for a license to construct the repository. Delivery of the application was specified to be no later than June 30, 2008.

If the Yucca Mountain site receives final approval for repository construction, the total cost is estimated to be as high as $100 billion. In July 2006, the DOE determined that the repository would receive its first shipment of nuclear waste on March 31, 2017. However, the proposal continues to be vociferously opposed. Nevadans in particular are irate over the fact that a site was chosen in their state despite the fact that Nevada has no nuclear power plants within its borders. Concern was raised as well about Environmental Protection Agency (EPA) waste disposal standards, which specified that radiation levels would not exceed established levels for 10,000 years following the closure of the repository. Court rulings on this provision were found to be inconsistent with earlier recommendations issued by the National Academy of Sciences. Following this ruling the EPA proposed new radiation dosage limits to be effective following the 10,000-year period and extending to one million years following repository closing. No regulatory proposal has ever been made for this long of a period of time.

Nuclear wastes are now stored in containers at 126 sites in the United States, presenting multiple security and safety issues. Nevertheless, alternative storage options, including multiple monitored retrievable burial sites, have largely remained unconsidered. In 2006, a number of politicians suggested that the basic issue of underground storage of nuclear wastes be reexamined. The suggestion has been advanced to find alternatives to the Yucca Mountain underground plan. Political leaders are proposing a moratorium on Yucca Mountain and inviting scientists to come up with other plans for disposing of nuclear wastes. As of 2007, therefore, the viability of Yucca Mountain as a solution to the nuclear waste problem remains unresolved.

SEE ALSO: Bureau of Land Management (BLM); Department of Energy (DOE) (U.S.); Desert; Environmental Protection Agency (EPA); Movements, Environmental; Nuclear Power; Nuclear Regulatory Commission (NRC) (U.S.); United States, Southwest.

BIBLIOGRAPHY. Jeff Johnson, "Yucca Mountain: Building a Final Home for the Nation's Nuclear Waste," *Chemical and Engineering News* (v.80/27); Raymond L. Murray, *Understanding Radioactive Waste* (Battelle Press, 2003); David P. O'Very, Christopher E. Paine, and Dan W. Reicher, eds., *Controlling the Atom in the 21st Century* (Westview Press, 1994); K. S. Shrader-Frechette, *Buying Uncertainty: Risk and the Case against Geological Disposal of Nuclear Waste* (University of California Press, 1993).

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Zambia

FORMERLY A BRITISH colony known as Northern Rhodesia, the Republic of Zambia was created in 1964 after independence from Britain. Copper mining had long been the mainstay of the country's economy, and price reductions in the 1980s and 1990s along with prolonged drought jeopardized the economy of the new country. Contested elections and political corruption threatened political stability until 2002 when an anticorruption campaign was initiated. By 2004 copper prices had recovered, and new mines had begun operation. Other resources with the potential for improving Zambia's economy include: cobalt, zinc, lead, coal, emeralds, gold, silver, uranium, and hydropower.

Economic prosperity in Zambia is hampered by high foreign debt, made more complicated by restructuring through the International Monetary Fund, though multilateral agencies are working with the government to effectuate debt relief. With a per capita income of only $900, Zambia is the 17th-poorest country in the world. Eighty-six percent of the population lives in poverty and nearly half of Zambians are seriously undernourished. The richest 10 percent of the population hold 41 percent of the wealth, while the poorest segments share just over one percent of resources. Around eight percent of land area is arable, but 85 percent of the population are engaged in the agricultural sector, mostly at the subsistence level. Half of the workforce is unemployed. The United Nations Development Programme's Human Development Reports rank Zambia 166 of 232 countries on overall quality of life issues.

Zambia is landlocked but has 11,890 square kilometers of inland water resources. Land borders are shared with Angola, the Democratic Republic of the Congo, Malawi, Mozambique, Namibia, Tanzania and Zimbabwe. The terrain of Zambia is made up of plateaus rising to isolated hills and mountains. Elevations range from 329 meters at the Zambezi River, which forms a riverine boundary with Zimbabwe, to 2,301 meters in the Mafinga Hills. The tropical climate is moderated by the rainy season between October and April. Zambia is subject to periodic droughts, and tropical storms are possible throughout much of the rainy season.

Zambia's population of 11,502,010 is subject to major environmental health hazards. With one of the highest HIV/AIDS adult prevalence rates in the world (16.5 percent), 920,000 Zambians are living with the disease. Approximately 89,000 people have died with HIV/AIDS since 2003. Only 55 percent of the population has access to safe drinking water, and only 45 percent has access to improved sanitation. Consequently, Zambians have a very high risk of contracting food and waterborne diseases such as bacterial diarrhea, hepatitis A, typhoid fever, and the water contact disease schistosomiasis. In some areas, Zambians are at high risk for contracting malaria and plague. As a result of high incidences of disease, Zambians have a lower-than-normal life expectancy (40.03 years) and growth rate (2.11 percent), and higher-than-normal infant mortality (86.84 deaths per 1,000 live births) and death rates (19.93 deaths/1,000 population). The high fertility rate of 5.39 children per female presents health hazards for Zambian women.

Centuries of mineral extraction and refining have led to acid rain produced by air pollution. Despite the abundance of water sources, inadequate treatment facilities lead to major health threats to Zambians. Desertification is widespread. Around 42 percent of land area is forested, but deforestation is occurring at a rate of 2.4 percent per year. Soil erosion is extensive as a result of agricultural mismanagement.

The government has protected almost one-third of the land area, including 19 national parks and 31 game management areas. Nevertheless, watersheds contaminated by chemical runoff threaten rhinoceros, elephant, antelope, and large cat populations. The number of endangered species among the 233 mammals that inhabit Zambia is not known, but 11 of the 252 bird species are threatened. A 2006 study by scientists at Yale University ranked Zambia 98 of 132 countries on environmental performance, above the relevant income and geographic groups. The low ranking in environmental health, however, reduced Zambia's overall ranking.

The Zambian Parliament enacted the Environmental Protection and Pollution Control Act of 1990 to provide a framework for environmental policy. In 1992, the Environment Council of Zambia was created and charged with protecting the environment and health of the Zambian population and of animals and plants by controlling pollution and promoting sustainable development. Specific elements of Zambia's environmental policy deal with controlling air pollution, managing water resources, regulating the use of pesticides and toxic substances, and conservation of natural resources. The Copperbelt Environmental Project was established to deal with the impact of copper mining on the environment.

Zambia participates in the following international agreements on the environment: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Ozone Layer Protection, and Wetlands. The government has signed but not ratified the Climate Change–Kyoto Protocol.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Desertification; National Parks.

BIBLIOGRAPHY. Central Intelligence Agency, "Zambia," *World Factbook,* www.cia.gov (cited April 2006); Timothy Doyle, *Environmental Movements in Minority and Majority Worlds: A Global Perspective* (Rutgers University Press, 2005); Environment Council of Zambia, www.necz.org.zm (cited April 2006); Kevin Hillstrom and Laurie Collier Hillstrom, *Africa and the Middle East: A Continental Overview of Environmental Issues* (ABC-CLIO, 2003); Valentine Udoh James, *Africa's Ecology: Sustaining the Biological and Environmental Diversity of a Continent* (McFarland, 1993); United Nations Development Programme, "Human Development Report: Zambia," hdr.undp.org (cited April 2006); World Bank, "Zambia," lnweb18.worldbank.org (cited April 2006); Yale University, "Pilot 2006 Environmental Performance Index," www.yale.edu/epi (cited April 2006).

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Zebra Mussels

ZEBRA MUSSELS *(Dreissena polymorpha*) are fingernail-size bivalves indigenous to parts of eastern Europe and the Caspian Sea region of Eurasia. Similar to other mussels, they are planktonic for the first few weeks of life, floating in currents and able to colonize new areas. They then attach to a hard substrate and become sedentary. Females are prolific, producing from 30,000 to over a million eggs during one spawning event.

Zebra mussels spread to western Europe approximately 200 years ago, invading all major rivers via canals. They have since spread to North America, presumably in the ballast water of ocean-going vessels. The mussels were first noticed in 1988 in Lake St. Clair in the Great Lakes region and have since spread to many lakes and river systems in both Canada and the United States. Although they have predators, including several species of freshwater fish and diving ducks, these predators have been unable to stabilize population growth.

In Europe as in North America, the mussels have caused significant ecological and economic harm. Zebra mussels grow together in dense mats attached to a variety of living and nonliving substrates. These dense colonies clog water intake pipes of waterworks, power plants, and other industrial users of water, causing millions of dollars of damage and necessitating the application of chemical treatments or the reconfiguration of the piping of these plants.

Zebra mussels have proven to be a very successful species in their newly colonized territories. They have a formidable ability to filter water, consuming nearly all the available phytoplankton and small zooplankton. They out-compete other species that also feed on microscopic plankton, and in this way, change food web dynamics, impacting larval and juvenile fish as well as other filter feeders. Zebra mussels preferentially remove a variety of nutrients and chemicals from the water column. Phosphorus is removed and sequestered in their shells, changing the phosphorus cycle in aquatic ecosystems where the mussel is found.

North America was home to the greatest biodiversity of freshwater mussels. Many of these populations have declined in numbers or even been extirpated due to combinations of overharvest, pollution, and habitat destruction. Managers are concerned about the threat that zebra mussels pose to many of the remaining native mussel species, such as the endangered winged mapleleaf clam (*Quadrula fragosa*), found in the St. Croix River in the upper Mississippi watershed.

When the zebra mussel was first encountered in North America, there was no regulatory or legal framework in place to stop ballast water introductions of exotic species. In Canada, ballast water introductions are generally addressed through voluntary guidelines under the Canada Shipping Act. In the United States, however, prompted by the negative impacts of the zebra mussel and by concern over the potential for more new invading species, new legislation was passed. In 1990, the U.S. Congress passed the Nonindigenous Aquatic Nuisance Prevention and Control Act, which was reauthorized, amended, and renamed the National Invasive Species Act of 1996.

Despite these measures, new exotic species have continued to appear. Some scientists believe that the Quagga mussel (*D. bugensis*), a close relative of the zebra mussel, may pose a more serious threat to native species in the Great Lakes region of North America than the zebra mussel. The Quagga mussel is larger, does not go dormant in the winter, and has a wider habitat range in which it can live. It appears to compete directly with the zebra mussel, and since 2000, the Quagga has replaced the zebra mussel in many areas of Lake Michigan.

SEE ALSO: Food Webs (or Food Chain); Marine Pollution; Predator/Prey Relations; Species Invasion.

BIBLIOGRAPHY. Renata Claudi and Joseph H. Leach, eds., *Nonindigenous Freshwater Organisms: Vectors, Biology, and Impacts* (Lewis Publishers, 1999); Frank M. D'Itri, ed., *Zebra Mussels and Aquatic Nuisance Species* (Ann Arbor Press, 1997); Thomas F. Nalepa and Donald W. Schloesser, eds., *Zebra Mussels: Biology, Impacts, and Control* (Lewis Publishers, 1993).

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Zero Population Growth (ZPG)

ZERO POPULATION GROWTH (ZPG) refers to a state in nature at which the birth rate is equivalent to the death rate, meaning that the population remains exactly at a specific level. There has been speculation about the appropriate level of population that may be sustainable given the restraints of existing economic and environmental resources. In a small state such as Singapore, where severe spatial restraints exist, it has been necessary to limit population growth for the sake of maintaining a consistent standard of living. However, the measures necessary to achieve this are believed by many people to infringe civil liberties or religious tenets on birth control. In other countries where space is not so limited, innovations in productivity and technology have so far managed to ensure that some of the more pessimistic predictions of those who fear continued growth in population, notably the 18th-century economist Thomas Malthus and, more recently, Paul Ehrlich, have yet to come to pass.

Despite its often vaunted environmental advantages, demographic decline has led to several unintended social consequences. In some Western countries, the native born populations are in decline, leading to an increasing reliance on a foreign-born immigrant workforce. In China and India, state and family efforts to control growth have led to a disproportionate rate of abortions of female fetuses, resulting in a large overall imbalance in the ratio of boys to girls for an emerging generational cohort.

From 1968 until 2002, Zero Population Growth (ZPG) was also the name of the U.S. organization now called Population Connection. The organization was created to promote the link between environmental problems and growing population levels and how, consequently, a tipping point is likely to arrive after which the impoverishment of the world must follow. This effort brought ZPG into contact with the feminist movement and other progressive causes favoring sexual freedom through contraception. This has led many to consider the ZPG cause to be political and religious in nature. ZPG's message has changed from its original prescription to have no more than two children and to tell other people about that decision.

As an organization, Population Connection addresses a number of different population issues across a range of activities including research, promotion, lobbying, education, and publication. It relies upon the contributions of its subscribing members and also on the sale of merchandise. The organization changed its name in part because Zero Population Growth was seen as a term with negative and draconian connotations. So too, population control and resources conservation are complex and multifaceted and not necessarily achieved by uniformity of behavior. Instead, the organization advocates a sophisticated regime of incentives to encourage people to behave in ways that are economically and environmentally sustainable.

SEE ALSO: Ehrlich, Paul and Anne; Malthus, Thomas; One Child Policy, China; Overpopulation; Population.

BIBLIOGRAPHY. Paul R. Ehrlich, *The Population Bomb* (Buccaneer Books, 1995); Thomas R. Malthus, *An Essay on the Principle of Population*, ed. by Geoffrey Gilbert (Oxford University Press, 1999); Population Connection, www.populationconnection.org (cited July 2006).

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Zimbabwe

ZIMBABWE COVERS OVER 390,000 square kilometers (about the size of Montana), and is bordered by South Africa on the south, Mozambique on the east, Botswana on the west, and Zambia on the north. Its environment varies from semi-arid regions to moist mountainous areas. It is home to most of the large African mammals, many of which are located in its 11 national parks. Victoria Falls, located along the Zambezi River and the border with Zambia, is one of these parks; during the rainy season, it contains one of the world's largest waterfalls.

Zimbabwe is home to over 12 million people and the population is made up primarily of two ethnic groups—Shona (about 82 percent) and the Ndebele (about 14 percent)—in addition to a small white minority. Zimbabwe was known as Rhodesia until it declared independence from Great Britain in 1980. The British South Africa Company, owned by Cecil Rhodes, colonized the area in the 1880s and the new colony was named in Rhodes's honor. The mission of the company was to exploit the natural resources of Rhodesia for Britain. From the 1880s until independence in 1980, a white-led government ruled Zimbabwe, and the racial segregation in place during that time has been compared to South Africa's apartheid system. Blacks were forbidden to own land outside of reserve areas, and as a result,

Great Zimbabwe

Although Victoria Falls remains the major tourist attraction in the country, the stone buildings of Great Zimbabwe are the most well-known manmade ruins in Africa south of the Sahara Desert. They are the most spectacular of the 150 or so walled remains in the country.

Adam Renders, an American sailor, came across the ruins in 1867, by which time they had been plundered for many years. The first foreigner who was able to write of his experiences was the German Carl Mauch who arrived in 1871 and saw the ruins in a more pristine state than they are in today.

It appears that the stone buildings and walls were the center of a great civilization that existed from the 11th until the 15th century, with a population of as many as 10,000–20,000. Trade was conducted, almost certainly through many intermediaries, with all parts of the world as artifacts from China and India have been found in the remains. Some early historians linked the stone walls to the lands of King Solomon or the Queen of Sheba, but there is no link with any Biblical story.

There were a number of large carved birds at the site; one South African hunter carried one back with him in 1889. It eventually ended up with Cecil Rhodes, who mounted it in the library of his home in Cape Town, subsequently the residence of the South African prime minister. A representation of the bird now appears on the Zimbabwean flag.

With no surviving written records, archaeologists, historians, and ethnologists have long debated the purpose of the stone structures and the walls. Some of the buildings were undoubtedly used to store grain, while others have been identified as the palaces of the king and his family and courtiers. The great mystery is why the civilization ended: Some suggest pestilence, or an environmental catastrophe that exhausted their food supplies.

the limited land in the reserves grew crowded. Until recently, the white minority owned over 70 percent of the arable land, which led to a land redistribution campaign as this system of unequal land access persisted through independence in 1980.

Robert Mugabe was elected the first prime minister in 1980, and in 1987, he declared himself president. When elected, he began a program of land reform based on the "willing seller/willing buyer" system. This continued until 1999 and at this time, he began to use force to remove white farmers from their land to redistribute it to black farmers, a system that was highly criticized by Western countries. Zimbabwe's agricultural base has not recovered since the redistribution and food aid has been needed to feed the country. Mugabe was reelected in 2002 in what most international observers considered a fixed election. Since then, the inflation rate has risen almost 600 percent, with the unemployment rate at 80 percent.

Before the collapse of the agricultural sector, Zimbabwe was known as the breadbasket of southern Africa. Agricultural products included wheat, corn, tobacco, and cotton. The country also contains large deposits of gold and chromite. Before 2000, tobacco—followed by cotton—accounted for the largest export earnings; with the collapse of the agricultural sector, however, gold and cotton now are bigger earners. Complicating Zimbabwe's food shortage and the chaos of the land reform policies is an extremely high rate of HIV/AIDS; it is estimated that about 25 percent of the adult population is HIV positive. The labor shortages due to illness have also contributed to a negative 5 percent gross domestic product growth rate.

SEE ALSO: Acquired Immune Deficiency Syndrome (AIDS); Colonialism; National Parks.

BIBLIOGRAPHY. E. Kalipeni, S. Craddock, J. Oppong, and J. Ghosh, eds., *HIV & AIDS in Africa: Beyond Epidemiology* (Blackwell Publishing, 2004); S. Moyo, "The Political Economy of Land Acquisition and Redistribution in Zimbabwe, 1990–1999," *Journal of Southern African Studies 2000* (v.26, 2000).

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Zoology

ZOOLOGY IS AN area of biology that deals with the study of the animal kingdom (or Animalia). One purpose of zoology is to analyze and classify animals. Documents in the Hippocratic Collection state that the earliest attempts to classify animals originated in 400 B.C.E. Hippocrates arranged animals according to their habitat and mode of reproduction; in his *Historia Animalim*, he noted developmental stages of fish and aquatic animals, and studied sexual and asexual reproduction. During Roman times, Pliny the Elder compiled *Historia Naturalis,* a collection of folklore, superstition, and myth that was widely read in the Middle Ages. The Greek physician Galen, who dissected mammals and accurately described their internal features, produced another influential work.

Modern classification of animals began sometime in the 17th and 18th centuries. A system of nomenclature that we still use today—the binomial system of genus and species—was developed by Swedish botanist Carolus Linnaeus, who also established taxonomy as a discipline when he classified animals according to their teeth and toes, and classified birds according to the shape of their beaks. In the 17th century, English scientist Robert Hooke introduced the word *cell,* and after this, the field of embryology evolved. Scientific expeditions dedicated to studying animal life began in the 18th and 19th centuries.

Today, zoology has diversified as a field of science. With new technologies and discoveries, zoology has branched into subjects like biochemistry, genetics, and ecology. These fields deal with different areas of science and apply the acquired knowledge to study the animal kingdom. The main branches of zoology are taxonomy, physiology, and morphology.

Taxonomy deals with animal life based on different divisions. For example, the study of animals with backbones is classified under vertebrate zoology, which is further divided into herpetology, ichthyology, mammalogy, and ornithology. The study of animals that deals with multicellular animals without backbones is called invertebrate zoology, which is further divided into malacology and entomology. Taxonomic groups also subdivide paleontology, a field that deals with fossils. These subdivisions of zoology are aimed at studying the life cycle, distribution, classification, and evolutionary history of a group of animals of a particular animal. Most zoologists specialize in one of these fields and dedicate their research in that specific area.

Physiology deals with the function of body organs. If physiology deals with cellular functions, it is called cellular physiology and is closely connected to molecular biology. A study that deals with the physical connection of animals with their environment is called physiological ecology. This field aims to study animals in different environments like deserts, oceans, and the arctic.

Another study that examines full structures and systems, such as bones, brain, and muscles is called morphology, which generally includes gross morphology. The study that deals with body tissues at the microscopic level is called histology. Cytology examines cells and how cellular components function. With the advent of powerful machines like the electron microscope and the scanning tunneling electron microscope, cytology has made tremendous progress in the field of researching structural detail at levels of high magnification. Methods have been invented for studying neural networks inside the brain, and even studying individual impulses from specific brain areas and even individual brain cells.

The capstone field of zoology is called evolutionary zoology; it is connected to all of the above fields. Evolutionary zoology examines how an animal evolves—through speciation and adaptation—and what happens to the animal in the future as a result.

SEE ALSO: Animals; Ecology; Evolution; Genetics and Genetic Engineering; Linnaeus, Carl; Species.

BIBLIOGRAPHY. Cleveland P. Hickman, Jr., Larry S. Roberts, Allan Larson, and Helen I'Anson, *Integrated Principles of Zoology* (McGraw-Hill Science/Engineering/Math, 2005); Stephen A. Miller and John P. Harley, *Zoology* (McGraw-Hill Science/Engineering/Math, 2004).

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Zoos

THE HISTORICAL PREDECESSORS of modern zoos were primarily showcases of empire or poorly-maintained public spectacles, but zoos now promote themselves as institutions dedicated to conservation and education. Animal rights advocates and conservationists today debate the implications of zoos for threatened wildlife species and the ethics of animal captivity. Royal menageries in ancient China, Egypt, and Rome, and their counterparts in early modern Europe, Central America, and South Asia, symbolized the monarch's power to command an extensive and exotic empire. In the 18th and 19th centuries, menageries grew into larger zoological gardens associated with royal scientific societies. These institutions added a layer of scholarly legitimacy to the royal menageries, but they remained a part of the imperial project. With growing popular interest in science, zoos such as the London Zoological Gardens attracted an increasingly broad public, though some were open only to dues-paying members.

Beginning in the late 18th century, animal collections became more accessible to the public. Some impresarios operated traveling zoos, transporting animals from town to town for display in the public square, and later Phineas T. Barnum led the establishment of early circuses in large cities. Public institutions such as New York's Central Park and Philadelphia's Fairmount Park attempted to create more educational exhibits in the 1860s, and though they were extremely popular with urban residents, they lacked the funding to maintain animals safely or to rise above the status of humble entertainment.

Beginning with the National Zoological Park in Washington, D.C., in 1889, and the New York Zoological Park in the Bronx (later known as the Bronx Zoo and now the Wildlife Conservation Park) in 1898, zoos began to take on a conservation mission. Early wildlife advocates such as William Hornaday hoped to use these zoos as arks for disappearing species, most notably bison, from across the American continent, and as stages from which to deliver a conservation message to the public. With public and private funding, they were able to display more species and to construct more spacious, outdoor enclosures to simulate wild habitats and encourage "natural" animal behavior.

Much as in history, animal collections in existence today range from modest petting zoos to the private collections of wealthy and ostentatious individuals. The question remains whether they are sites of spectacle, science, power, conservation, or all of the above. Of the 1,700 animal exhibits in the United States, however, fewer than 200 are accredited by the American Zoo and Aquarium Association (AZA), a group that promotes zoos as a means to advance wildlife conservation and education. These include most major city zoos.

In the 1970s, two new challenges came together to force these zoos to consider their role in the conservation of wild species. One was the passage of the U.S. Endangered Species Act in 1973, which restricted zoos from taking members of listed species, and the other was the growing recognition that zoo collections were becoming inbred. Without taking in new animals, zoos could only expect to see the inbreeding problem worsen. In 1976, striving to become more progressive, AZA adopted a code of ethics governing the treatment and use of zoo animals.

In 1981, the organization began to coordinate Species Survival Plans (SSPs) among its members in order to produce healthier captive populations, rely more on captive breeding rather than capturing new free-ranging animals, and, ideally, benefit the genetic stock of threatened wild populations. American zoos have since integrated their efforts with those of zoo associations around the world, and have created an international database to optimize breeding arrangements. With increasing commitment to the genetic side of conservation, zoos are adding sperm bank to their list of cultural and environmental roles. Zoos now organize breeding exchanges, managing increased reproduction of threatened species with an eye toward introducing zoo-bred individuals back into wild populations. Captive breeding programs have brought a number of species back from the brink of extinction, for example the California condor. SSPs, however, cannot solve the biological difficulties of breeding for many species, and breeding may produce "surplus" offspring that raise another set of ethical issues.

Ethicists concerned about animal rights and conservation also question whether zoos' contributions are adequate for them to truly deserve the label of conservation institutions, and to justify keeping animals captive. They ask, for example, whether zoos adequately integrate their own activities with conservation needs outside the zoo gates—that is, into what conditions will zoo-bred animals be introduced? If wild habitats are depleted or wild populations unhealthy, zoos' breeding efforts may be wasted. Besides, some argue that very few individuals are ever actually integrated into wild habitats. In the meantime, however, zoo advocates say that they at least maintain an ark of genetic diversity that will last until the time viable wild populations can be supported. They point out that so-called wild populations are actually highly manipulated in a world where reserves must be set aside and managed; therefore, they suggest that to regard zoos as artificial, and zoo animals as wrongly captive, is to overstate the "natural-ness" of the rest of the world.

Zoo advocates also contend that keeping those animals captive is justified because seeing animals in zoos and participating in zoo education programs will ultimately increase public sympathy for conservation causes and thereby benefit animals in the wild. Some say that this is the true contribution of zoos, given the limited effect of SSPs. The Wildlife Conservation Society (WCS), a nonprofit organization based in New York City, is a leading proponent of this view. WCS manages several zoos, including the Bronx's Wildlife Conservation Park, and promotes the use of zoos for education and conservation. WCS facilities deliver carefully designed educational programs to the public, and staff work to support wildlife reserves worldwide.

Meanwhile, ecocritics—scholars of the cultural studies of nature—argue that zoos may reinforce broad cultural conceptions that humans are separate from and superior to nature, rather than encourage concern for nature as zoo advocates claim. Specifically, seeing wild animals contained within enclosures, no matter how naturalistic, gives the impression that nature can be subsumed into an anthropocentric world view.

Frank Buck

Frank Buck (1884–1950) was born in Gainesville, Texas, where he became honorary ringmaster of the Gainesville Community Circus. In 1911, he travelled to South America in search of jaguars and other wild animals. During the 1920s, he operated in Southeast Asia, especially in Singapore, where he captured wild animals for zoos around the world. Buck wrote about his exploits in three books: *Bring 'Em Back Alive* (1930), *Wild Cargo* (1932), and *All in a Lifetime* (1941). He played roles in jungle adventure films such as *Wild Cargo* (based on his book), *Jungle Cavalcade, Jacare,* and *Killer of the Amazon*. Buck was also the subject of a British television series, *Bring 'Em Back Alive*, in the early 1980s. A Frank Buck Zoo remains in existence in Gainesville, Texas.

Frank Buck, his films, and the Gainesville Zoo itself were a part of a larger, deeply fictionalized, romantic, and domineering view of nature typical of their time. Their influence on the form and style of nature documentary cannot be underestimated, however. Later media, including Disney film features and television, from Mutual of Omaha's *Wild Kingdom* to *The Crocodile Hunter*, all drew on the style and popularity of Buck's previous work. Arguably, today's popular nature media, though informed by superior natural history and a less sensationalistic approach, still retain an element of Buck's style. The Discovery Channel and Animal Planet networks are heirs to Frank Buck's natural circus theatricality.

SEE ALSO: Animals; Animal Rights; Anthropocentrism; Conservation.

BIBLIOGRAPHY. Vicki Croke, *The Modern Ark* (Scribner, 1997); R.J. Hoage and William A. Deiss, *New Worlds, New Animals* (Johns Hopkins, 1996); Randy Malamud, *Reading Zoos* (New York University Press, 1998); Bryan G. Norton, Michael Hutchins, Elizabeth F. Stevens, and Terry L. Maple, *Ethics on the Ark* (Smithsonian, 1995); Yi-Fu Tuan, *Dominance and Affection* (Yale, 1984); World Zoo Organization, *The World Zoo Conservation Strategy* (World Conservation Union, 1993).

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Resource Guide

BOOKS

Aaron, Sachs. *Eco-Justice: Linking Human Rights and the Environment*. World Watch Paper No. 127. (World Watch Institute, 1995)

Angel, Bradley. *Toxic Threat to Indian Lands: A Greenpeace Report* (Greenpeace, 1991)

Barrow, C.J. *Environmental Management and Development* (Routledge, 2005)

Beacham, Walton, Castronova, Frank V. and Freedman, Bill (eds.). *Beacham's Guide to International Endangered Species* (Beacham Publishing Corporation, 2000)

Beasley, Conger. *Confronting Environmental Racism: Voices from the Grassroots* (South End Press, 1993)

Berry, Brian L., et. al. *The Social Burdens of Environmental Pollution: Comparative Metropolitan Data Source* (Ballinger Publishing Co., 1997)

Bewers, Michael J. *Analysis of Questionnaire Responses* (Global Environment Facility, International Waters Program Study, 2000)

Boserup, Ester. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (George. Allen and Unwin, 1965)

Botkin, Daniel *Discordant Harmonies: A New Ecology for the Twenty-first Century* (Oxford University Press, 1992)

Bowles, Ian A. and Pickett, Glenn T. *Reframing the Green Window: An Analysis of the GEF Pilot Phase Approach to Biodiversity and Global Warming and Recommendations for the Operational Phase* (Conservation International and Natural Resource Defense Council, 1994)

Brady, N.C. and Weil, R.R. *The Nature and Properties of soil*s (Prentice Hall, 2002)

Brown, Phil and Mikelson, Edwin J. *No Safe Place: Toxic Waste, Leukemia, and Community Action* (University of California Press, 1990)

Bryant, Bunyan (ed.). *Environmental Justice: Issues, Policies, and Solutions* (Island Press, 1995)

Bryant, Bunyan and Mohai, Paul (eds.). *Race and the Incidence of Environmental Hazards: A Time for Discourse (*Westview Press, 1992)

Bryant, Dirk, Nielson, Daniel, and Tangley, Laura. *The Last Frontier Forests: Ecosystems and Economies on the Edge* (World Resources Institute, 1997)

Bullard, Robert D. *Unequal Protection: Environmental Justice and Communities of Color* (Sierra Club Press, 1993)

Byron, William J. *Toward Stewardship: An Interim Ethic of Poverty, Power, and Pollution* (Paulist Press, 1995)

California State Legislature, Senate, Urban Growth Policy Project. *Prosperity, Equity, and Environmental Quality: Meeting the Challenge*

of California's Growth: Final Findings and Recommendations (Senate Publications, 1991)
Castro, Fidel. *Tomorrow Is Too Late: Development And the Environmental Crisis in the Third World* (Ocean Press, 1993)
Chatterjee, Pratap and Finger, Mathias. *The Earth Brokers: Power, Politics and World Development* (Routledge, 1994).
Churchill, Ward. *Struggle for the Land: Indigenous Resistance to Genocide, Ecocide, and Expropriation in Contemporary North America* (Common Courage Press, 1993)
Coggin, Terrance P. and Seidl, John M. *Politics American Style: Race, Environment and Central Cities*. (Prentice-Hall, 1972)
Colorado Journal of International Environmental Law and Politics. *Endangered Peoples: Indigenous Rights and the Environment* (University Press of Colorado, 1994)
Commission for Racial Justice, United Church of Christ. *Toxic Wastes and Race in the United States: A National Report on the Racial and Socioeconomic Characteristics of Communities with Hazardous Wastes Sites* (Public Data Access Inc., 1987)
Conca, Ken and Dabelko, Geoffrey (eds.). *Environmental Peacemaking* (Woodrow Wilson Center Press, 2002)
Crosby, Alfred. *Ecological Imperialism: The Biological Expansion of Europe, 900-1900, New edition* (Cambridge University Press, 2004)
Dana, Alson (ed.). *We Speak for Ourselves: Social Justice, Race and Environment* (Panos Institute, 1990)
Davies, Ben. *Black Market: Inside the Endangered Species Trade in Asia* (Ten Speed Press, 2005)
Diehl, Paul and Petter, Nils Gleditsch (eds.). *Environmental Conflict* (Westview Press, 2001)
Dryzek, John *The Politics of the Earth: Environmental Discourses* (Oxford University Press, 1997)
Durett, Dan. *Environmental Justice: Breaking New Ground* (Committee of the National Institute for the Environment, 1993)
Ecologist Magazine. *Whose Common Future: Reclaiming the Commons* (New Society Publishers, 1993)
Edelstein, Michael R. *Contaminated Communities: The Social and Psychological Impacts of Residential Toxic Exposure* (Westview Press, 1987)
Eichstaedt, Peter H. *If You Poison Us: Uranium and Native Americans* (Red Crane Books Company, 1994)
Fitton, Laura. *A Study of the Correlation between the Siting of Hazardous Waste Facilities and Racial and Socioeconomic Characteristics* (Center for Policy Alternatives, 1992)
Frankel, Otto H. and Soule, Michael. *Conservation and Evolution* (Cambridge University Press, 1981)
Gadgil, Madhav and Guha, Ramachandra. *Ecology and Equity* (Routledge Press, 1995)
Gadgil, Madhav and Guha, Ramachandra. *This Fissured Land: An Ecological History of India* (Oxford University Press, 1992)
Gedicks, Al. *The New Resource Wars: Native and Environmental Struggles Against Multinational Corporations* (South End Press, 1993)
Gerrard, Michael B. *Whose Backyard, Whose Risk: Fear and Fairness in Toxic and Nuclear Waste Siting* (MIT Press, 1994)
Gillroy, J.M., (ed.). *Environmental Risk, Environmental Values, and Political Choices: Beyond Efficiency Trade-offs in Public Policy Analysis* (Westview Press, 1993)
Global Environment Facility. *Achieving the Millennium Development Goals: A GEF Progress Report* (Global Environment Facility, 2005)
Global Land Project (GLP). *Science Plan and Implementation Strategy* (IGBP, 2005)
Goldman, Benjamin A. *Not Just Prosperity: Achieving Sustainability With Environmental Justice* (National Wildlife Federation, Corporate Conservation Council, 1993)
Gould, J. M. *Quality of Life in American Neighborhoods: Levels of Affluence, Toxic Waste, and Cancer Mortality in Residential Zip Code Areas* (Westview Press, 1986)
Griffiths, T. and Robin, L. (eds.). *Ecology and Empire* (University of Washington Press, 1997)
Grinde, Donald A. and Johansen, Bruce E. *Ecocide of Native America: Environmental Destruction of Indian Lands and People* (Clear Light Publishers, 1995)
Guha, Ramachandra and Martinez-Alier, Juan. *Varieties of Environmentalism: Essays North and South* (Earthscan Publications, 1997)
Guha, Ramachandra. *Nature's Spokesman – M. Krishnan and Indian Wildlife* (Oxford University Press, 2002)

Guruswamy, Lakshman D. and McNeely, Jeffrey A. (eds.). *Protection of Global biodiversity: Converging Strategies* (Duke University Press, 1998)

Hall, Annabel T. *The Egg: An Eco-Justice Quarterly by the National Council of Churches Eco-Justice Working Group* (Cornell University, 1993)

Harrison, D., Jr. *Who Pays for Clean Air: The Cost and Benefit Distribution of Automobile Emission Standards* (Ballinger, 1975)

Held, David, McGrew, Anthony ,Goldblatt, David, and Perraton, Jonathan *Global Transformations: Politics, Economics and Culture* (Stanford University Press, 1999)

Hellawell, John M. *Biological Indicators of Freshwater Pollution and Environmental Management* (Elsevier Applied Science Publishers, 1986)

Hill, David (ed.) *The Quality of Life in America; Pollution, Poverty, Power, and Fear* (Holt, Rinehart and Winston, 1973)

Hofrichter, Richard (ed.). *Toxic Struggles: The Theory and Practice of Environmental Justice* (New Society Publishers, 1993)

Horta, Korinna, Round, Robin and Young, Zoe. *The Global Environment Facility: The First Ten Years – Growing Pains or Inherent Flaws?* (Environmental Defense and Halifax Initiative, 2002)

Houston, Stuart, Ball, Tim and Houston, Mary. *Eighteenth-Century Naturalists of Hudson Bay* (McGill-Queen's University Press, 2003)

Hurley, Andrew. *Environmental Inequalities: Class, Race, and Industrial Pollution in Gary, Indiana, 1945-1980* (University of North Carolina Press, 1995)

Jenny, H., *Factors of Soil Formation: A System of Quantitative Pedology* (McGraw-Hill, 1941)

Jim, Schwab. *Deeper Shades of Green: The Rise of Blue-Collar and Minority Environmentalism in America* (Sierra Club Press, 1994)

Johnston, Barbara R (ed.). *Who Pays the Price? The Sociocultural Context of Environmental Crisis* (Island Press, 1994)

Karliner, Joshua. *Toxic Empire: The Wmx Corporation, Hazardous Waste, and Global Strategies For Environmental Justice* (Political Ecology Group, 1994)

Kasperson, Roger E.(ed.). *Equity in Radioactive Waste Management*. (Oegleschlager, Gunn, and Hain, 1983)

Kroll-Smith, Steven, Brown, Phil and Gunter, Valerie. *Illness and the Environment: A Reader in Contested Medicine* (NYU, 2000)

LaBalme, J. *A Road to Walk, A Struggle for Environmental Justice* (Regulator Press, 1987)

Leopold, Aldo. *A Sand County Almanac and Sketches Here and There* (Oxford University Press, 1949)

Levy, Barry and Sidel, Victor (eds.) *War and Public Health* (American Public Health Association, 2000)

Lotka, Alfred J. *Elements of Mathematical Biology*. (Dover Publications, Inc., 1956).

Mandelker, D.R. *Environment and Equity: A Regulatory Challenge* (McGraw Hill, 1981)

Mann, Eric. *L.A.'s Lethal Air: New Strategies for Policy, Organization and Action.* (Labor/Community Strategy Center, 1991)

Manwaring, Max (ed.). *Environmental Security and Global Stability* (Lexington Books, 2002)

Marsh, George. *Man and Nature* (Harvard University Press,1965)

Meffe, G.K. and Carroll, C.R. *Principles of Conservation Biology* (Sunderland, 1994)

Merchant, Carolyn, (ed.). *Major Problems in American Environmental History, 2nd edition* (Houghton Mifflin Co., 2005)

Merchant, Carolyn. *Radical Ecology: The Search for a Livable World* (Routledge, 1992)

Meyer, Art. *Earth Keepers: Environmental Perspectives on Hunger, Poverty, and Injustice* (Herald Press, 1991)

Millennium Ecosystem Assessment. *Ecosystems and Human Well-being: Synthesis* (Island Press, 2005)

Neuman, Roderick. *Making Political Ecology* (Hodder Arnold, 2003)

Norris, R. *Pills, Pesticides and Profits: International Trade in Toxic Substances* (North River Press, 1982)

Pease, W. and Morello-Frosch, R. *The Distribution of Air Toxics Emissions in the San Franicsco Bay Area: A Preliminary Environmental Justice Analysis* (UC Berkeley, School of Public Health, Environmental Health Program, 1995)

Perrin, Constance. *Everything in its Place: Social Order and Land Use in America*. Princeton University Press, 1992)

Pielou, Evelyn C. *Mathematical Ecology* (John Wiley & Sons, 1977)

Pinchot, G. *Breaking New Ground* (Harcourt, Brace and Company, 1947)
Portney, Kent E. *Siting Hazardous Waste Treatment Facilities: The Nimby Syndrome* (Auburn House, 1991)
Primack, Richard B. *A Primer of Conservation Biology* (Sinauer Associates, Inc., 2004)
Purvis, M. and Grainger, A. (eds.). *Exploring Sustainable Development: Geographical Perspectives* (Earthscan Publications, 2004)
Regan, Richard. *Environmental Racism: An Annotated Bibliography (*Center for Policy Alternatives, 1993)
Ricklefs, Robert E. and Miller, Gary L. *Ecology* (W.H. Freeman & Co., 2000)
Russell, E. *War and Nature* (Cambridge University Press, 2001)
Shapiro, Judith. *Mao's War Against Nature* (Cambridge University Press, 2001)
Smith, J.N., (ed.). *Environmental Quality and Social Justice in Urban America: An Exploration of Conflict and Concord Among Those Who Seek Environmental Quality and Those Who Seek Social Justice* (Conservation Foundation, 1974)
Snow, Donald. *Inside the Environmental Movement: Meeting the Leadership Challenge* (Island Press, 1992)
Sontheimer, Sally (ed.). *Women and the Environment: Crisis and Development in the Third World*. (Monthly Review Press, 1991)
Southwest Organizing Project. *Intel Inside New Mexico: A Case Study of Environmental and Economic Injustice* (Southwest Organizing Project, 1995)
Sparke, Mathew *Introduction to Globalization: The Ties That Bind* (Blackwell, 2006)
Speth, James. *Red Sky at Morning* (Yale University Press, 2004)
Szasz, Andrew. *Ecopopulism: Toxic Waste and the Movement for Environmental Justice* (University of Minnesota Press, 1994)
The World Bank. *Global Environment Facility: Independent Evaluation of the Pilot Phase* (Washington, DC: The World Bank, 1994).
Turner, B.L II, Clark, W., Kates, R.W., Richards, J.F., Mathews, J.T., and Meyer, W.B. (eds.). *The Earth As Transformed By Human Action: Global and Regional Changes in the Biosphere Over the Past 300 Years* (Cambridge University Press, 2003)
United Nations Development Programme, United Nations Environment Programme and United States General Accounting Office. *Siting of Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities* (GPO, 1983)
Vallette, J. *The International Trade in Wastes: A Greenpeace Inventory* (Greenpeace, 1989)
VanDeveer, Stacy and Dabelko, Geoffrey D. (eds.) *Protecting Regional Seas: Developing Capacity and Fostering Environmental Cooperating in Europe* (Woodrow Wilson International Center for Scholars, 1999)
Wasserstrom, R.F. and R. Wiles, R. *Field Duty: US Farm Workers and Pesticide Safety* (World Resources Institute, 1985)
Wells, Michael P. *The Global Environment Facility and Prospects for Biodiversity Conservation* (Global Environment Facility, 2005)
Wenz, Peter S. *Environmental Justice* (State University of New York Press, 1988)
Wernette, D. *Minorities, Age Groups, and Substandard Air Quality Areas: An Analysis of Regional and Urban Patterns* (Environmental Assessment and Information Sciences Division Argonne National Laboratory, 1992)
World Commission on Environment and Development (WCED). *Our Common Future* (Oxford University Press, 1987)
Worster, D. *Nature's Economy: A History of Ecological Ideas. 2nd Edition.*
Young, M.D. *Sustainable Investment and Resource Use: Equity, Environmental Integrity, and Economic Efficiency* (Parthenon Publishing Group, 1992)

PERIODICALS

Agroforestry Systems
Association for Temperate Agroforestry
Alternatives
Alternatives Inc.
American Naturalist
Thomson Corporation
Amicus Journal
National Resources Defense Council
Annual Review of Anthropology
Annual Reviews
Annual Review of Ecology and Systematics
Annual Reviews
Audubon

National Audubon Society
Biodiversity and Conservation
Chapman and Hall
Biological Conservation
Elsevier Science
BioScience
American Institute and Biological Sciences
Boston College Environmental Affairs Law Review Boston College
Capitalism, Nature, Socialism
Routledge
Chemical & Engineering News
American Chemical Society
Chemical Week
Chemical Week Associates
Chemistry & Industry
Society of Chemical Industry
Christian Science Monitor
Church of Christ, Scientist
Communications in Soil Science and Plant Analysis Taylor and Francis Group
Comparative Farming Systems
Guilford Press
Conservation Biology
Blackwell Publishing
Critical Reviews in Environmental Science and Technology
Taylor and Francis Group
Crossroads
ASERI Students Association
Demography
Population Association of America
Earth Island Journal
Earth Island Institute
Ecological Economics
International Ecological Economics
Ecology Law Quarterly
University of California, Berkeley
Energy and Environment
Multi-Science Publishing Co. Inc.
Environment
Voyage Publications
Environment and Behavior
SAGE Publications
Environmental Action
American Chemical Society
Environmental Ethics
Center for Environmental Philosophy
Environmental Law
Oxford University Press
Environmental Management
Academic Press
Environmental Politics
Frank Cass
Environmental Science and Technology
Center for Environment and Energy Research
EPA Journal
Environmental Planning Agency
Global Environment Politics
MIT Press
Global Environmental Change
Royal Society of Chemistry
Global Environmental Politics
MIT Press
Harvard International Law Journal
Harvard University
Hazardous Waste
BPI News
Health and Social Policy
Haworth Press
Human and Ecological Risk Assessment
Taylor and Francis Group
Human Ecology
Springer Science and Business Media
International Journal of Health Service
Baywood Publishing
International Journal of Sustainable Development & World Ecology
Taylor and Francis
Journal of Agricultural & Food Information
Extension Journal, Inc.
Journal of Environment and Development
SAGE Publications
Journal of Environmental Economics and Management
Academic Press Inc.
Journal of Environmental Education
Heldref Education
Journal of Environmental Health
Taylor and Francis Group
Journal of Environmental Management
Academic Presss
Journal of Forestry
Oxford University Press
Journal of Geochemical Exploration
Elsevier Science
Journal of Policy Analysis and Management
Wiley InterScience
Journal of Public Health Policy
Palgrave Macmillin
Journal of Risk: Issues in Health and Safety
Franklin Pierce Law Center

Journal of Social Issues
Society for the Psychological Study of Social Issues
Journal of the American Medical Association
American Medical Association
Land Economics
University of Wisconsin Press
Meanjin
Meanjin Company Ltd.
Multinational Monitor
Essential Information Inc.
National Wildlife
National Wildlife Federation
Natural Resources Forum
Blackwell Publishing
Natural Resources Journal
University of New Mexico
Nature
Palgrave Macmillan
New England Journal of Medicine
Massachusetts Medical Society
New Scientist
Reed Business Information Ltd.
Planning
Oxford University Press
Policy Studies Journal
Blackwell Publishing
Polity
Palgrave Macmillan Ltd.
Population and Environment
Center for Environment and Population
Progress in Human Geography
SAGE Publications
Progressive
Progressive Inc.
Quarterly Review of Biology
University of Chicago Press
Sierra
The Sierra Club
Society and Natural Resources
Routlage
Soil Science
Wiley InterScience
The Ecologist
Ecosystems Ltd.
The Professional Geographer
Association of American Geographers
Toxicology and Industrial Health
SAGE Publications
Trends in Ecology and Evolution
Oxford University Press
Utne Reader
Utne Publishing
Waste Age
Prism Business Media Inc.
Water Resources
Springer Science and Business Media
Whole Earth Review
Point Foundation

Chronology

400,000–350,000 B.C.E.: Human beings master the art of lighting and tending fires.

12,000–10,000 B.C.E.: The first Agricultural Revolution occurs in the Fertile Crescent region of the Middle East.

500 B.C.E.–500 C.E.: A significant increase in demand for luxury items accompanies the rise of the Roman Empire.

Ivory, a hard dentine substance notable for its beauty and durability, becomes a valuable commodity. The Romans use it to create such items as musical instruments, statues, furniture, floor coverings, chariots and bird cages.

889–904 C.E.: The first instance of the use of aquaculture, the method of cultivating aquatic organisms in underwater environments, occurs in China, where innovators breed carp fish in flooded rice fields.

1273 C.E.: Shortly after taking power, King Edward I of England engages in one of the first acts of environmental protection in history when he bans the use of coal fires throughout the whole of England.

1347–1350: The Black Death, a disease caused by the transfer of the bacteria *Bacillus pestis* from rats to humans, devastates Europe. Over one-third of its population is left dead.

1690: Colonial Governor William Penn of Pennsylvania forces laborers to engage in one of the first acts of forest conservation when he requires that one acre of forest be preserved for every acre that is cut down.

1789: German chemist Martin Heinrich Klaproth discovers uranium, an element later used in the development of the atomic bomb.

1804: Meriwether Lewis and William Clark embark on their famous expedition to the Pacific Coast and back.

1841: Construction is completed on the 38-mile long Croton River Aqueduct in southeastern New York State. Its opening is attended by U.S. President John Tyler along with three former Presidents.

1849: Following the Mexican-American War, which ended with significant territorial acquisitions by the U.S., the ability to manage land becomes a top national priority, and the Department of Interior is established. The department's duties mainly revolve around the preservation of federal land. The American bison, which at the time was being threatened with extinction due to excessive hunting, is prominently featured on the logo of the department.

1850: The first use of septic systems, or underground waste treatment centers, occurs in France.

1853: Scientists Alexander Wood and Charles Pravaz invent the hypodermic needle, a device later used to administer preventative vaccinations to such diseases as rabies and polio.

1858: Central Park is constructed in New York City. Designers Frederick Olmstead and Calvert Vaux attempt to conceal the visual din of the surrounding urban ugliness by making the park rich with lush and vibrant greenery.

1862: French scientist Louis Pasteur invents pasteurization, the process of heating food to kill harmful bacteria and viruses.

1862: U.S. President Abraham Lincoln creates the Department of Agriculture, a noncabinet department, whose purpose is to promote increased agriculture production and protect natural resources.

1872: Yellowstone, an area located within the states of Wyoming, Montana, and Idaho, is officially designated by the U.S. federal government as the world's first national park.

1872: Prospectors in the newly settled American West are given free reign to engage in mineral exploration as part of the passage of the U.S. General Mining Law.

1877: In one of the first examples of a government-led effort to reduce pest infestation, Great Britain passes the Destructive Insects Act, providing funds to rid England of the Colorado potato beetle.

1879: The United States Geological Survey is established as a subdepartment of the Department of the Interior. The agency is responsible for "classification of the public lands, and examination of the geological structure, mineral resources, and products of the national domain."

1880: Construction is completed in the Australian city of Warwick on the world's first concrete-arch dam, called the 75-miles Dam.

1883: Concerns that widespread hunting of exotic birds will ultimately lead to their extinction prompts the founding of the American Ornithologist's Union.

1889: U.S. President Grover Cleveland signs into law a bill promoting the head of the Department of Agriculture to a cabinet-level position.

1891: The U.S. Congress passes the Forest Reserve Act, granting the President the authority to designate certain public domain lands as national forest reserves.

1892: Environmental preservationist John Muir founds the Sierra Club, an organization that would increase its membership to 750,000 people by 2006.

1896: The state of Connecticut files suit against Edward M. Greer, who had legally obtained animals in one state but attempted to sell them in another state where it would be considered illegal to do so. The Supreme Court rules that animal rights fall under the jurisdiction of individual states, rather than private interests. The Court's ruling would be later be overturned in the 1979 case of *Hughes v. Oklahoma*.

1897: Congress passes the Forest Organic Act for the purpose of, among other things, to "furnish a continuous supply of timber for the use and necessities of citizens of the United States." It grants the President the authority to select public domain lands as forest preserves. Conservationists argue that forests should be preserved for their natural beauty, and not for timber supply.

1902: President Theodore Roosevelt signs into law the Reclamation Act, providing funds for the irrigation of arid land on the West Coast of the United States.

1902: Various Audubon Societies across the United States combine forces to form the National Audubon Society, which would be instrumental in the coming years in the passage of legislation to protect various bird species from becoming extinct.

1905: The U.S. National Forest Service is created. Over time, the service would be responsible with overseeing the management of over 150 national forests.

1906: Congress passes the U.S. Antiquities Act, granting the President the authority to designate certain land owned by the federal government as "national monuments" and therefore closed to excavation. Among the notable geological phenomena that were originally designated as "national monuments" is the Grand Canyon.

1910: A massive fire in the northern Rockies of the United States destroys over 12,000 square kilometers of forest.

1914–1918: During World War I, one-fifth of the world's population becomes infected with influenza, resulting in an estimated death toll of 35 million people.

The country most affected by the outbreak of influenza was the United States, which experienced a decrease in its life expectancy rate by 10 years. The term The Great Influenza Pandemic has been coined to describe this period.

1916: The U.S. Congress passes a bill creating the National Park Service, a federal agency that would be responsible for managing all of the U.S. state parks. By 2006, the agency would have control of over 84 million acres of land.

1929–1970: Venezuela exports more oil than any other nation.

1930: General Motors and DuPont introduce Freon, a refrigerant containing the synthetic chemical chlorofluorocarbon which was later found to be harmful to the upper ozone layer.

1931: The Yellow River, the second largest river in China, experiences heavy flooding, resulting in a massive death toll estimated to be between 850,000 and 4,000,000 people.

1931–1936: The Hoover Dam is constructed at a total cost of $49 million on the border between Arizona and Nevada.

The second largest damn ever constructed in the United States, the Hoover Dam would provide over 2,000 megawatts of electricity to millions of people living in the Western United States.

1932: Vincent J. Schaefer and Irving Langmuir are awarded the 1932 Nobel Prize in Chemistry for their pioneering work in manipulating clouds to avert rainfall.

Their method involved supercooling clouds so that they are unable to bond together and produce rain.

1935: As the Dust Bowl reaches its midway point, hundreds of thousands of farmers are given relief when the U.S. Soil Conservation Service is created. Through partnerships with local agencies, the service instructs farmers on the proper way to utilize their farmland without repeating the same mistakes that led to the Dust Bowl's beginnings.

1936: A severe drought in the Chinese province of Sichuan displaces over 30 million farmers and causes the deaths of an estimated 5 million people.

1939: The U.S. Fish and Wildlife Service is created. By 2006, the service's duties would grow to include the management of more than 520 National Wildlife Refuges and over 66 National Fish Hatcheries.

1946: The International Convention for the Regulation of Whaling is held in Washington, D.C. with representatives from 42 nations present. As a result of the conference, the official definition of "whale-catcher" was broadened to include helicopters and ships.

1946: The U.S. Congress passes the Atomic Energy Act, creating the Atomic Energy Commission, the purpose of which is to regulate and monitor the development of nuclear technology. The act states that regulation and monitoring shall be placed under civilian, rather than military, control.

1948: Swiss chemist Paul Herman Muller is awarded the Nobel Prize for his discovery that the chemical DDT (dichlorodiphenyl-trichloroethane) can be used as an insecticide. DDT would help significantly lower the prevalence of malaria in Europe and North America.

1953: Mountaineers Tenzing Norgay and Edmund Hillary became the first people to successfully reach the summit of Mount Everest, which at a height of nearly 30,000 feet, is the highest mountain in the world.

1956: Construction begins on the Glen Canyon Dam in the U.S. state of Arizona. Upon completion, it would become the second highest concrete-arch dam in the country.

1958: The U.S. Congress passes the Food, Drugs, and Cosmetic Act. The act contains a clause called the Delaney Amendment which states that, "the Secretary [of the Food and Drug Administration] shall not approve for use in food any chemical additive found to induce cancer in man, or, after tests, found to induce cancer in animals."

1960: Jane Goodall travels to the Gombe Stream Chimpanzee Reserve in the African country of Tanzinia, beginning her 45-year study of the complex social behavior of the animal from which humans descended.

1962: Cesar Chavez initiates the merger of the National Farm Workers Association and the Agricultural Workers Organization to form the United Farm Workers.

The organization would use such nonviolent methods as fasts, emulating the methods used by Mahatma Gandhi and Martin Luther King, Jr.

1962: Environmental advocate Rachel Carson publishes *Silent Spring,* in which she details the careless handling of hazardous chemicals by major industrial companies. The book facilitated the growth of the modern environmentalist movement.

1962–1971: During the Vietnam War, the U.S. Air Force sprays large quantities of the dioxin chemical "Agent Orange" onto areas of South Vietnam. Later studies concluded that many American veterans of the war were contaminated with the chemical and experienced debilitating effects to their health years later.

To counter claims of negligence, the Dow Chemical company releases a report entitled *Trace Chemistries of Fire,* in which it is alleged that Agent Orange, among other dioxins, is derived naturally from forest fires. The theory is almost immediately debunked by credible experts.

1964: The U.S. Congress passes the Land and Water Conservation Act, providing funds for government-supervised construction of public parks and recreation areas.

1964: U.S. President Lyndon Johnson signs into law the Wilderness Act, creating the National Wilderness Preservation System. The act designates over 9 million acres of land in the U.S. as closed to excavation, as well as officially defining wilderness as "an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

1968: U.S. President Lyndon Johnson signs into law the National Wild & Scenic Rivers Act, enabling the federal government to monitor and correct the destruction of various rivers.

1968: The chemical PCB is found in hundreds of rice paddies in Japan. Over 17,000 cases of PCB infection are reported.

1969: Following significant oil spills in the North Sea, the countries of Belgium, Denmark, France, Germany, Norway, Sweden, and the United Kingdom sign the Bonn Agreement, pledging to offer mutual assistance to fight environmental pollution.

1969: The first oil spill in the United States to gain national attention occurs off the coast of California. Over 200,000 gallons of oil spill from an offshore well.

1970: The League of Conservation Voters, one of the largest environmental lobbying groups in the U.S., is founded.

1970: After touring a region devastated by an oil spill, U.S. Senator Gaylord Nelson of Wisconsin is stricken with a crisis of conscience and proposes on the Senate floor a bill to establish Earth Day as a holiday on April 22 of each year.

1970: The government of West Germany issues the Emergency Program for Environmental Protection.

1970: The National Environmental Policy Act is signed into law by U.S. President Richard Nixon. The preamble of the Act expresses the need "to declare a national policy which will encourage productive and enjoyable harmony between man and his environment."

1970: The Clean Air Act is passed by Congress in an attempt to protect the public from harmful airborne contaminants such as sulfur dioxide. The act would be amended in 1977 and again in 1990 to include more stringent regulations.

1970: U.S. President Richard Nixon signs into law a bill creating the Environmental Protection Agency (EPA). The agency provides a federally coordinated effort to enforce environmental regulations.

1970: The most deadly tropical cyclone in history with winds of 120 mph hits East Pakistan. Officials place the death toll at 500,000, attributing the high number of dead to the fact that the cyclone made landfall at a time when most residents in East Pakistan were sleeping.

1970: The National Oceanic and Atmospheric Administration is created for the purpose of obtaining "a better understanding of the intelligent use of the United States' marine resources."

1971: Egyptian and Sudanese laborers complete construction on the Aswan High Dam. Built to prevent overflooding of the Nile River, the dam is 3,600 meters in length and nearly 1000 meters wide.

1972: A week-long blizzard in Iran results in the deaths of 4,000 people, making it the most deadly blizzard of the 20th century.

1972: Congress passes the Ocean Dumping Act, requiring companies to be granted licenses by the Environmental Protection Agency in order to dump industrial, medical, and radioactive waste into U.S. territorial waters. The Act would be amended in 1988 as part of the passage of the Ocean Dumping Act, which outright banned the dumping of the aforementioned substances. An incident where large amounts of medical waste washed up on the shores of New Jersey prompted the Act's revision.

1972: The state legislature of Florida passes a series of laws to protect the Everglades, marshlands located in southeastern Florida that had been threatened due to population growth.

1972: The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is passed by Congress, requiring chemical manufacturers to submit their unlicensed products to the Environmental Protection Agency in order to ascertain its proper usage and any potential safety hazards.

1972: The U.S. Congress bans the usage of the chemical DDT (dichlorodiphenyl-trichloroethane) within the United States after it is revealed that the chemical has a high potential to spread cancer infection.

Despite the banning, the chemical continues to provide revenue for its manufacturers when it begins to be marketed and sold to Third World countries.

1973: The U.S. Congress signs the Endangered Species Act into law. The act equips federal officials with greater tools to combat the potential extinction of certain species of animal.

1973: Growing international concern for the plight of endangered species prompts the creation of the Convention on the International Trade in Endangered Species. The Convention offers funds to protect from extinction some 33,000 species of animals and plants.

1974: Congress passes the Eastern Wilderness Act, enabling the preservation of wilderness areas in the densely populated and industrially polluted Eastern United States.

1974: In her book *Le Feminisme ou la Mort* (*Feminism or Death*), French author Francoise d'Eaubonne posits that the societal instinct to destroy nature for industrial purposes is primarily patriarchal in nature. She encapsulates her philosophy by coining the term ecofeminism.

1974: Through the passage of the Safe Drinking Water Act, the U.S. Environmental Protection Agency is given the authority to enforce safety standards for drinking water at any level of government, whether it be state, local, or federal.

1975: Novelist Edward Abbey publishes *The Monkey Wrench*. The title refers to acts of nonviolent civil disobedience designed to protect the environment, such as tree spiking and billboard graffiti.

1976: The U.S. Congress passes the Toxic Substances Control Act, heavily regulating the usage of the organic compound polychlorinated biphenyl.

1977: Professor Wangari Maathai founds the Green Belt Movement, an organization dedicated to providing environmentalist jobs such as tree planting to poor women in rural Africa.

1977: In response to a sharp increase in the price of oil initiated by the Organization of the Petroleum Exporting Countries, The U.S. Department of Energy is established, bringing together dozens of energy-related organizations and agencies.

1978: The supertanker *Amoco Cadiz* splits in two after accidentally running aground off the coast of France into the Portsall Rocks, spilling 68 million gallons of oil into the surrounding waters. Damages are estimated to be equal to the value of $250,000,000. The French government, however, requests a payment of $2,000,000,000 from the American Oil Company, the owner of the doomed vessel.

1979: A "loss-of-coolant accident" occurs at the Three Mile Island nuclear plant near Harrisburg, Pennsylvania. The accident is later determined to be caused by faulty instrument readings.

1979–1989: The emergence of Japan as an economic superpower following the post-World War II reconstruction period creates a large upper class of Japanese citizens who flaunt their wealth with ivory-made items imported from Africa. As a result of this an other factors, the African elephant population drops nearly in half, from 1,300,000 to 750,000.

1980–2004: The international fish market grows from $15.7 billion to $71 billion.

1980: The U.S. Congress passes the Comprehensive Environmental Resource and Liability Act (CERCLA), giving government the power to identify hazardous waste sites and provide funding to facilitate the cleanup of the sites.

1981: The first confirmed case of the AIDS virus in human beings is reported by the U.S. Center for Disease Control and Prevention. Homosexual men in the city of Los Angeles are found to have unusually large "clusters of pneunomia."
Health officials at first erroneously assume that the disease has something to do with the men's sexual orientation, and name the disease GRID, or Gay-Related Immune Deficiency.

1981–2000: 40 million people are infected with Acquired Immune Deficiency Syndrome (AIDS). Nearly 50 percent of those affected with the virus are left dead.

1983: In an attempt to bridge a compromise between members of the tropical timber industry and conservationists, 54 nations pledge to sign the International Tropical Timber Agreement. Subsequent revisions to the agreement would be made in 1994, 1997, and in 2006, when the total number of countries adhering to the agreement's terms expanded to 180.

1984: The United Nations Educational, Scientific and Cultural Organization designates Yosemite National Park as a World Heritage Site, one of only 10 U.S. national parks to receive such an honor.

1986: 135,000 people are forced to permanently evacuate their homes as a result of a nuclear reactor explosion at the Chernobyl power plant in the Ukraine.

While not causing a significant number of deaths, radioactive material from the explosion continued to drift across the European continent in the coming years.

1986: The Slow Food Movement, an organization dedicated to stopping the spread of culturally damaging fast food restaurants such as McDonald's, is founded in the northern part of Italy. The organization's membership would grow to include 83,000 people by 2006.

1987: The Montreal Protocol becomes open for signature as concerns over the depletion of the ozone layer reach a fevered pitch. The 189 nations that eventually sign the treaty agree to phase out the usage of certain types of substances that are believed to cause ozone depletion.

1988: Members of the World Meteorological Organization and the United Nations Environmental Program combine their respective areas of expertise to form the Intergovernmental Panel on Climate Change (IPCC), for the purpose of studying the causes and potential outcomes of global warming.

1989: The *Exxon-Valdez* oil tanker crashes in Prince William Sound off the coast of Alaska, spilling over 11 million gallons of crude oil. Along with damaging the habitats of countless organisms, the oil spill causes considerable economic damage with estimates ranging up to $43,000,000. The U.S. Congress passes the Oil Pollution Act, requiring oil tankers to meet stringent regulations, in the wake of the incident.

1990: The Human Genome Project, a highly ambitious attempt to identify the purpose of the 20-25,000 genes contained in the human body, is formally launched at a cost of $3,000,000,000 by the U.S. Department of Energy and the U.S. National Institute of Health. Geneticists from Japan, Germany, China, and France make significant contributions to the project.

1990-2006: Following its reunification, Germany invests heavily in wind energy technology through the passage of such legislation as the Renewable Energy Sources Act. It would become the world leader in wind energy power, accounting for nearly half (39 percent) of the world's consumption.

1990: The Intergovernmental Panel on Climate Change (IPCC) concludes after two years of research that global warming poses a serious threat to the environment and that it is likely due to pollution caused by humans.

1991: The U.S. Food and Drug Administration estimates that 36 percent of all food imported to the U.S. is contaminated with harmful amounts of pesticide residue.

1992: The United Nations Conference on Environment and Development is held in the Brazilian city of Rio de Janeiro, with representatives from 172 governments present.
Among the topics discussed at the conference is the feasibility of converting to alternative sources of energy, and the growing problem of worldwide water shortages.

1993: Construction begins on the Three Gorges Dam alongside the Chinese Yangtze River, a river historically prone to dangerous flooding. At 600 feet high and 1.5 miles long, it is the largest hydroelectric dam ever designed.

1994: Mexico, Canada, and the United States enter into the North American Free Trade Agreement, creating the largest free trade area in the world. Environmental advocates complain that the industrial expansion that will result from increased trade will severely harm the environment. In response, the Commission for Environmental Cooperation and the Border Environment Cooperation Commission are created. Both commissions are given operating funds exceeding $1,000,000,000.

1995: A catastrophic heat wave in the U.S. city of Chicago and its surrounding metropolitan areas leaves over 500 people dead.

1995: Members of the Aum Shinrikyo, a Japanese religious cult, release a large quantity of the poisonous gas sarin on 5 separate railway trains in the capital of Tokyo, resulting in a dozen deaths and hundreds of injuries.

1996: In an out-of-court settlement, Pacific Gas & Electric Co. is forced to pay $333 million to the townspeople of Hinkly, California, who had sued the energy giant for contaminating their drinking water with a harmful toxin named hexavalent chromium.

It was the largest settlement ever paid in a direct-action lawsuit in U.S. history. The film *Erin Brockovich,* named after a law clerk who was instrumental in filing the case against PG&E, received 5 Academy Award nominations.

1997: The Kyoto Protocol to the United Nations Framework Convention on Climate Change becomes open for signature. The protocol requires countries to pledge to reduce greenhouse gas emissions by a certain percentage in order to gain membership. The protocol would grow in membership to include 166 countries by 2006.

1999: A startling discovery that 500 tons of animal feed accidentally laced with the carcinogenic chemical PCB were distributed to farms in Belgium prompts farmers to wastefully slaughter a total of over 2 million chickens.

1999: The West Nile Virus, a "flu-like" disease that is contracted through the bites of infected mosquitoes, first appears in the United States in the New York City borough of The Bronx.

1999-2003: The U.S. Center for Disease Control and Prevention reports nearly 15,000 cases of human West Nile Virus infection.

2001: A mere few weeks after the September 11 attacks, letters contaminated with the deadly poison anthrax arrive in the offices of U.S. Senators Tom Daschle and Patrick Leahy, as well as several major news organizations. 17 people are infected, resulting in five deaths.

2004: A 9.0 magnitude earthquake erupts underneath the Indian Ocean, causing a massive tsunami that devastates parts of Indonesia, Thailand, Burma, India, and Sri Lanka. The total death toll is reported to be 200,000 people. A combination of nations including Australia, which pledged to provide funds equal to 25 percent of its gross domestic product, offer a total aid package of $7,000,000,000.

2004: Halliburton Energy Services settles a class-action asbestos lawsuit out of court for a total of $4,200,000,000.

2004: Novelist Michael publishes *State of Fear,* imagining a scenario where ecoterrorists stage a tsunami with the support of media companies in order to bring about climate change legislation.

2005: The Joint United Nations Program on HIV/AIDS estimates that two-thirds of those affected by the AIDS virus live in Sub-Saharan Africa.

2005: The category 3 Hurricane Katrina makes landfall in the southeastern United States. Damages are estimated at $80,000,000,000. 80 percent of the city of New Orleans becomes flooded, leaving a significant portion of the city's population unable to fend for themselves. Television cameras capture images of those waiting to be rescued on the streets of New Orleans, shockingly revealing that most of them are African-American. Many Americans begin to question once again the validity of racial equality.

2005: Hazardous environmental conditions caused by more than a decade of warfare place Afghanistan at the top of the list of the countries with the highest infant mortality rate. According to statistics, approximately 17.5 percent of Afghanis die shortly after being born.

2005: The U.S. Environmental Protection Agency concludes that the herbicide 2,4-D does not pose a risk to human health when it is used in the method described in the product's instruction manual.

2006: Former Vice President Al Gore's film *An Inconvenient Truth*, in which he discusses the effect of global warming, becomes the third highest grossing documentary film of all time.

2006: In its annual report of countries' environmental performance, Yale University ranks New Zealand as the most environmentally friendly nation out of 133 ranked countries. The United States is ranked 28th, nearly the lowest among industrialized nations. Ranking last is the African country of Niger, which also has among the world's lowest GDPs.

2006: Scientists announce the possibility of the avian bird flu mutating into a much more deadly version of itself due to hazardous environmental conditions.

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Glossary

Abatement: Reducing the degree or intensity of, or eliminating, pollution.

Absorbed Dose: In exposure assessment, the amount of a substance that penetrates an exposed organism's absorption barriers (e.g. skin, lung tissue, gastrointestinal tract) through physical or biological processes. The term is synonymous with internal dose.

Absorption: The uptake of water, other fluids, or dissolved chemicals by a cell or an organism (as tree roots absorb dissolved nutrients in soil.)

Accident Site: The location of an unexpected occurrence, failure or loss, either at a plant or along a transportation route, resulting in a release of hazardous materials.

Acclimatization: The physiological and behavioral adjustments of an organism to changes in its environment.

Acid Deposition: A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either wet or dry form. The wet forms, popularly called "acid rain," can fall to earth as rain, snow, or fog. The dry forms are acidic gases or particulates.

Acid Mine Drainage: Drainage of water from areas that have been mined for coal or other mineral ores. The water has a low pH because of its contact with sulfur-bearing material and is harmful to aquatic organisms.

Acid Rain: (See: acid deposition.)

Acidic: The condition of water or soil that contains a sufficient amount of acid substances to lower the pH below 7.0.

Activated Carbon: A highly adsorbent form of carbon used to remove odors and toxic substances from liquid or gaseous emissions. In waste treatment, it is used to remove dissolved organic matter from waste drinking water. It is also used in motor vehicle evaporative control systems.

Active Ingredient: In any pesticide product, the component that kills, or otherwise controls, target pests. Pesticides are regulated primarily on the basis of active ingredients.

Acute Exposure: A single exposure to a toxic substance which may result in severe biological harm or death. Acute exposures are usually characterized as lasting no longer than a day, as compared to longer, continuing exposure over a period of time.

Acute Toxicity: The ability of a substance to cause severe biological harm or death soon after a single exposure or dose. Also, any poisonous effect resulting from a single short-term exposure to a toxic substance.

Adaptation: Changes in an organism's physiological structure or function or habits that allow it to survive in new surroundings.

Administered Dose: In exposure assessment, the amount of a substance given to a test subject (human or animal) to determine dose-response relationships. Since exposure to chemicals is usually inadvertent, this quantity is often called potential dose.

Adsorption: Removal of a pollutant from air or water by collecting the pollutant on the surface of a solid material; e.g., an advanced method of treating waste in which activated carbon removes organic matter from wastewater.

Adulterants: Chemical impurities or substances that by law do not belong in a food, or pesticide.

Advanced Wastewater Treatment: Any treatment of sewage that goes beyond the secondary or biological water treatment stage and includes the removal of nutrients such as phosphorus and nitrogen and a high percentage of suspended solids.

Advisory: A nonregulatory document that communicates risk information to those who may have to make risk management decisions.

Aeration: A process which promotes biological degradation of organic matter in water. The process may be passive (as when waste is exposed to air), or active (as when a mixing or bubbling device introduces the air).

Aerobic: Life or processes that require, or are not destroyed by, the presence of oxygen.

Aerosol: A finely divided material suspended in air or other gaseous environment.

Afforestation: Conversion of land to forest cover where forests have not historically occurred.

Agent: Any physical, chemical, or biological entity that can be harmful to an organism (synonymous with stressors.)

Agricultural Pollution: Farming wastes, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; improper disposal of animal manure and carcasses; crop residues, and debris.

Agricultural Waste: Poultry and livestock manure, and residual materials in liquid or solid form generated from the production and marketing of poultry, livestock or fur-bearing animals; also includes grain, vegetable, and fruit harvest residue.

Agroecosystem: Land used for crops, pasture, and livestock; the adjacent uncultivated land that supports other vegetation and wildlife; and the associated atmosphere, the underlying soils, groundwater, and drainage networks.

Air Pollutant: Any substance in air that could, in high enough concentration, harm man, other animals, vegetation, or material. Pollutants may include almost any natural or artificial composition of airborne matter capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in combination thereof.
Generally, they fall into two main groups: (1) those emitted directly from identifiable sources and (2) those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photoactivation. Exclusive of pollen, fog, and dust, which are of natural origin, about 100 contaminants have been identified. Air pollutants are often grouped in categories for ease in classification; some of he categories are: solids, sulfur compounds, volatile organic chemicals, particulate matter, nitrogen compounds, oxygen compounds, halogen compounds, radioactive compound, and odors.

Air Pollution Control Device: Mechanism or equipment that cleans emissions generated by a source (e.g., industrial smokestack, or an automobile exhaust system) by removing pollutants that would otherwise be released to the atmosphere.

Air Pollution: The presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects.

Air Quality Standards: The level of pollutants prescribed by regulations that are not be exceeded during a given time in a defined area.

Airborne Particulates: Total suspended particulate matter found in the atmosphere as solid particles or liquid droplets. Chemical composition of particulates varies widely, depending on location and time of year. Sources of airborne particulates include: dust, emissions from industrial processes, combustion products from the burning of wood and coal, combustion products associated with motor vehicle or non-road engine exhausts, and reactions to gases in the atmosphere.

Algae: Simple rootless plants that grow in sunlit waters in proportion to the amount of available nutrients. They can affect water quality adversely by lowering the dissolved oxygen in the water. They are food for fish and small aquatic animals.

Algal Blooms: Sudden spurts of algal growth, which can affect water quality adversely and indicate potentially hazardous changes in water chemistry.

Alkaline: The condition of water or soil which contains a sufficient amount of alkali substance to raise the pH above 7.0.

Alkalinity: The capacity of bases to neutralize acids. An example is lime added to lakes to decrease acidity.

Allergen: A substance that causes an allergic reaction in individuals sensitive to it.

Alternative Fuels: Substitutes for traditional liquid, oil-derived motor vehicle fuels like gasoline and diesel. Includes mixtures of alcohol-based fuels with gasoline, methanol, ethanol, compressed natural gas, and others.

Anaerobic Decomposition: Reduction of the net energy level and change in chemical composition of organic matter caused by microorganisms in an oxygen-free environment.

Anaerobic: A life or process that occurs in, or is not destroyed by, the absence of oxygen.

Animal Dander: Tiny scales of animal skin, a common indoor air pollutant.

Animal Studies: Investigations using animals as surrogates for humans with the expectation that the results are pertinent to humans.

Antarctic "Ozone Hole": Refers to the seasonal depletion of ozone in the upper atmosphere above a large area of Antarctica.

Anti-Degradation Clause: Part of federal air quality and water quality requirements prohibiting deterioration where pollution levels are above the legal limit.

Anti-Microbial: An agent that kills microbes.

Aquifer: An underground geological formation, or group of formations, containing water. Are sources of groundwater for wells and springs.

Aquitard: Geological formation that may contain groundwater but is not capable of transmitting significant quantities of it under normal hydraulic gradients. May function as confining bed.

Architectural Coatings: Coverings such as paint and roof tar that are used on exteriors of buildings.

Area Source: Any source of air pollution that is released over a relatively small area but which cannot be classified as a point source. Such sources may include vehicles and other small engines, small businesses and household activities, or biogenic sources such as a forest that releases hydrocarbons.

Artesian (Aquifer or Well): Water held under pressure in porous rock or soil confined by impermeable geological formations.

Asbestos: A mineral fiber that can pollute air or water and cause cancer or asbestosis when inhaled, and is restricted.

Asbestosis: A disease associated with inhalation of asbestos fibers. The disease makes breathing progressively more difficult and can be fatal.

Attenuation: The process by which a compound is reduced in concentration over time, through absorption, adsorption, degradation, dilution, and/or transformation. an also be the decrease with distance of sight caused by attenuation of light by particulate pollution.

Avoided Cost: The cost a utility would incur to generate the next increment of electric capacity using its own resources; many landfill gas projects' buy back rates are based on avoided costs.

Backflow/Back Siphonage: A reverse flow condition created by a difference in water pressures that causes water to flow back into the distribution pipes of a drinking water supply from any source other than the intended one.

Background Level: 1. The concentration of a substance in an environmental media (air, water, or soil) that occurs naturally or is not the result of human activities. 2. In exposure assessment the concentration of a substance in a defined control area, during a fixed period of time before, during, or after a data-gathering operation.

Backyard Composting: Diversion of organic food waste and yard trimmings from the municipal waste stream by composting hem in one's yard through controlled decomposition of organic matter by bacteria and fungi into a humus-like product. It is considered source reduction, not recycling, because the composted materials never enter the waste stream.

Bacteria: (Singular: bacterium) Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills or other pollutants. However, bacteria in soil, water or air can also cause human, animal and plant health problems.

Bactericide: A pesticide used to control or destroy bacteria, typically in the home, schools, or hospitals.

Basalt: Consistent year-round energy use of a facility; also refers to the minimum amount of electricity supplied continually to a facility.

Benefit-Cost Analysis: An economic method for assessing the benefits and costs of achieving alternative health-based standards at given levels of health protection.

Best Available Control Measures (BACM): A term used to refer to the most effective measures (according to EPA guidance) for controlling small or dispersed particulates and other emissions from sources such as roadway dust, soot and ash from woodstoves and open burning of rush, timber, grasslands, or trash.

Best Available Control Technology (BACT): The most stringent technology available for controlling emissions; major sources are required to use BACT, unless it can be demonstrated that it is not feasible for energy, environmental, or economic reasons.

Best Demonstrated Available Technology (BDAT): As identified by EPA, the most effective commercially available means of treating specific types of hazardous waste. The BDATs may change with advances in treatment technologies.

Best Management Practice (BMP): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources.

Bioaccumulants: Substances that increase in concentration in living organisms as they take in contaminated air, water, or food because the substances are very slowly metabolized or excreted.

Bioconcentration: The accumulation of a chemical in tissues of a fish or other organism to levels greater than in the surrounding medium.

Biodegradable: Capable of decomposing under natural conditions.

Biodiversity: Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequencies. For biological diversity, these items are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different ecosystems, species, and genes.

Biological Contaminants: Living organisms or derivates (e.g. viruses, bacteria, fungi, and mammal and bird antigens) that can cause harmful health effects when inhaled, swallowed, or otherwise taken into the body.

Biological Integrity: The ability to support and maintain balanced, integrated, functionality in the natural habitat of a given region. Concept is applied primarily in drinking water management.

Biological Magnification: Refers to the process whereby certain substances such as pesticides or heavy metals move up the food chain, work their way into rivers or lakes, and are eaten by aquatic organisms such as fish, which in turn are eaten by large birds, animals or humans. The substances become concentrated in tissues or internal organs as they move up the chain.

Biological Oxygen Demand (BOD): An indirect measure of the concentration of biologically degradable material present in organic wastes. It usually reflects the amount of oxygen consumed in five days by biological processes breaking down organic waste.

Biologicals: Vaccines, cultures, and other preparations made from living organisms and their products, intended for use in diagnosing, immunizing, or treating humans or animals, or in related research.

Biomass: All of the living material in a given area; often refers to vegetation.

Biome: Entire community of living organisms in a single major ecological area.

Biomonitoring: 1. The use of living organisms to test the suitability of effluents for discharge into receiving waters and to test the quality of such waters downstream from the discharge. 2. Analysis of blood, urine, tissues, etc., to measure chemical exposure in humans.

Bioremediation: Use of living organisms to clean up oil spills or remove other pollutants from soil, water, or wastewater; use of organisms such as non-harmful insects to remove agricultural pests or counteract diseases of trees, plants, and garden soil.

Biosphere: The portion of Earth and its atmosphere that can support life.

Biotechnology: Techniques that use living organisms or parts of organisms to produce a variety of products (from medicines to industrial enzymes) to improve plants or animals or to develop microorganisms to remove toxics from bodies of water, or act as pesticides.

Bloom: A proliferation of algae and/or higher aquatic plants in a body of water; often related to pollution, especially when pollutants accelerate growth.

Bottle Bill: Proposed or enacted legislation which requires a returnable deposit on beer or soda containers and provides for retail store or other redemption. Such legislation is designed to discourage use of throw-away containers.

British Thermal Unit: Unit of heat energy equal to the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit at sea level.

Brownfields: Abandoned, idled, or under used industrial and commercial facilities/sites where expansion or redevelopment is complicated by real or perceived environmental contamination. They can be in urban, suburban, or rural areas. EPA's Brownfields initiative helps communities mitigate potential health risks and restore the economic viability of such areas or properties.

Bubble: A system under which existing emissions sources can propose alternate means to comply with a set of emissions limitations; under the bubble concept, sources can control more than required at one emission point where control costs are relatively low in return for a comparable relaxation of controls at a second emission point where costs are higher.

Building Related Illness: Diagnosable illness whose cause and symptoms can be directly attributed to a specific pollutant source within a building (e.g., Legionnaire's disease, hypersensitivity, pneumonitis.)

Burial Ground (Graveyard): A disposal site for radioactive waste materials that uses earth or water as a shield.

By-product: Material, other than the principal product, generated as a consequence of an industrial process or as a breakdown product in a living system.

Cadmium (Cd): A heavy metal that accumulates in the environment.

Cap: A layer of clay, or other impermeable material installed over the top of a closed landfill to prevent entry of rainwater and minimize leachate.

Carbon Monoxide (CO): A colorless, odorless, poisonous gas produced by incomplete fossil fuel combustion.

Carcinogen: Any substance that can cause or aggravate cancer.

Carrying Capacity: 1. In recreation management, the amount of use a recreation area can sustain without loss of quality. 2. In wildlife management, the maximum number of animals an area can support during a given period.

Catalyst: A substance that changes the speed or yield of a chemical reaction without being consumed or chemically changed by the chemical reaction.

Catalytic Converter: An air pollution abatement device that removes pollutants from motor vehicle exhaust, either by oxidizing them into carbon dioxide and water or reducing them to nitrogen.

Cells: 1. In solid waste disposal, holes where waste is dumped, compacted, and covered with layers of dirt on a daily basis. 2. The smallest structural part of living matter capable of functioning as an independent unit.

Channelization: Straightening and deepening streams so water will move faster, a marsh-drainage tactic that can interfere with waste assimilation capacity, disturb fish and wildlife habitats, and aggravate flooding.

Chemical Compound: A distinct and pure substance formed by the union or two or more elements in definite proportion by weight.

Chisel Plowing: Preparing croplands by using a special implement that avoids complete inversion of the soil as in conventional plowing. Chisel plowing can leave a protective cover or crops residues on the soil surface to help prevent erosion and improve filtration.

Chlorinated Hydrocarbons: 1. Chemicals containing only chlorine, carbon, and hydrogen. These include a class of persistent, broad-spectrum insecticides that linger in the environment and accumulate in the food chain. Among them are DDT, aldrin, dieldrin, heptachlor, chlordane, lindane, endrin, Mirex, hexachloride, and toxaphene. Other examples include TCE, used as an industrial solvent. 2. Any chlorinated organic compounds including chlorinated solvents such as dichloromethane, trichloromethylene, chloroform.

Chlorination: The application of chlorine to drinking water, sewage, or industrial waste to disinfect or to oxidize undesirable compounds.

Chlorofluorocarbons (CFCs): A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere they drift into the upper atmosphere where their chlorine components destroy ozone.

Chronic Exposure: Multiple exposures occurring over an extended period of time or over a significant fraction of an animal's or human's lifetime (usually seven years to a lifetime.)

Circle of Poison: the import of crops from foreign countries that have been contaminated by pesticides produced by the importing country.

Clean Fuels: Blends or substitutes for gasoline fuels, including compressed natural gas, methanol, ethanol, and liquified petroleum gas.

Cleanup: Actions taken to deal with a release or threat of release of a hazardous substance that could affect humans and/or the environment. The term "cleanup" is sometimes used interchangeably with the terms remedial action, removal action, response action, or corrective action.

Clearcut: Harvesting all the trees in one area at one time, a practice that can encourage fast rainfall or snowmelt runoff, erosion, sedimentation of streams and lakes, and flooding.

Climate Change (also referred to as 'global climate change'): The term *climate change* is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, *climate change* has been used synonymously with the term, *global warming*; scientists however, tend to use the term in the wider sense to also include natural changes in climate.

Cloning: In biotechnology, obtaining a group of genetically identical cells from a single cell; making identical copies of a gene.

Coastal Zone: Lands and waters adjacent to the coast that exert an influence on the uses of the sea and its ecology, or whose uses and ecology are affected by the sea.

Cogeneration: The consecutive generation of useful thermal and electric energy from the same fuel source.

Columbian Exchange: The interchange of diseases, crop plants, livestock, cultural practices, and people between Eurasia/Africa and North/South America during the period after first contact in 1492.

Combined Sewer Overflows: Discharge of a mixture of storm water and domestic waste when the flow capacity of a sewer system is exceeded during rainstorms.

Commercial Waste: All solid waste emanating from business establishments such as stores, markets, office buildings, restaurants, shopping centers, and theaters.

Commodity Chain: a networked pathway along which a good travels from the site of raw material production, through processing and value-added, ultimately to the consumer as a finished product.

Common Property Resources: those resources owned and managed in common by a group or community, often managed through sophisticated institutions

Communism: a mode of social and economic organization in which communal ownership of productive capital is paramount and profit-seeking is central

Community: In ecology, an assemblage of populations of different species within a specified location in space and time. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake or the soil arthropod community in a forest.

Comparative Risk Assessment: Process that generally uses the judgement of experts to predict effects and set priorities among a wide range of environmental problems.

Compost: The relatively stable humus material that is produced from a composting process in which bacteria in soil mixed with garbage and degradable trash break down the mixture into fertilizer.

Composting: The controlled biological decomposition of organic material in the presence of air to form a humus-like material. Controlled methods of composting include mechanical mixing and aerating, ventilating the materials by dropping them through a vertical series of aerated chambers, or placing the compost in piles out in the open air and mixing it or turning it periodically.

Compressed Natural Gas (CNG): An alternative fuel for motor vehicles; considered one of the cleanest because of low hydrocarbon emissions and its vapors are relatively nonozone producing. However, vehicles fueled with CNG do emit a significant quantity of nitrogen oxides.

Concentration: The relative amount of a substance mixed with another substance. An example is five ppm of carbon monoxide in air or 1 mg/l of iron in water.

Conservation Easement: Easement restricting a landowner to land uses that that are compatible with long-term conservation and environmental values.

Conservation: Preserving and renewing, when possible, human and natural resources. The use, protection, and improvement of natural resources according to principles that will ensure their highest economic or social benefits.

Consumptive Water Use: Water removed from available supplies without return to a water resources system, e.g., water used in manufacturing, agriculture, and food preparation.

Contact Pesticide: A chemical that kills pests when it touches them, instead of by ingestion. Also, soil that contains the minute skeletons of certain algae that scratch and dehydrate waxy-coated insects.

Contaminant: Any physical, chemical, biological, or radiological substance or matter that has an adverse effect on air, water, or soil.

Contamination: Introduction into water, air, and soil of microorganisms, chemicals, toxic substances, wastes, or wastewater in a concentration that makes the medium unfit for its next intended use. Also applies to surfaces of objects, buildings, and various household and agricultural use products.

Contour Plowing: Soil tilling method that follows the shape of the land to discourage erosion.

Conventional Tilling: Tillage operations considered standard for a specific location and crop and that tend to bury the crop residues; usually considered as a base for determining the cost effectiveness of control practices.

Cooling Tower: A structure that helps remove heat from water used as a coolant; e.g., in electric power generating plants.

Cost Recovery: A legal process by which potentially responsible parties who contributed to contamination at a Superfund site can be required to reimburse the Trust Fund for money spent during any cleanup actions by the federal government.

Cost Sharing: A publicly financed program through which society, as a beneficiary of environmental protection, shares part of the cost of pollution control with those who must actually install the controls. In Superfund, for example, the government may pay part of the cost of a cleanup action with those responsible for the pollution paying the major share.

Cost/Benefit Analysis: A quantitative evaluation of the costs which would have incurred by implementing an environmental regulation versus the overall benefits to society of the proposed action.

Cradle-to-Grave or Manifest System: A procedure in which hazardous materials are identified and followed as they are produced, treated, transported, and disposed of by a series of permanent, linkable, descriptive documents (e.g. manifests). Commonly referred to as the cradle-to-grave system.

Cross Contamination: The movement of underground contaminants from one level or area to another due to invasive subsurface activities.

Cryptosporidium: A protozoan microbe associated with the disease cryptosporidiosis in man. The disease can be transmitted through ingestion of drinking water, person-to-person contact, or other pathways, and can cause acute diarrhea, abdominal pain, vomiting, fever, and can be fatal.

Cultural Ecology: A field of research concerned with the interrelationships between humans and their surrounding environment, typically involving detailed small-scale analysis of communities and livelihoods

Cultures and Stocks: Infectious agents and associated biologicals including cultures from medical and pathological laboratories; cultures and stocks of infectious agents from research and industrial laboratories; waste from the production of biologicals; discarded live and attenuated vaccines; and culture dishes and devices used to transfer, inoculate, and mix cultures.

Cumulative Exposure: The sum of exposures of an organism to a pollutant over a period of time.

DDT: The first chlorinated hydrocarbon insecticide chemical name: Dichloro-Diphenyl-Trichloroethane. It has a half-life of 15 years and can collect in fatty tissues of certain animals. EPA banned registration and interstate sale of DDT for virtually all but emergency uses in the United States in 1972 because of its persistence in the environment and accumulation in the food chain.

Decomposition: The breakdown of matter by bacteria and fungi, changing the chemical makeup and physical appearance of materials.

Decontamination: Removal of harmful substances such as noxious chemicals, harmful bacteria or other organisms, or radioactive material from exposed individuals, rooms and furnishings in buildings, or the exterior environment.

Degree-Day: A rough measure used to estimate the amount of heating required in a given area; is defined as the difference between the mean daily temperature and 65 degrees Fahrenheit. Degree-days are also calculated to estimate cooling requirements.

Density: A measure of how heavy a specific volume of a solid, liquid, or gas is in comparison to water. depending on the chemical.

Dermal Toxicity: The ability of a pesticide or toxic chemical to poison people or animals by contact with the skin.

Desertification: The degradation of arid and semiarid lands, resulting in lower levels of productivity and desert-like conditions.

Designer Bugs: Popular term for microbes developed through biotechnology that can degrade specific toxic chemicals at their source in toxic waste dumps or in ground water.

Diffusion: The movement of suspended or dissolved particles (or molecules) from a more concentrated to a less concentrated area. The process tends to distribute the particles or molecules more uniformly.

Dioxin: Any of a family of compounds known chemically as dibenzo-p-dioxins. Concern about them arises from their potential toxicity as contaminants in commercial products. Tests on laboratory animals indicate that it is one of the more toxic anthropogenic (man-made) compounds.

Direct Discharger: A municipal or industrial facility which introduces pollution through a defined conveyance or system such as outlet pipes; a point source.

Disinfectant: A chemical or physical process that kills pathogenic organisms in water, air, or on surfaces. Chlorine is often used to disinfect sewage treatment effluent, water supplies, wells, and swimming pools.

Dispersant: A chemical agent used to break up concentrations of organic material such as spilled oil.

Disposal Facilities: Repositories for solid waste, including landfills and combustors intended for permanent containment or destruction of waste materials. Excludes transfer stations and composting facilities.

Drainage Basin: The area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel.

Drainage Well: A well drilled to carry excess water off agricultural fields. Because they act as a funnel from the surface to the groundwater below. Drainage wells can contribute to groundwater pollution.

Drainage: Improving the productivity of agricultural land by removing excess water from the soil by such means as ditches or subsurface drainage tiles.

Drawdown: 1. The drop in the water table or level of water in the ground when water is being pumped from a well. 2. The amount of water used from a tank or reservoir. 3. The drop in the water level of a tank or reservoir.

Dredging: Removal of mud from the bottom of water bodies. This can disturb the ecosystem and causes silting that kills aquatic life. Dredging of contaminated muds can expose biota to heavy metals and other toxics. Dredging activities may be subject to regulation under Section 404 of the Clean Water Act.

Ecological Entity: In ecological risk assessment, a general term referring to a species, a group of species, an ecosystem function or characteristic, or a specific habitat or biome.

Ecological Impact: The effect that a man-caused or natural activity has on living organisms and their non-living (abiotic) environment.

Ecological Indicator: A characteristic of an ecosystem that is related to, or derived from, a measure of biotic or abiotic variable, that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability.

Ecological Integrity: A living system exhibits integrity if, when subjected to disturbance, it sustains and organizes self-correcting ability to recover toward a biomass end-state that is normal for that system. End-states other than the pristine or naturally whole may be accepted as normal and good.

Ecological Risk Assessment: The application of a formal framework, analytical process, or model to estimate the effects of human actions(s) on a natural resource and to interpret the significance of those effects in light of the uncertainties identified in each component of the assessment process. Such analysis includes initial hazard identification, exposure and dose-response assessments, and risk characterization.

Ecological/Environmental Sustainability: Maintenance of ecosystem components and functions for future generations.

Ecology: The relationship of living things to one another and their environment, or the study of such relationships.

Ecosystem Structure: Attributes related to the instantaneous physical state of an ecosystem; examples include species population density, species richness or evenness, and standing crop biomass.

Ecosystem: The interacting system of a biological community and its nonliving environmental surroundings.

Ecotone: A habitat created by the juxtaposition of distinctly different habitats; an edge habitat; or an ecological zone or boundary where two or more ecosystems meet.

Effluent: Wastewater—treated or untreated—that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Emergency and Hazardous Chemical Inventory: An annual report by facilities having one or more extremely hazardous substances or hazardous chemicals above certain weight limits.

Emission Cap: A limit designed to prevent projected growth in emissions from existing and future stationary sources from eroding any mandated reductions. Generally, such provisions require that any emission growth from facilities under the restrictions be offset by equivalent reductions at other facilities under the same cap.

Emission: Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.

Emissions Trading: The creation of surplus emission reductions at certain stacks, vents or similar emissions sources and the use of this surplus to meet or redefine pollution requirements applicable to other emissions sources. This allows one source to increase emissions when another source reduces them, maintaining an overall constant emission level. Facilities that reduce emissions substantially may "bank" their "credits" or sell them to other facilities or industries.

Endangered Species: Animals, birds, fish, plants, or other living organisms threatened with extinction by anthropogenic (man-caused) or other natural changes in their environment. Requirements for declaring a species endangered are contained in the Endangered Species Act.

End-of-the-pipe: Technologies such as scrubbers on smokestacks and catalytic convertors on automobile tailpipes that reduce emissions of pollutants after they have formed.

Engineered Controls: Method of managing environmental and health risks by placing a barrier between the contamination and the rest of the site, thus limiting exposure pathways.

Enlightenment: The historical philosophical movement in the 1700s and after emphasizing scientific methods, empiricism, and rationality.

Environmental Determinism: A largely discredited body of theory that explains human culture, history, and race solely with reference to climatic and topographical conditions

Environmental Equity/Justice: Equal protection from environmental hazards for individuals, groups,

or communities regardless of race, ethnicity, or economic status.
This applies to the development, implementation, and enforcement of environmental laws, regulations, and policies, and implies that no population of people should be forced to shoulder a disproportionate share of negative environmental impacts of pollution or environmental hazard due to a lack of political or economic strength levels.

Environmental Indicator: A measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management programs or of the state or condition of the environment.

Environmental Justice: The fair treatment of people of all races, cultures, incomes, and educational levels with respect to the development and enforcement of environmental laws, regulations, and policies.

Environmental Sustainability: Long-term maintenance of ecosystem components and functions for future generations.

Environmental/Ecological Risk: The potential for adverse effects on living organisms associated with pollution of the environment by effluents, emissions, wastes, or accidental chemical releases; energy use; or the depletion of natural resources.

Epidemiology: Study of the distribution of disease, or other health-related states and events in human populations, as related to age, sex, occupation, ethnicity, and economic status in order to identify and alleviate health problems and promote health.

Equilibrium: In relation to radiation, the state at which the radioactivity of consecutive elements within a radioactive series is neither increasing nor decreasing.

Ethanol: An alternative automotive fuel derived from grain and corn; usually blended with gasoline to form gasohol.

Eutrophication: The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears. During the later stages of eutrophication the water body is choked by abundant plant life due to higher levels of nutritive compounds such as nitrogen and phosphorus. Human activities can accelerate the process.

Evapotranspiration: The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.

Exotic Species: A species that is not indigenous to a region.

Exposure: The amount of radiation or pollutant present in a given environment that represents a potential health threat to living organisms.

Externality: The cost or benefit in an action, transaction, or exchange that is borne by parties external to that transaction.

Fecal Coliform Bacteria: Bacteria found in the intestinal tracts of mammals. Their presence in water or sludge is an indicator of pollution and possible contamination by pathogens.

Feng Shui: Geomantic principles for the arrangement of the built environment to assure good fortune and health.

Filtration: A treatment process, under the control of qualified operators, for removing solid (particulate) matter from water by means of porous media such as sand or a man-made filter; often used to remove particles that contain pathogens.

Floodplain: The flat or nearly flat land along a river or stream or in a tidal area that is covered by water during a flood.

Fluoridation: The addition of a chemical to increase the concentration of fluoride ions in drinking water to reduce the incidence of tooth decay.

Food Chain: A sequence of organisms, each of which uses the next, lower member of the sequence as a food source.

Food Web: The feeding relationships by which energy and nutrients are transferred from one species to another.

Fossil Fuel: Fuel derived from ancient organic remains; e.g. peat, coal, crude oil, and natural gas.

Free Trade Associations/Zones: Groups of nations or regions where tariff and quotas barriers are reduced or eliminated to spur increased economic activity.

Fresh Water: Water that generally contains less than 1,000 milligrams-per-liter of dissolved solids.

Fuel Efficiency: The proportion of energy released by fuel combustion that is converted into useful energy.

Fugitive Emissions: Emissions not caught by a capture system.

Fungicide: Pesticides which are used to control, deter, or destroy fungi.

Fungus (Fungi): Molds, mildews, yeasts, mushrooms, and puffballs, a group of organisms lacking in chlorophyll (i.e., are not photosynthetic) and which are usually non-mobile, filamentous, and multicellular. Some grow in soil, others attach themselves to decaying trees and other plants whence they obtain nutrients. Some are pathogens, others stabilize sewage and digest composted waste.

Genetic Engineering: A process of inserting new genetic information into existing cells in order to modify a specific organism for the purpose of changing one of its characteristics.

Geographic Information System (GIS): A computer system designed for storing, manipulating, analyzing, and displaying data in a geographic context.

Giardia Lamblia: Protozoan in the feces of humans and animals that can cause severe gastrointestinal ailments. It is a common contaminant of surface waters.

Global Warming: An increase in the near surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases. Scientists generally agree that the Earth's surface has warmed by about 1 degree Fahrenheit in the past 140 years. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that increased concentrations of greenhouse gases are causing an increase in the Earth's surface temperature and that increased concentrations of sulfate aerosols have led to relative cooling in some regions, generally over and downwind of heavily industrialized areas.

Gray Water: Domestic wastewater composed of wash water from kitchen, bathroom, and laundry sinks, tubs, and washers.

Greenhouse Effect: The warming of the Earth's atmosphere attributed to a buildup of carbon dioxide or other gases; some scientists think that this buildup allows the sun's rays to heat the Earth, while making the infrared radiation atmosphere opaque to infrared radiation, thereby preventing a counterbalancing loss of heat.

Greenhouse Gas: A gas, such as carbon dioxide or methane, which contributes to potential climate change.

Ground Water: The supply of fresh water found beneath the Earth's surface, usually in aquifers, which supply wells and springs. Because ground water is a major source of drinking water, there is growing concern over contamination from leaching agricultural or industrial pollutants or leaking underground storage tanks.

Ground-Penetrating Radar: A geophysical method that uses high frequency electromagnetic waves to obtain subsurface information.

Ground-Water Discharge: Ground water entering near coastal waters which has been contaminated by landfill leachate, deep well injection of hazardous wastes, septic tanks, etc.

Habitat: The place where a population (e.g., human, animal, plant, microorganism) lives and its surroundings, both living and non-living.

Half-Life: 1. The time required for a pollutant to lose one-half of its original coconcentrationor example, the biochemical half-life of DDT in the environment is 15 years. 2. The time required for half of the atoms of a radioactive element to undergo self-transmutation or decay (half-life of radium is 1620 years). 3. The time required for the elimination of half a total dose from the body.

Hazard Assessment: Evaluating the effects of a stressor or determining a margin of safety for an organism by comparing the concentration which causes toxic effects with an estimate of exposure to the organism.

Heat Island Effect: A "dome" of elevated temperatures over an urban area caused by structural and pavement heat fluxes, and pollutant emissions.

Herbicide: A chemical pesticide designed to control or destroy plants, weeds, or grasses.

High Seas: Portions of the ocean beyond the limits of national jurisdictions as defined by the Third United Nations Convention on the Law of the Sea.

High-Level Nuclear Waste Facility: Plant designed to handle disposal of used nuclear fuel, high-level radioactive waste, and plutonium waste.

High-Level Radioactive Waste (HLRW): Waste generated in core fuel of a nuclear reactor, found at nuclear reactors or by nuclear fuel reprocessing; is a serious threat to anyone who comes near the waste without shielding.

High-Risk Community: A community located within the vicinity of numerous sites of facilities or other potential sources of envienvironmental exposure/health hazards which may result in high levels of exposure to contaminants or pollutants.

Host: 1. In genetics, the organism, typically a bacterium, into which a gene from another organism is transplanted. 2. In medicine, an animal infected or parasitized by another organism.

Hydrocarbons (HC): Chemical compounds that consist entirely of carbon and hydrogen.

Hydrogeology: The geology of ground water, with particular emphasis on the chemistry and movement of water.

Hypersensitivity Diseases: Diseases characterized by allergic responses to pollutants; diseases most clearly associated with indoor air quality are asthma, rhinitis, and pneumonic hypersensitivity.

Ignitable: Capable of burning or causing a fire.

Incineration: A treatment technology involving destruction of waste by controlled burning at high temperatures; e.g., burning sludge to remove the water and reduce the remaining residues to a safe, non-burnable ash that can be disposed of safely on land, in some waters, or in underground locations.

Incinerator: A furnace for burning waste under controlled conditions.

Indicator: In biology, any biological entity or processes, or community whose characteristics show the presence of specific environmental conditions. 2. In chemistry, a substance that shows a visible change, usually of color, at a desired point in a chemical reaction. 3. A device that indicates the result of a measurement; e.g. a pressure gauge or a moveable scale.

Indirect Discharge: Introduction of pollutants from a non-domestic source into a publicly owned waste-treatment system. Indirect dischargers can be commercial or industrial facilities whose wastes enter local sewers.

Indirect Source: Any facility or building, property, road or parking area that attracts motor vehicle traffic and, indirectly, causes pollution.

Indoor Air Pollution: Chemical, physical, or biological contaminants in indoor air.

Industrial Waste: Unwanted materials from an industrial operation; may be liquid, sludge, solid, or hazardous waste.

Infectious Agent: Any organism, such as a pathogenic virus, parasite, or or bacterium, that is capable of invading body tissues, multiplying, and causing disease.

Infiltration: 1. The penetration of water through the ground surface into sub-surface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls. 2. The technique of applying large volumes of waste water to land to penetrate the surface and percolate through the underlying soil.

Inorganic Chemicals: Chemical substances of mineral origin, not of basically carbon structure.

Insecticide: A pesticide compound specifically used to kill or prevent the growth of insects.

Interstate Commerce Clause: A clause of the U.S. Constitution which reserves to the federal government the right to regulate the conduct of business across state lines. Under this clause, for example, the U.S. Supreme Court has ruled that states may not inequitably restrict the disposal of out-of-state wastes in their jurisdictions.

Interstate Waters: Waters that flow across or form part of state or international boundaries; e.g., the Great Lakes, the Mississippi River, or coastal waters.

Inversion: A layer of warm air that prevents the rise of cooling air and traps pollutants beneath it; can cause an air pollution episode.

Irradiated Food: Food subject to brief radioactivity, usually gamma rays, to kill insects, bacteria, and mold, and to permit storage without refrigeration.

Irradiation: Exposure to radiation of wavelengths shorter than those of visible light (gamma, x-ray, or ultra- violet), for medical purposes, to sterilize milk or other foodstuffs, or to induce polymerization of monomers or vulcanization of rubber.

Irrigation: Applying water or wastewater to land areas to supply the water and nutrient needs of plants.

Karst: A geologic formation of irregular limestone deposits with sinks, underground streams, and caverns.

Kinetic Energy: Energy possessed by a moving object or water body.

Laboratory Animal Studies: Investigations using animals as surrogates for humans.

Landfills: 1. Sanitary landfills are disposal sites for non-hazardous solid wastes spread in layers, compacted to the smallest practical volume, and covered by material applied at the end of each operating day. 2. Secure chemical landfills are disposal sites for hazardous waste, selected and designed to minimize the chance of release of hazardous substances into the environment.

Landscape Ecology: The study of the distribution patterns of communities and ecosystems, the ecological processes that affect those patterns, and changes in pattern and process over time.

Landscape: The traits, patterns, and structure of a specific geographic area, including its biological composition, its physical environment, and its anthropogenic or social patterns. An area where interacting ecosystems are grouped and repeated in similar form.

Lead (Pb): A heavy metal that is hazardous to health if breathed or swallowed. Its use in gasoline, paints, and plumbing compounds has been sharply restricted or eliminated by federal laws and regulations.

Lethal Dose 50: Also referred to as LD50, the dose of a toxicant that will kill 50 percent of test organisms within a designated period of time; the lower the LD 50, the more toxic the compound.

Lifetime Exposure: Total amount of exposure to a substance that a human would receive in a lifetime (usually assumed to be 70 years).

Limnology: The study of the physical, chemical, hydrological, and biological aspects of fresh water bodies.

Litter: 1. The highly visible portion of solid waste carelessly discarded outside the regular garbage and trash collection and disposal system. 2. leaves and twigs fallen from forest trees.

Low-Level Radioactive Waste (LLRW): Wastes less hazardous than most of those associated with a nuclear reactor; generated by hospitals, research laboratories, and certain industries. The Department of Energy, Nuclear Regulatory Commission, and EPA share responsibilities for managing them.

Marsh: A type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh or saltwater, tidal or nontidal.

Medical Waste: Any solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, excluding hazardous waste identified or listed under 40 CFR Part 261 or any household waste as defined in 40 CFR Sub-section 261.4 (b)(1).

Mercury (Hg): Heavy metal that can accumulate in the environment and is highly toxic if breathed or swallowed.

Methane: A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds. A major component of natural gas used in the home.

Methanol: An alcohol that can be used as an alternative fuel or as a gasoline additive. It is less volatile than gasoline; when blended with gasoline it lowers the carbon monoxide emissions but increases hydrocarbon emissions. Used as pure fuel, its emissions are less ozone-forming than those from gasoline. Poisonous to humans and animals if ingested.

Microclimate: 1. Localized climate conditions within an urban area or neighborhood. 2. The climate around a tree or shrub or a stand of trees.

Mitigation: Measures taken to reduce adverse impacts on the environment.

Monoculture: Agriculture in which only one crop is planted at a time, usually over a large area

Montreal Protocol: Treaty, signed in 1987, governs stratospheric ozone protection and research, and the production and use of ozone-depleting substances. It provides for the end of production of ozone-depleting substances such as CFCS. Under the Protocol, various research groups continue to assess the ozone layer.

Morbidity: Rate of disease incidence.

Municipal Sewage: Wastes (mostly liquid) orginating from a community; may be composed of domestic wastewaters and/or industrial discharges.

Municipal Solid Waste: Common garbage or trash generated by industries, businesses, institutions, and homes.

Mutagen/Mutagenicity: An agent that causes a permanent genetic change in a cell other than that which occurs during normal growth. Mutagenicity is the capacity of a chemical or physical agent to cause such permanent changes.

Natural Resources: Objects and entities in the material world considered by people to have utility or value, specifically including only those materials not produced through human industry.

Navigable Waters: Traditionally, waters sufficiently deep and wide for navigation by all, or specified vessels; such waters in the United States come under federal jurisdiction and are protected by certain provisions of the Clean Water Act.

Netting: A concept in which all emissions sources in the same area that owned or controlled by a single company are treated as one large source, thereby allowing flexibility in controlling individual sources in order to meet a single emissions standard.

NIMBY: An acronym for “Not in My Backyard” that identifies the tendency for individuals and communities to oppose the siting of noxious or hazardous materials and activities in their vicinity. It implies a limited or parochial political vision of environmental justice.

Nitrate: A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and which can have harmful effects on humans and animals. Nitrates in water can cause severe illness in infants and domestic animals. A plant nutrient and inorganic fertilizer, nitrate is found in septic systems, animal feed lots, agricultural fertilizers, manure, industrial waste waters, sanitary landfills, and garbage dumps.

Nitrification: The process whereby ammonia in wastewater is oxidized to nitrite and then to nitrate by bacterial or chemical reactions.

No Till: Planting crops without prior seedbed preparation, into an existing cover crop, sod, or crop residues, and eliminating subsequent tillage operations.

Nonpoint Sources: Diffuse pollution sources (i.e. without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by storm water. Common nonpoint sources are agriculture, forestry, urban, mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Nuclear Reactors and Support Facilities: Uranium mills, commercial power reactors, fuel reprocessing plants, and uranium enrichment facilities.

Nuclear Winter: Prediction by some scientists that smoke and debris rising from massive fires of a nuclear war could block sunlight for weeks or months, cooling the earth's surface and producing climate changes that could, for example, negatively affect world agricultural and weather patterns.

Nutrient: Any substance assimilated by living things that promotes growth. The term is generally applied to nitrogen and phosphorus in wastewater, but is also applied to other essential and trace elements.

Oil Spill: An accidental or intentional discharge of oil which reaches bodies of water. Can be controlled by chemical dispersion, combustion, mechanical containment, and/or adsorption. Spills from tanks and pipelines can also occur away from water bodies, contaminating the soil, getting into sewer systems and threatening underground water sources.

Open Dump: An uncovered site used for disposal of waste without environmental controls.

Osmosis: The passage of a liquid from a weak solution to a more concentrated solution across a semipermeable membrane that allows passage of the solvent (water) but not the dissolved solids.

Ozone (O_3): Found in two layers of the atmosphere, the stratosphere and the troposphere. In the stratosphere (the atmospheric layer 7 to 10 miles or more above the earth's surface) ozone is a natural form of oxygen that provides a protective layer shielding the earth from ultraviolet radiation.In the troposphere (the layer extending up 7 to 10 miles from the earth's surface), ozone is a chemical oxidant and major component of photochemical smog. It can seriously impair the respiratory system and is one of the most widespread of all the criteria pollutants for which the Clean Air Act required EPA to set standards. Ozone in the troposphere is produced through complex chemical reactions of nitrogen oxides, which are among the primary pollutants emitted by combustion sources; hydrocarbons, released into the atmosphere through the combustion, handling and processing of petroleum products; and sunlight.

Ozone Depletion: Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life. This destruction of ozone is caused by the breakdown of certain chlorine and/or bromine containing compounds (chlorofluorocarbons or halons), which break down when they reach the stratosphere and then catalytically destroy ozone molecules.

Ozone Hole: A thinning break in the stratospheric ozone layer. Designation of amount of such depletion as an "ozone hole" is made when the detected amount of depletion exceeds 50 percent. Seasonal ozone holes have been observed over both the Antarctic and Arctic regions, part of Canada, and the extreme northeastern United States.

Ozone Layer: The protective layer in the atmosphere, about 15 miles above the ground, that absorbs some of the sun's ultraviolet rays, thereby reducing the amount of potentially harmful radiation that reaches the earth's surface.

Pandemic: A widespread epidemic throughout an area, nation or the world.

Particulates: 1. Fine liquid or solid particles such as dust, smoke, mist, fumes, or smog, found in air or emissions. 2. Very small solids suspended in water; they can vary in size, shape, density and electrical charge and can be gathered together by coagulation and flocculation.

Parts Per Billion (ppb)/Parts Per Million (ppm): Units commonly used to express contamination ratios, as in establishing the maximum permissible amount of a contaminant in water, land, or air.

Pathogens: Microorganisms (e.g., bacteria, viruses, or parasites) that can cause disease in humans, animals and plants.

Peak Electricity Demand: The maximum electricity used to meet the cooling load of a building or buildings in a given area.

Percolating Water: Water that passes through rocks or soil under the force of gravity.

Percolation: 1. The movement of water downward and radially through subsurface soil layers, usually continuing downward to ground water. Can also involve upward movement of water. 2. Slow seepage of water through a filter.

Permeability: The rate at which liquids pass through soil or other materials in a specified direction.

Permit: An authorization, license, or equivalent control document issued by EPA or an approved state agency to implement the requirements of an environmental regulation; e.g., a permit to operate a wastewater treatment plant or to operate a facility that may generate harmful emissions.

Persistence: Refers to the length of time a compound stays in the environment, once introduced. A compound may persist for less than a second or indefinitely.

Pest: An insect, rodent, nematode, fungus, weed or other form of terrestrial or aquatic plant or animal life that is injurious to health or the environment.

Pesticide: Substances or mixture there of intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.

Petroleum: Crude oil or any fraction thereof that is liquid under normal conditions of temperature and pressure. The term includes petroleum-based substances comprising a complex blend of hydrocarbons derived from crude oil through the process of separation, conversion, upgrading, and finishing, such as motor fuel, jet oil, lubricants, petroleum solvents, and used oil.

pH: An expression of the intensity of the basic or acid condition of a liquid; may range from 0 to 14, where 0 is the most acid and 7 is neutral. Natural waters usually have a pH between 6.5 and 8.5.

Photosynthesis: The manufacture by plants of carbohydrates and oxygen from carbon dioxide mediated by chlorophyll in the presence of sunlight.

Plankton: Tiny plants and animals that live in water.

Plastics: Nonmetallic chemoreactive compounds molded into rigid or pliable construction materials, fabrics, etc.

Point Source: A stationary location or fixed facility from which pollutants are discharged; any single identifiable source of pollution; e.g., a pipe, ditch, ship, ore pit, factory smokestack.

Political Ecology: A field of research concerned with the relationship of systems of social and economic power to environmental conditions, natural resources, and conservation.

Pollen: The fertilizing element of flowering plants; background air pollutant.

Pollutant: Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution: Generally, the presence of a substance in the environment that because of its chemical composition or quantity prevents the functioning of natural processes and produces undesirable environmental and health effects.Under the Clean Water Act, for example, the term has been defined as the man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Polychlorinated Biphenyls: A group of toxic, persistent chemicals used in electrical transformers and capacitors for insulating purposes, and in gas pipeline systems as lubricant. The sale and new use of these chemicals, also known as PCBs, were banned by law in 1979.

Population at Risk: A population subgroup that is more likely to be exposed to a chemical, or is more sensitive to the chemical, than is the general population.

Porosity: Degree to which soil, gravel, sediment, or rock is permeated with pores or cavities through which water or air can move.

Postcolonialism: An analytical approach to explaining the persisting conditions of exploitation and domination between historical colonial powers and previously colonized parts of the globe. From this perspective colonial habits, power relations, and ways of thinking remain ingrained in current scientific, political and economic relationships.

Precautionary Principle: When information about potential risks is incomplete, basing decisions about the best ways to manage or reduce risks on a preference for avoiding unnecessary health risks instead of on unnecessary economic expenditures.

Primary Waste Treatment: First steps in wastewater treatment; screens and sedimentation tanks are used to remove most materials that float or will settle. Primary treatment removes about 30 percent of carbonaceous biochemical oxygen demand from domestic sewage.

Prior Appropriation: A doctrine of water law that allocates the rights to use water on a first-come, first-served basis.

Producers: Plants that perform photosynthesis and provide food to consumers.

Proteins: Complex nitrogenous organic compounds of high molecular weight made of amino acids; essential for growth and repair of animal tissue. Many, but not all, proteins are enzymes.

Protozoa: One-celled animals that are larger and more complex than bacteria. May cause disease.

Public Water System: A system that provides piped water for human consumption to at least 15 service connections or regularly serves 25 individuals.

Radioactive Decay: Spontaneous change in an atom by emission of of charged particles and/or gamma rays; also known as radioactive disintegration and radioactivity.

Radioactive Waste: Waste that emits energy as rays, waves, streams or energetic particles. Radioactive materials are often mixed with hazardous waste, from nuclear reactors, research institutions, or hospitals.

Radon: A colorless naturally occurring, radioactive, inert gas formed by radioactive decay of radium atoms in soil or rocks.

Rational Choice Theory: A theory of individual decision-making that views human actions as motivated by seeking the most benefit for the least coast.

Recombinant DNA: The new DNA that is formed by combining pieces of DNA from different organisms or cells.

Recycle/Reuse: Minimizing waste generation by recovering and reprocessing usable products that might otherwise become waste (i.e., recycling of aluminum cans, paper, and bottles, etc.)

Red Tide: A proliferation of a marine plankton toxic and often fatal to fish, perhaps stimulated by the addition of nutrients. A tide can be red, green, or brown, depending on the coloration of the plankton.

Reforestation: Conversion of land to forest cover on deforested land.

Remote Sensing: The collection and interpretation of information about an object without physical contact with the object; e.g., satellite imaging, aerial photography, and open path measurements.

Reservoir: Any natural or artificial holding area used to store, regulate, or control water.

Residential Use: Pesticide application in and around houses, office buildings, apartment buildings, motels, and other living or working areas.

Residential Waste: Waste generated in single and multi-family homes, including newspapers, clothing, disposable tableware, food packaging, cans, bottles, food scraps, and yard trimmings other than those that are diverted to backyard composting.

Reuse: Using a product or component of municipal solid waste in its original form more than once; e.g., refilling a glass bottle that has been returned or using a coffee can to hold nuts and bolts.

Reverse Osmosis: A treatment process used in water systems by adding pressure to force water through a semi-permeable membrane. Reverse osmosis removes most drinking water contaminants. Also used in wastewater treatment. Large-scale reverse osmosis plants are being developed.

Ribonucleic Acid (RNA): A molecule that carries the genetic message from DNA to a cellular protein-producing mechanism.

Riparian Habitat: Areas adjacent to rivers and streams with a differing density, diversity, and productivity of plant and animal species relative to nearby uplands.

Riparian Rights: Entitlement of a land owner to certain uses of water on or bordering the property, including the right to prevent diversion or misuse of upstream waters. Generally a matter of state law.

Risk Assessment: Qualitative and quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence and/or use of specific pollutants.

Risk Communication: The exchange of information about health or environmental risks among risk assessors and managers, the general public, news media, interest groups, etc.

Risk Management: The process of evaluating and selecting alternative regulatory and non-regulatory responses to risk. The selection process necessarily requires the consideration of legal, economic, and behavioral factors.

Risk: A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

River Basin: The land area drained by a river and its tributaries.

Rodenticide: A chemical or agent used to destroy rats or other rodent pests, or to prevent them from damaging food, crops, etc.

Sanitation: Control of physical factors in the human environment that could harm development, health, or survival.

Secondary Treatment: The second step in most publicly owned waste treatment systems in which bacteria consume the organic parts of the waste. It is accomplished by bringing together waste, bacteria, and oxygen in trickling filters or in the activated sludge process. This treatment removes floating and settleable solids and about 90 percent of the oxygen-demanding substances and suspended solids. Disinfection is the final stage of secondary treatment.

Sediments: Soil, sand, and minerals washed from land into water, usually after rain. They pile up in reservoirs, rivers and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall.

Senescence: The aging process. Sometimes used to describe lakes or other bodies of water in advanced stages of eutrophication. Also used to describe plants and animals.

Septic System: An on-site system designed to treat and dispose of domestic sewage. A typical septic system consists of tank that receives waste from a residence or business and a system of tile lines or a pit for disposal of the liquid effluent (sludge) that remains after decomposition of the solids by bacteria in the tank and must be pumped out periodically.

Sewage: The waste and wastewater produced by residential and commercial sources and discharged into sewers.

Sewer: A channel or conduit that carries wastewater and storm-water runoff from the source to a treatment plant or receiving stream. "Sanitary" sewers carry household, industrial, and commercial waste. "Storm" sewers carry runoff from rain or snow. "Combined" sewers handle both.

Sick Building Syndrome: Building whose occupants experience acute health and/or comfort effects that appear to be linked to time spent therein, but where no specific illness or cause can be identified. Complaints may be localized in a particular room or zone, or may spread throughout the building.

Silviculture: Management of forest land for timber.

Sludge: A semi-solid residue from any of a number of air or water treatment processes; can be a hazardous waste.

Smog: Air pollution typically associated with oxidants.

Smoke: Particles suspended in air after incomplete combustion.

Soil and Water Conservation Practices: Control measures consisting of managerial, vegetative, and structural practices to reduce the loss of soil and water.

Soil Moisture: The water contained in the pore space of the unsaturated zone.

Solid Waste: Nonliquid, nonsoluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes hazardous substances. Solid wastes also include sewage sludge, agricultural refuse, demolition wastes, and mining residues. Technically, solid waste also refers to liquids and gases in containers.

Species: 1. A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2. An organism belonging to belonging to such a category.

Sprawl: Unplanned development of open land.

Spring: Ground water seeping out of the earth where the water table intersects the ground surface.

Stakeholder: Any organization, governmental entity, or individual that has a stake in or may be impacted by a given approach to environmental regulation, pollution prevention, energy conservation, etc.

Stratification: Separating into layers.

Stratigraphy: Study of the formation, composition, and sequence of sediments, whether consolidated or not.

Stratosphere: The portion of the atmosphere 10-to-25 miles above the earth's surface.

Structural Adjustment: A set of policies, typically imposed by multilateral lending agencies like the World Bank and the International Monetary Fund during a national financial crisis, which imposes restrictions on government trade regulations, subsidies, and labor / environmental standards.

Surface Runoff: Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes.

Surface Water: All water naturally open to the atmosphere (rivers, lakes, reservoirs, ponds, streams, impoundments, seas, estuaries, etc.).

Suspended Solids: Small particles of solid pollutants that float on the surface of, or are suspended in, sewage or other liquids. They resist removal by conventional means.

Swamp: A type of wetland dominated by woody vegetation but without appreciable peat deposits. Swamps may be fresh or salt water and tidal or nontidal.

Systemic Pesticide: A chemical absorbed by an organism that interacts with the organism and makes the organism toxic to pests.

Tailings: Residue of raw material or waste separated out during the processing of crops or mineral ores.

Tailpipe Standards: Emissions limitations applicable to mobile source engine exhausts.

Technology-Based Standards: Industry-specific effluent limitations applicable to direct and indirect sources which are developed on a category-by-category basis using statutory factors, not including water-quality effects.

Teratogenesis: The introduction of nonhereditary birth defects in a developing fetus by exogenous factors such as physical or chemical agents acting in the womb to interfere with normal embryonic development.

Tertiary Treatment: Advanced cleaning of wastewater that goes beyond the secondary or biological stage, removing nutrients such as phosphorus, nitrogen, and most BOD and suspended solids.

Tidal Marsh: Low, flat marshlands traversed by channels and tidal hollows, subject to tidal inundation; normally, the only vegetation present is salt-tolerant bushes and grasses.

Tillage: Plowing, seedbed preparation, and cultivation practices.

Topography: The physical features of a surface area including relative elevations and the position of natural and man-made (anthropogenic) features.

Total Dissolved Solids (TDS): All material that passes the standard glass river filter; now called total filtrable residue. Term is used to reflect salinity.

Toxic Release Inventory: Database of toxic releases in the United States compiled from SARA Title III Section 313 reports.

Toxic Waste: A waste that can produce injury if inhaled, swallowed, or absorbed through the skin.

Toxicity: The degree to which a substance or mixture of substances can harm humans or animals. *Acute toxicity* involves harmful effects in an organism through a single or short-term exposure. *Chronic toxicity* is the ability of a substance or mixture of substances to cause harmful effects over an extended period, usually upon repeated or continuous exposure sometimes lasting for the entire life of the exposed organism. *Subchronic toxicity* is the ability of the substance to cause effects for more than one year but less than the lifetime of the exposed organism.

Transmissivity: The ability of an aquifer to transmit water.

Transpiration: The process by which water vapor is lost to the atmosphere from living plants. The term can also be applied to the quantity of water thus dissipated.

Treatment Plant: A structure built to treat wastewater before discharging it into the environment.

Trust Fund (CERCLA): A fund set up under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to help pay for cleanup of hazardous waste sites and for legal action to force those responsible for the sites to clean them up.

Tundra: A type of treeless ecosystem dominated by lichens, mosses, grasses, and woody plants. Tundra is found at high latitudes (arctic tundra) and high altitudes (alpine tundra). Arctic tundra is underlain by permafrost and is usually water saturated.

Ultraviolet Rays: Radiation from the sun that can be useful or potentially harmful. UV rays from one part of the spectrum (UV-A) enhance plant life. UV rays from other parts of the spectrum (UV-B) can cause skin cancer or other tissue damage. The ozone layer in the atmosphere partly shields us from ultraviolet rays reaching the earth's surface.

Underground Storage Tank (UST): A tank located at least partially underground and designed to hold gasoline or other petroleum products or chemicals.

Unsaturated Zone: The area above the water table where soil pores are not fully saturated, although some water may be present.

Urban Runoff: Storm water from city streets and adjacent domestic or commercial properties that carries pollutants of various kinds into the sewer systems and receiving waters.

User Fee: Fee collected from only those persons who use a particular service, as compared to one collected from the public in general.

Vadose Zone: The zone between land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore space also typically contains air or other gases. The capillary fringe is included in the vadose zone.

Value-added: A procedure that increases the worth of a product or raw material through transformation and processing.

Vapor: The gas given off by substances that are solids or liquids at ordinary atmospheric pressure and temperatures.

Vector: 1. An organism, often an insect or rodent, that carries disease. 2. Plasmids, viruses, or bacteria used to transport genes into a host cell. A gene is placed in the vector; the vector then “infects” the bacterium.

Viscosity: The molecular friction within a fluid that produces flow resistance.

Volatile: Any substance that evaporates readily.

Waste Generation: The weight or volume of materials and products that enter the waste stream before recycling, composting, landfilling, or combustion takes place. Also can represent the amount of waste generated by a given source or category of sources.

Waste Treatment Plant: A facility containing a series of tanks, screens, filters and other processes by which pollutants are removed from water.

Waste: 1. Unwanted materials left over from a manufacturing process. 2. Refuse from places of human or animal habitation.

Waste-to-Energy Facility/Municipal-Waste Combustor: Facility where recovered municipal solid waste is converted into a usable form of energy, usually via combustion.

Wastewater: The spent or used water from a home, community, farm, or industry that contains dissolved or suspended matter.

Water Pollution: The presence in water of enough harmful or objectionable material to damage the water’s quality.

Water Supplier: One who owns or operates a public water system.

Water Supply System: The collection, treatment, storage, and distribution of potable water from source to consumer.

Water Table: The level of groundwater.

Water Well: An excavation where the intended use is for location, acquisition, development, or artificial recharge of ground water.

Watershed Approach: A coordinated framework for environmental management that focuses public and private efforts on the highest priority problems within hydrologically-defined geographic areas taking into consideration ground and surface flow.

Watershed: The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Weight of Scientific Evidence: Considerations in assessing the interpretation of published information about toxicity—quality of testing methods, size and power of study design, consistency of results across studies, and biological plausibility of exposure-response relationships and statistical associations.

Weir: 1. A wall or plate placed in an open channel to measure the flow of water. 2. A wall or obstruction used to control flow from settling tanks and clarifiers to ensure a uniform flow rate and avoid short-circuiting.

Well: A bored, drilled, or driven shaft, or a dug hole whose depth is greater than the largest surface dimension and whose purpose is to reach underground water supplies or oil, or to store or bury fluids below ground.

Wetlands: An area that is saturated by surface or ground water with vegetation adapted for life under those soil conditions, as swamps, bogs, fens, marshes, and estuaries.

Wildlife Refuge: An area designated for the protection of wild animals, within which hunting and fishing are either prohibited or strictly controlled.

Xenobiota: Any biotum displaced from its normal habitat; a chemical foreign to a biological system.

Yard Waste: The part of solid waste composed of grass clippings, leaves, twigs, branches, and other garden refuse.

Yield: The quantity of water (expressed as a rate of flow or total quantity per year) that can be collected for a given use from surface or groundwater sources.

Zooplankton: Small (often microscopic) free-floating aquatic plants or animals.

Appendix

UNITED NATIONS MAIN ENVIRONMENTAL INDICATORS

Environment statistics covering a range of issues related to Water, Air, Waste and Land, are compiled by the United Nations Statistics Division, Department of Economic and Social Affairs. The data are official data supplied by national statistical offices and/or ministries of environment (or equivalent institutions) in countries in response to a biennial UNSD/UNEP questionnaire, sent out in March 2004. They are supplemented by data taken from UNFCCC (United Nations Framework Convention on Climate Change) for data on greenhouse gas emissions, and FAO (Food and Agriculture Organisation of the United Nations, for data on water resources. Data from OECD countries and from most European countries are taken from OECD and from Eurostat. For land area, agricultural area and forest area, all data are from FAO, awaiting the results of an in-depth analysis of the differences between FAO data and country data sent to UNSD/UNEP.

Results show that environment statistics is still in an early stage of development in many countries, and data are often sparse. Information on the data quality and comparability is given at the end of each table.

Data are provided for the following topics:

Water	**Air Pollution**	**Climate Change**	**Waste**	**Land Use**
Water resources	SO2 emissions	Greenhouse gas emissions	Municipal waste collection	Area of country
Public water supply	NOx emissions	CO2 emissions	Municipal waste treatment	Forest area
Waste water		CH4 and N2O emissions	Hazardous waste	Agricultural land

ENVIRONMENTAL INDICATORS

Water

Water resources: long term annual average *last update: April 2007*

	Precipitation mio m3	Internal flow mio m3	Actual external inflow of surface and ground waters mio m3	Total renewable fresh water resources mio m3	Total renewable fresh water resources per capita m3/person
Afghanistan	213 429	55 000	10 000	65 000	2 177
Albania	42 700	26 900	14 800	41 700	13 324
Algeria	211 498	13 900	420	14 320	436
Andorra	406[1]	...	...	...	...
Angola	1 258 793	184 000	0	184 000	11 542
Antigua and Barbuda	500	52	0	52	638
Argentina	1 642 104	276 000	538 000	814 000	21 008
Armenia	17 640	6 317	940	7 257	2 406[*]
Australia	3 631 000	387 000	0	387 000	19 201[*]
Austria	92 000	50 000	27 000	77 000	9 402[*]
Azerbaijan	36 978	10 330	20 573	30 903	3 674[*]
Bahamas	17 934	20	0	20	62
Bahrain	59	4	112	116	160
Bangladesh	383 832	105 000	1 105 644	1 210 644	8 536
Barbados	600	80	0	80	298
Belarus	136 186	52 938	23 200[2]	76 138	7 805[2*]
Belgium	29 000	12 000	8 000	21 000	2 016[*]
Belize	39 100	16 000	2 555	18 555	68 789
Benin	117 046	10 300	14 500	24 800	2 939
Bermuda	8	7	0	7	113[*]
Bhutan	103 400	95 000	0	95 000	43 930
Bolivia	1 258 863	303 531	319 000	622 531	67 799
Bosnia-Herzegovina	52 562	35 500	2 000	37 500	9 598
Botswana	241 825	2 900	11 500	14 400	8 159
Brazil	15 333 391	5 658 600	2 768 672	8 427 271	45 209[*]
Brunei Darussalam	15 706	8 500	0	8 500	22 738
Bulgaria	67 389	21 000	300	21 300	2 757
Burkina Faso	204 925	12 500	0	12 500	945
Burundi	33 903	3 600	0	3 600	477
Cambodia	344 628	120 570	355 540	476 110	33 836
Cameroon	762 463	273 000	12 500	285 500	17 492
Canada	4 930 000	2 740 000	52 000	2 792 000	86 525
Cape Verde	900	300	0	300	592
Central African Republic	836 662	141 000	3 400	144 400	35 763
Chad	413 191	15 000	28 000	43 000	4 411
Chile	1 151 600	884 000	38 000	922 000	56 581
China	6 172 800	2 840 500	21 400	861 900	2 175[*]
China, Hong Kong SAR	2 431	1 075	...	...	...
China, Macao SAR	51	...	...	...	...
Colombia	2 974 605	2 112 000	20 000	2 132 000	46754
Comoros	2 000	1 200	0	1 200	1504
Congo	562 932	222 000	610 000	832 000	208057
Costa Rica	149 529	112 400	0	112 400	25975
Cote d'Ivoire	434 676	76 700	4 300	81 000	4462
Croatia	62 912	37 700	67 800	105 500	23180
Cuba	147 965	38 120	0	38 120	3383
Cyprus	4 420	781	0	781	935[*]
Czech Republic	55 000	15 000	1 000[3]	16 000[3]	1566[3*]
Democratic Republic of the Congo	3 618 119	900 000	383 000	1 283 000	22294
Denmark	38 000	16 000	0	16 000	2946[*]

Water: *Water resources: long term annual average*

	Precipitation	Internal flow	Actual external inflow of surface and ground waters	Total renewable fresh water resources	Total renewable fresh water resources per capita
	mio m3	mio m3	mio m3	mio m3	m3/person
Djibouti	5 100	300	0	300	378
Dominica	2 577	...	...	...	...
Dominican Republic	68 700	21 000	0	21 000	2 360
Ecuador	582 985	...	0	264 618	20 004*
Egypt	51 400	1 800	85 000	86 800	1 172
El Salvador	56 052	23 212	635	23 847	3 466*
Equatorial Guinea	60 481	26 000	0	26 000	51 637
Eritrea	45 147	2 800	3 500	6 300	1 431
Estonia	30 647	12 044	9 070	21 114	15 879*
Ethiopia	936 005	110 000	0	110 000	1 421
Fiji	47 356	28 550	0	28 550	33 679
Finland	222 000	107 000	3 000	110 000	20 956*
France	488 000	178 000	11 000[4]	189 000[4]	3 124[4*]
French Guiana	260 550	134 000	0	134 000	716 363
Gabon	489 997	164 000	0	164 000	118 511
Gambia	9 099	- 3 423[5]	6 279	2 856	1 883*
Georgia	83 141	46 845	6 931[6]	53 776	12 019*
Germany	307 000	117 000	71 000	188 000	2 274*
Ghana	283 195	30 300	22 900	53 200	2 406
Greece	115 000	60 000	12 000	72 000	6 475*
Greenland	759 000	603 000	0	603 000	10 594 560
Grenada	522	...	...	...	...
Guadeloupe	422	...	...	...	...
Guatemala	217 300	109 200	2 070	111 270	8832
Guinea	405 939	226 000	0	226 000	24037
Guinea-Bissau	56 972	16 000	15 000	31 000	19542
Guyana	513 112	241 000	0	241 000	320812
Haiti	39 966	13 010	1 015	14 025	1645
Honduras	221 434	95 929	0	95 929	13315
Hungary	58 000	6 000	114 000	120 000	11884*
Iceland	200 000	170 000	0	170 000	577130*
India	3 558 800	1 260 540	647 220	1 907 760	1729
Indonesia	5 146 529	2 838 000	0	2 838 000	12739
Iran (Islamic Republic of)	375 790	128 500	9 010	137 510	1978
Iraq	94 677	35 200	61 220	96 420	3347
Ireland	81 000	49 000	1 000	50 000	12054*
Israel	9 200	750	920	1 670	248
Italy	243 000	88 000	8 000	95 000	1635*
Jamaica	22 542	9 404	0	9 404	3548
Japan	649 000	424 000	0	424 000	3310*
Jordan	9 929	680	200	880	154
Kazakhstan	680 408	75 420	34 190	109 610	7394
Kenya	401 906	20 200	10 000	30 200	882
Korea, Dem. People's Rep. of	127 000	67 000	10 135	77 135	3430
Korea, Republic of	127 600	73 100	0	73 100	1529*
Kuwait	2 160	0	20	20	7
Kyrgyzstan	106 500	46 450	0	46 450	8824
Lao People's Dem. Rep.	434 362	190 420	143 130	333 550	56303
Latvia	43 443	18 444	17 748	36 192	15688*
Lebanon	6 900	4 800	37	4 837	1352
Lesotho	23 928	5 230	0	5 230	2914
Liberia	266 286	200 000	32 000	232 000	70661
Libyan Arab Jamahiriya	98 500	600	0	600	103

Water: *Water resources: long term annual average*

	Precipitation	Internal flow	Actual external inflow of surface and ground waters	Total renewable fresh water resources	Total renewable fresh water resources per capita
	mio m3	mio m3	mio m3	mio m3	m3/person
Lithuania	44 010	15 510	8 990	24 500	7141*
Luxembourg	2 300	1 100	700	1 800	3872*
Madagascar	888 192	337 000	0	337 000	18113
Malawi	139 960	16 140	1 140	17 280	1341
Malaysia	948 163	580 000	0	580 000	22882
Maldives	58 592	30	0	30	91
Mali	349 610	60 000	40 000	100 000	7397
Malta	181	67	0	67	167*
Martinique	2 894	...	...	...	...
Mauritania	94 656	400	11 000	11 400	3715
Mauritius	3 700	2 590	0	2 590	2081*
Mexico	1 515 000	424 000	49 000	473 000	4419*
Monaco	2	...	...	...	...
Mongolia	377 370	34 800	0	34 800	13150
Morocco	150 000	29 000	0	29 000	921*
Mozambique	827 200	99 000	117 110	216 110	10919
Myanmar	1 414 594	880 600	165 001	1 045 601	20697
Namibia	235 252	6 160	39 300	45 460	22380
Nepal	220 800	198 200	12 000	210 200	7747
Netherlands	29 770	8 480	81 200[7]	89 680[7]	5522[7]*
New Caledonia	27 831	...	...	...	...
New Zealand	537 000	327 000	0	327 000	81174*
Nicaragua	310 856	189 740	6 950	196 690	35849
Niger	190 810	3 500	30 150	33 650	2411
Nigeria	1 062 336	221 000	65 200	286 200	2176
Norway	471 000	359 000	12 000	371 000	80298*
Oman	26 600	985	0	985	384
Pakistan	393 300	52 400	181 370	233 770	1480
Palestine	120	46	10	56	15
Panama	203 300	147 420	560	147 980	45793
Papua New Guinea	1 454 104	801 000	0	801 000	136059
Paraguay	459 546	94 000	242 000	336 000	54561
Peru	2 233 700	1 616 000	297 000	1 913 000	68399
Philippines	704 340	479 000	0	479 000	5767
Poland	193 000	55 000	8 000	63 000	1635*
Portugal	82 000	39 000	35 000	74 000	7051*
Puerto Rico	18 383	7 100	0	7 100	1795
Qatar	811	51	2	53	65
Republic of Moldova	16 959	1 300	11 500	12 800	3043*
Réunion	7 500	5 000	0	5 000	6368
Romania	154 000	39 415	2 878	42 293	1948*
Russian Federation	7 854 684	4 312 700	194 550	4 507 250	31475
Rwanda	31 932	5 200	0	5 200	575
Saint Helena	237	...	...	...	...
Saint Kitts and Nevis	500	24	0	24	553
Saint Lucia	1 427	...	...	...	...
Samoa	8 496	...	...	...	...
Sao Tome and Principe	3 100	2 180	0	2 180	13928
Saudi Arabia	126 800	2 400	0	2 400	98
Senegal	135 048	26 400	13 000	39 400	3380
Serbia	56 115[8]	12 776[8]	162 600[8]	175 376[8]	...
Seychelles	887	...	...	...	...
Sierra Leone	181 215	160 000	0	160 000	28957

Water: *Water resources: long term annual average*

	Precipitation	Internal flow	Actual external inflow of surface and ground waters	Total renewable fresh water resources	Total renewable fresh water resources per capita
	mio m3	mio m3	mio m3	mio m3	m3/person
Singapore	1 700[9]	830[9]	0[9]	830[9]	192*
Slovakia	37 000	13 000	67 000[10]	80 000[10]	14812[10*]
Slovenia	22 298	7 406	13 496	20 902	10627*
Solomon Islands	87 509	44 700	0	44 700	93565
Somalia	180 075	6 000	7 500	13 500	1641
South Africa	524 600	...	7 273[11]	31 738	669*
Spain	347 000	111 000	0	111 000	2578*
Sri Lanka	112 337	50 000	0	50 000	2410
St. Vincent and the Grenadines	617	...	...	...	...
Sudan	1 043 670	30 000	119 000	149 000	4112
Suriname	380 582	88 000	34 000	122 000	271571
Swaziland	13 678	2 640	1 870	4 510	4368
Sweden	336 000	170 000	11 000	181 000	20019*
Switzerland	60 000	40 000	13 000[12]	53 000	7308*
Syrian Arab Republic	46 700	7 000	39 080	46 080	2420
Tajikistan	98 900	66 300	33 430	99 730	15327
Thailand	832 435	210 000	199 944	409 944	6382
The Former Yugoslav Rep. of Macedonia	15 914	5 400	1 000	6 400	3146
Togo	66 302	11 500	3 200	14 700	2392
Tonga	1 474	...	...	...	...
Trinidad and Tobago	11 300	3 840	0	3 840	2942
Tunisia	36 000	4 170*	...	4 170	413*
Turkey	501 000	227 400	6 900	234 300	3197*
Turkmenistan	78 731	1 360	59 500	60 860	12592
Uganda	284 500	39 000	27 000	66 000	2290
Ukraine	340 970	53 100	86 450	139 550	3002
United Arab Emirates	6 529	150	0	150	33
United Kingdom	268 000	143 000	3 000	146 000	2447*
United Rep. of Tanzania	1 012 191	82 000	9 000	91 000	2374
United States	6 440 000	2 460 000	18 000	2 478 000	8309*
Uruguay	222 865	59 000	80 000	139 000	40136
Uzbekistan	92 299	16 340	55 870	72 210	2715
Venezuela	1 710 094	722 451	510 719	1 233 170	46101
Viet Nam	604 008	366 500	524 710	891 210	10580
Yemen	88 329	4 100	0	4 100	195
Zambia	767 436	80 200	25 000	105 200	9016
Zimbabwe	270 523	14 100	5 900	20 000	1537

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaires on Environment statistics, Water section.
OECD/Eurostat 2004 questionnaire on Environment statistics, Water section.
OECD Environmental Data, Compendium 2006, Inland Waters section, marked with "*".
AQUASTAT database of the Food and Agriculture Organization of the United Nations (FAO); http://www.fao.org/ag/agl/aglw/aquastat/main/index.stm. Whenever data were not available for
"Total renewable fresh water resources" variable from UNSD or OECD/Eurostat questionnaire, AQUASTAT data were used.

Footnotes:
1.Data refer to average of 3 meteorological stations.
2.Data only include surface water. Groundwater is excluded.
3.Excludes underground flows.
4.Excludes underground flows. Rhine excluded.
5.The numbers are negative because evapotranspiration covers both waters from precipitations and external inflow of waters. Whereas precipitations covers waters from rains that fall
within the National territory.
6.Data refer to the sum of inflows from Armenia and Turkey.
7.Excludes underground flows, estimated at 2 billion m3.
8.Data refer to the Republic of Serbia without the territory of Kosovo Province.
9.Data refer to years 1990-2005.

Water: *Water resources: long term annual average*

10.Excludes underground flows (representing 946 million m3).
11.Data refer to inflows from Lesotho and Swaziland.
12.Inflow excludes Liechtenstein (about 1%).

Definitions & Technical notes:
Precipitation refers to the total volume of atmospheric wet deposition (rain, snow, hail, dew, etc) falling on the territory of the country over one year, in millions of cubic metres. Long term annual average is the arithmetic average over at least 20 years. Internal flow is the total volume of river run-off and ground water generated in natural conditions, exclusively by precipitation within the country. The internal flow is equal to precipitation less actual evapotranspiration and can be calculated or measured. Actual external inflow of surface and ground waters refers to the total volume of actual flow of rivers and groundwater, coming from neighboring countries. Total renewable fresh water resources_ = Internal flow + Actual external inflow of surface and groundwaters.

Data Quality:
Countrywide precipitation is usually calculated on the basis of measurements at a selected number of measuring stations within the country. Data is considered to be fairly reliable. Internal flow is the fresh water generated in the country and is usually calculated by subtracting natural evapotranspiration from precipitation. The reliability of the data depends essentially on the estimation method for evapotranspiration. For most countries, actual external inflow of surface and ground water contains only the surface water flow, since ground water flows are often not well known. Surface water flows of inflowing rivers should be measured at the border. Dry countries in particular, tend to have reliable data.

Policy Relevance:
Water is essential to life, for drinking and cooking, for hygiene, agriculture, industrial production and for growing food. In some regions of the world it provides transport for goods and people, giving access to markets and services not available locally. Water scarcity happens when the supply of water is unable to meet the demand. Today, some 460 million people, over eight percent of the world's population, live in areas of water scarcity, mainly the areas situated in Southern Africa, Northern Africa, the Middle East and South Western Asia. Without adequate management of water resources, it is estimated that by 2025 at least 3.5 billion people, almost 50 percent of the world's population, will face water scarcity (International Hydropower Association, Feb 2004: Sustainability Guidelines). Rivers and aquifers are no respecters of political boundaries, and apart from island states, most countries share water resources with their immediate neighbours, and in the case of long rivers, with other countries much further away. This makes water management a particularly sensitive political issue in many parts of the world.
The data shown for total renewable fresh water resources do not represent the volume of water that can be freely exploited by the country for its own needs; countries downstream may rely on a regular inflow in the same rivers, lakes and aquifers to meet their needs. Equally, if the flow of water is seriously reduced, the ecological balance of the water body may be disrupted, affecting the livelihood of fishermen and others, and potentially creating health risks.

ENVIRONMENTAL INDICATORS

Water

Public water supply last update: April 2007

	Latest year available	Total public water supply (PWS) mio m3	Total PWS per capita m3/person	% Population connected to PWS %	Total PWS per capita connected m3/person	PWS delivered to households mio m3	PWS delivered to households mio m3
Algeria	2002	3300	106	...	...	1559[1]	200[2]
Armenia	2004	125	41	88.9	46	91	7
Australia	2004	11337[3]	568[3]	95.0	598	3411[4]	2573[5]
Austria	1999	549	68	90.0[6]	75	383[4]	...
Azerbaijan	2005	498	59	48.0	123	433	...
Belarus	2002	...	...	...	...	794	...
Belgium	2002	340[7]	...	96.0	...	184[4]	95[8]
Belize	2005	6	24	58.9	40	...	...
Bermuda	2005	3	51	10.0[9]	...	2	0
Bolivia	2005	143	16	72.1[10]	...	113	3
Bosnia and Herzegovina	2004	166	43	...	...	114	...
Brazil	2000	16060	93	80.0	117	...	...
British Virgin Islands	2001	...	...	48.4	...	...	...
Brunei Darussalam	2005	169	451	99.0[6]	...	142	27
Bulgaria	2001	424	53	98.7	54	273	54
Canada	1996	5201	175	92.0[11]	...	3272	1928
Chile	2005	933	57	99.8	57	698[6]	221[6]
China, Hong Kong SAR	2005	968	137	99.9	138	...	...
China, Macao SAR	2005	59	129	...	...	25[6]	20[6,12]
Croatia	2004	311	69	...	...	183	...
Cuba	2000	1685	150	95.6[13]	...	...	...
Cyprus	1998	68	88	...	...	...	2[14]
Czech Republic	2004	543	53	92.0	58	472[4]	63[8]
Denmark	2002	380[15]	71[15]	97.0	73	291[4]	48[8]
Ecuador	2000	...	...	...	...	...	2330
Egypt	1996	...	...	...	...	2606[16]	...
Estonia	2001	66	49	71.0	69	...	...
Ethiopia	2001	66[17]	...	...	...	...	...
Finland	2001	408[18]	79[18]	90.0	87	245	50[8]
France	2001	5685	95	99.0	96	3414[4]	...
Gambia	2005	...	...	50.0	...	...	...
Georgia	2004	296	66	80.0	82	374[6]	36[6]
Germany	2004	4729	57	99.0	58	3752	976[8]
Greece	1980	750	...	...	...	670[19]	...
Guadeloupe	1998	36	87	...	...	36	...
Guinea	2005	25	3	...	...	9	2
Hungary	2002	546	55	93.0	59	486[4]	55[8]
Iceland	2003	67[20]	244[20]	95.0	244	30	5[21]
India	2000	...	...	...	...	4200[22]	8000[22]
Ireland	2002	...	...	90.0	...	...	...
Israel	2003	1860	289	...	...	698	117
Italy	1999	5653	98	99.7	99	4882[4]	503[8]
Jamaica	2005	94	35	70.0	51	...	...
Japan	2001	85968[23]	675[23]	97.0[6]	...	16279[4]	12849[8]
Jordan	2004	...	...	...	...	281	38
Kazakhstan	2002	14930	965	...	...	...	...
Korea, Republic of	2003	22275	467	89.0	525	5597[4]	1963[8]
Latvia	2001	302	129	...	...	...	78
Lebanon	2005	...	...	75.6[11]	...	...	...
Luxembourg	2004	33	72	100.0	72	23	13[24]

Water: *Public water supply*

	Latest year available	Total public water supply (PWS)	Total PWS per capita	% Population connected to PWS	Total PWS per capita connected	PWS delivered to households	PWS delivered to households
		mio m3	m3/person	%	m3/person	mio m3	mio m3
Madagascar	2005	77	4	...	...	57	5
Maldives	2005	2[25]	6[25]	...	...	1[25]	0.3[25]
Mali	2002	...	...	66.0	...	...	...
Martinique	1997	40	106	...	...	40	...
Mauritius	2005	214	172	98.7[26]	...	214	...
Mexico	2004	75430[27,28]	714[27,28]	90.0[29]	793	10670[4,27,28]	7298[8,27,28]
Monaco	2005	6[30]	171[30]	100.0	171	2	0.3
Morocco	2002	...	...	...	...	...	79[31]
Nepal	2004	...	...	...	...	94	...
Netherlands	2002	1257	78	100.0	79	990[4,14,32]	218[8,14]
New Zealand	2001	...	...	87.0	...	...	...
Norway	2002	808[33]	179[33]	89.0	201	299	145[8]
Palestine	2005	...	...	90.5	...	152[34]	...
Panama	2005	...	...	83.0	...	...	...
Peru	2001	660[35]	25[35]	...	...	295[26,35]	9[26,35]
Poland	2003	1657	43	85.0	51	1454[4]	203[8]
Portugal	1998	8754	878	92.0[10]	...	680[4]	...
Republic of Moldova	2004	786	186	...	...	118	21
Romania	2001	2462	110	...	...	988	...
Serbia	2004	509	48	72.0	67	368	77
Singapore	2005	506	117	100.0	117	253[4]	253[36]
Slovakia	2004	353	65	85.0	77	166[4]	...
Slovenia	2001	106	54	...	...	88	18
South Africa	2000	17246	392	...	...	3610[37]	...
Spain	2002	4339	106	...	...	3481[4]	459[8]
Sweden	2002	708	80	86.1[19]	...	618[4]	90
Switzerland	2002	1015	142	...	...	720[4]	184[8]
The Former Yugoslav Rep. of Macedonia	2004	363	179	94.0	190	75	31[14]
Trinidad and Tobago	2005	...	...	76.4[6]	...	179	36
Tunisia	2005	...	...	81.0	...	326	...
Turkey	2004	1988	28	74.0	37	1955[4]	27[8]
Ukraine	2004	1955	42	...	...	2300[6]	1586[6]
United Kingdom	2004	6876[38]	116[38]	99.0	117	...	...
United States	2000	...	...	85.0	...	...	...
Yemen	2005	84	4	17.5	23	84	...
Zimbabwe	2005	...	...	...	...	224	...

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaires on Environment statistics, Water section
OECD/Eurostat 2004 questionnaire on Environment statistics, Water section.
OECD Environmental Data, Compendium 2006, Inland Waters section.
UN Population Division.

Footnotes:
1. 2004 data.
2. Includes Manufacturing industries, Electricity industry and Other economic activities.
3. Data referring to "Distributed water" in Water account Australia 2004-2005; exclude in-stream and reused water.
4. Data refer to public supply water used by domestic sector.
5. Includes mining, manufacturing, electricity and gas.
6. 2002 data.
7. Water supply: Flanders and Wallonie only.
8. Data refer to public supply water used by all industry activities.
9. This is % provided with the piped water to top up the rainwater tanks. Water is trucked to the remaining households to top up the rainwater tanks.
10. 2003 data.
11. 1999 data.
12. Includes industrial and commercial activities.
13. 2005 data.

Water: *Public water supply*

14. 2001 data.
15. Public supply refers to public and private waterworks.
16. Data refer to the Commercial sector and Households.
17. Data refer to Addis Ababa city only.
18. Public supply: total includes leakages.
19. 1997 data.
20. Total supply: provisional data.
21. Refers to manufacturing industry and electricity production.
22. Data refer to projected water demands.
23. Public water supply includes self-supply and other supply.
24. Average between 1990 and 1995.
25. The figures given here are only pertaining to the water supplied by Male' Water and Sewage Co. Pvt. Ltd.
26. 2000 data.
27. Supply: abstracted volumes of water granted in concessions.
28. Public water supply includes self-supply.
29. Population connected to public water supply: access to safe water for population living in individual housing (of which 65.3% are supplied inside the house).
30. Includes "Water losses during transport".
31. Refers to consumption in urban areas, managed by ONEP.
32. Domestic sector includes agricultural sector (57 million m3 in 1999).
33. Public supply: total includes leakages.
34. Data include quantity of pumped water from wells and springs discharge.
35. The information corresponds to the province of Lima and Constitutional province of the Callao.
36. Data refer to non-domestic consumption, including water delivered to agriculture, manufacturing, electricity industry and other economic activities.
37. Data include Public supply to businesses, institutions, etc.
38. Total public supply includes distribution losses and nonpotable water delivered.

Definitions & Technical notes:
Public water supply refers to water supplied by both public bodies and private companies involved in the collection, purification and distribution of water. Total public water supplied per capita is calculated by dividing the total public water supplied by the total population of the country. Total public water supplied per capita connected is calculated by dividing the total public water supplied by the number of people connected to the public water supply. Percent of Population Connected to Public Water Supply is calculated by dividing the number of people connected to the public water supply by the total population of the country.

Data Quality:
Data on public water supply (PWS) is usually collected from municipalities. Data on population connected to PWS can be obtained through municipalities or through household surveys. Household surveys usually give more accurate results, since they do not rely on sometimes incomplete information about or held by municipalities. Data on amounts of water supplied can significantly vary between countries depending on the extent to which PWS delivers water to industries, businesses, agriculture and power stations in addition to households. Care must be taken when comparing data between countries.

Policy Relevance:
Access to a regular, clean and safe supply of water is essential to maintaining human health, and a key component of sustainable development. Connection to a public water supply not only reduces the risk of water borne diseases, it provides water for drinking, cooking, hygiene and washing, and is associated with improved health, in general. It also relieves women and children of the burden of having to fetch water, giving them time for more productive activities, or for schooling. 'Total public water supply' represents the demand for water from that part of the population that is connected to the public supply system, including any connected industries. The indicator 'total PWS per capita connected' shows the per capita demand for water, when water is readily available. In regions without access to public water supply, use of water tends to be much less. However, the difference between the indicator 'total PWS per capita connected' and the indicator 'total PWS per capita' can be seen as a rough indicator of the unmet demand for good quality water and therefore of how much water would need to be provided, if almost the whole country were provided with access to the public water supply. The extent to which industries are connected to the public water supply will depend on the cost, the required standard of water and the availability of alternatives. Food processing industries will require high quality water, and therefore may prefer to be connected to the public water supply, where the quality is assured. Industries relying on water for cooling are less concerned by the quality of the water, but require large quantities. They may prefer to site their factories close to rivers and lakes so as to extract the water they need, and later return it to the same water body, a few degrees warmer.

ENVIRONMENTAL INDICATORS

Water

Waste water *last update: April 2007*

	Latest year available	Population connected to public waste water collection system	Population connected to public waste water treatment plants
		%	%
Algeria	1998	66.3	3.9
Andorra	2005	100.0	47.7
Argentina	2001	42.5	42.5
Australia	2004	87.0[1]	...
Austria	2002	86.0	86.0
Azerbaijan	2005	30.0	30.0
Belarus	2004	90.8[2]	...
Belgium	2002	82.9[3]	45.9
Belize	2000	15.1	15.1
Bermuda	2005	5.0	5.0
Bolivia	2003	31.4[4]	...
Bosnia-Herzegovina	1990	38.0	...
Brazil	2004	54.1[2]	...
British Virgin Islands	2001	24.5	24.5
Bulgaria	2001	67.9	38.1
Canada	1999	74.3[5]	71.7[5]
Chile	2005	94.9[6]	73.3[7]
China	2004	45.7	32.5
China, Hong Kong SAR	2005	92.9	92.9
China, Macao SAR	1995	99.9	...
Costa Rica	2000	24.8	2.4
Cuba	2005	38.8	...
Cyprus	2000	34.5	34.5
Czech Republic	2004	77.9	71.1
Denmark	2002	87.9	87.9
Dominica	2005	23.0	13.0
Dominican Republic	2000	31.4	12.0[8,9]
Estonia	2000	70.0	69.0
Finland	2002	81.0	81.0
France	2001	81.5	79.4
French Guiana	2001	48.3	27.4
Germany	2004	95.5	93.5
Greece	1997	...	56.2
Guadeloupe	2001	40.9	40.5
Hungary	2002	61.9	57.4
Iceland	2003	89.0	50.0
Ireland	2001	93.0[10]	70.0[10]
Italy	1999	...	68.6
Japan	2003	67.0	67.0
Jordan	2004	97.7	...
Korea, Republic of	2003	78.8[11]	78.8
Kyrgyzstan	2004	27.0	...
Luxembourg	2003	94.8	94.8
Madagascar	2005	...	0.0[12]
Maldives	2005	100.0	...
Malta	2001	100.0	13.0
Martinique	2001	44.4	44.2
Mauritius	2005	23.0	23.0
Mexico	2005	67.6[13]	35.0[13,14]
Monaco	2005	100.0	100.0

Water: *Waste water*

	Latest year available	Population connected to public waste water collection system	Population connected to public waste water treatment plants
		%	%
Netherlands	2004	98.6	98.6
New Zealand	1999	…	80.0
Norway	2004	80.8	75.9
Palestine	2005	44.7	…
Panama	2005	…	37.0
Paraguay	2005	14.1	…
Peru	2004	74.0	…
Poland	2004	59.0[15]	59.0[15]
Portugal	2003	74.0	60.0[16]
Republic of Moldova	2004	60.0	60.0
Réunion	2001	34.8	33.3
Romania	1990	51.4	…
Singapore	2005	100.0	99.9
Slovakia	2003	55.4	52.3
Slovenia	1999	53.0	30.0
Spain	2002	61.8[17]	55.0[17]
Sweden	2002	85.0	85.0
Switzerland	2004	96.7	96.7
The Former Yugoslav Rep. of Macedonia	2000	49.0	5.0
Trinidad and Tobago	2005	20.0	20.0
Tunisia	2004	52.6	46.8
Turkey	2004	65.7[18]	35.0[18]
United Kingdom	2002	97.7[19]	97.5[19]
United States	1996	71.4	…

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaires on Environment statistics, Water section
OECD/Eurostat 2004 questionnaire on Environment statistics, Water section.
OECD Environmental Data, Compendium 2006, Inland Waters section

Footnotes:
1. Refers to reticulated sewerage.
2. Excludes Azores and Madeira Islands.
3. OECD secretariat estimates based on regional data.
4. Percentage of Homes with sewage system.
5. OECD secretariat estimates based on MUD Municipal Waste Water Database.
6. Information provided by the sanitary industry that operates in urban sectors to the Supervision of Sanitation Services respect to the percentage of residential buildings connected to the sewage system.
7. Information provided by the sanitary industry that operates in urban sectors to the Supervision of Sanitation Services respect to the percentage of connected residential buildings to the sewage system whose collected water receive treatment.
8. It corresponds to the city of Santo Domingo and represents 350,063 inhabitants.
9. 2005 data.
10. Data refers to agglomerations greater than or equal to 500 population equivalent.
11. Population connected may include population not connected by pipe.
12. No urban wastewater treatment plant.
13. Percentages based on population living in individual housing.
14. Estimates based on treated waste water.
15. Include population not connected by pipe (whose waste water are collected in septic tanks and delivered to urban waste water treatment plants by truck).
16. Public treatment: includes septic tanks (5% in 1998).
17. OECD secretariat estimates.
18. Data based on a sample survey covering 1911 municipalities.
19. Data refer to England and Wales and to the financial year (April to March).

Definitions & Technical notes:
Waste water refers to water that is discharged as being of no further immediate value for the purpose for which it was used. Public waste water collection system means a systems of conduits which collects and conducts urban waste water. Collecting systems are often operated by public authorities or semi-public associations. Population with access to public waste water collection system is the percentage of the population connected to the public sewerage system. Public waste water collection systems may deliver waste water to treatment plants or may discharge it to the environment, without treatment. Public waste water treatment plants refer to municipal treatment plants operated by official authorities or by private companies whose main activity is waste water treatment on behalf of local authorities. The treatment applied can be :
- mechanical, i.e. separates sludge through processes such as sedimentation, flotation, etc.
- biological, i.e. employs aerobic or anaerobic micro-organisms to separate sludges containing microbial mass together with pollutants.

Water: *Waste water*

- advanced, i.e. all treatments that are not considered mechanical or biological, particularly chemical treatments.

Population connected to waste water treatment is the percentage of the resident population whose waste water is treated at public waste water treatment plants.

Data Quality:
Data on population connected to waste water collection and waste water treatment can be obtained from municipalities or through household surveys. Household surveys usually give more accurate results, since they do not rely on sometimes incomplete information about or held by municipalities. In general, data quality can be considered to be fairly good.

Policy Relevance:
Waste water discharged without treatment into rivers or lakes contributes to eutrophication of the water body, affecting the health of the river or lake ecosystem, reducing the viability of the fish, birds and other beneficial organisms, and the livelihoods of populations that rely on these resources. Waste water discharged into the sea without treatment contributes to eutrophication of coastal waters, also affecting ecosystems. Shellfish living near the discharge point will be contaminated, and where these are harvested by the local population, represent a major health risk. Provision of waste water treatment systems is therefore essential for both environmental and public health.

ENVIRONMENTAL INDICATORS

Air Pollution

Emissions of SO_2 from fuel combustion *last update: June 2005*

	Latest year available	SO_2 emissions from fuel combustion	% change since 1990	SO_2 emissions from fuel combustion per capita
		1000 tonnes	%	kg
Algeria*	1995	49.0[1]	...	1.8
Antigua and Barbuda	1990	2.8	..	44.9
Australia	2002	751.0	17.9	38.4
Austria	2002	31.8	-57.3	3.9
Belgium	2002	131.9	-57.3	12.8
Belize	1994	0.5	...	2.6
Bolivia*	2000	10.3	5.0	1.2
Bulgaria	2002	966.9	...	121.4
Cambodia	1994	25.6	...	2.3
Chile	1994	146.2	...	10.4
Colombia	1994	162.5	19.9	4.3
Comoros	1994	0.4	...	0.6
Costa Rica	1996	1.8	...	0.5
Croatia	2002	66.6	-62.4	15.0
Cuba	1996	423.9	1.3	38.5
Czech Republic	2002	230.6	...	22.5
Democratic Republic of the Congo*	1994	0.1	51.7	0.0
Denmark	2002	24.9	-85.9	4.6
Dominican Republic	1994	114.5	51.7	15.1
Estonia	2002	96.3	...	72.0
Ethiopia	1995	13.0	18.2	0.2
Finland	2002	73.1	-54.4	14.1
France	2002	524.2	-57.7	8.8
Georgia*	2002	5.2	-97.9	1.0
Germany	2002	537.6	-89.5	6.5
Greece	2002	491.5	3.4	44.8
Guatemala*	1990	73.7	..	8.4
Haiti	1994	51.3	...	6.9
Honduras	1995	2.1	...	0.4
Hungary	2002	354.9	...	35.8
Iceland	2002	4.4	-12.6	15.3
Ireland	2002	96.0	-47.6	24.6
Israel*	2002	306.4[2]	12.5	48.6
Italy	2002	596.6	-63.9	10.4
Jamaica	1994	98.9	...	40.4
Japan	2002	765.0	-16.4	6.0
Kyrgyzstan	2000	30.2	-73.0	6.1
Latvia	2002	11.7	-87.6	5.0
Lebanon	1994	79.6	...	26.0
Lithuania	2002	45.7	-78.8	13.2
Luxembourg	2002	2.2	...	4.8
Malta	1994	24.3	...	64.9
Mauritius	1995	13.4	...	11.9
Micronesia, Federated States of	1994	0.5	...	5.0
Monaco*	2002	0.0	-27.2	1.3
Morocco	1994	285.0	...	10.8
Netherlands	2002	77.0	-58.2	4.8
New Zealand	2002	51.7	22.2	13.5
Norway	2002	8.8	-59.5	2.0
Peru	1994	105.2	...	4.5

Air Pollution: *Emissions of SO_2 from fuel combustion*

	Latest year available	SO_2 emissions from fuel combustion	% change since 1990	SO_2 emissions from fuel combustion per capita
		1000 tonnes	%	kg
Philippines	1994	433.4	...	6.5
Portugal	2002	269.0	-12.6	26.8
Republic of Moldova	1998	31.7	-88.0	7.4
Romania	2002	632.0	-33.0	28.2
Saint Lucia	1994	0.6	...	4.4
Slovakia	2002	102.3	...	18.9
Slovenia	2002	68.2	-72.4	34.3
Spain	2002	1 909.8	-8.9	46.6
Sri Lanka	1995	41.0	...	2.3
St. Vincent and the Grenadines	1997	0.3	26.8	2.8
Sweden	2002	41.1	-41.3	4.6
Switzerland	2002	13.0	-62.0	1.8
Tajikistan	1998	2.7	-92.1	0.5
Trinidad and Tobago*	1996	8.4[3]	...	6.6
Tunisia	1994	76.4	...	8.7
United Kingdom	2002	959.6	-73.4	16.2
United States	2002	12 469.2	-35.2	42.8
Uruguay	1998	52.3	27.8	15.9
Uzbekistan	1994	247.0	-52.3	11.1
Yemen	1995	2.9	...	0.2

Sources:
UN Framework Convention on Climate Change (UNFCCC) Secretariat (see: http://unfccc.int).
UNSD/UNEP 2004 questionnaire on Environment statistics, Air section.
UN Population Division.
Most data are from UNFCCC, except data for countries with "*" are from UNSD/UNEP 2004 questionnaire.

Footnotes:
1. Emissions from power stations in the north of the country + emissions from main industries + emissions from car traffic in the north of the country.
2. The total refers to emissions from fuel combustion, sectoral approach.
3. Refers to emissions from fuel combustion in energy industries, industry, and transport only.

Definitions & Technical notes:
Data on emissions of SO_2 are usually estimated according to international methodologies on the basis of national statistics on energy, industrial and agricultural production, waste management, etc. The most widely used methodologies are the 1996 Guidelines of the Intergovernmental Panel for Climate Change (IPCC) (see http://www.ipcc-nggip.iges.or.jp/public/gl/invs4.htm) which is the basis for reporting to the UNFCCC. In earlier years the guidelines produced for the UNECE Convention on Long Range Transboundary Air Pollution were widely used in Europe, and are still used in some countries. The main source of SO_2 is burning of fuels, including biomass. Therefore the data shown refer only to emissions from fuel combustion. This covers the combustion of fuels in the energy industries, all other industries and transport (except international aviation and marine transport) as well as small combustion activities such as in commercial, institutional or residential buildings, fuel combustion in agriculture and in all other activities.

Data Quality:
Standardised methods for calculating SO_2 emissions from fuel combustion have been available for many years. The amount of SO_2 emitted is directly related to the sulphur content of the fossil fuels consumed in the country, and the desulphurisation techniques used, if any. Data on emissions from fuel combustion are considered to be reasonable.

Policy Relevance:
SO_2 can be transported over large distances and is partly responsible for acidification of soil and water and for damage to sensitive plants and buildings many kilometres away from the source. The sulphur content of diesel fuels also has an impact on the emissions of particles from diesel engines, and thus impacts on human health. The main anthropogenic source of sulphur dioxide emissions is the combustion of coal, lignite and petroleum products. Some industrial processes also emit sulphur, but these emissions are less well documented, and are therefore not included in this table. While much of the sulphur in petroleum can be removed in the refinery, it is more difficult to remove sulphur from coal and lignite before burning. In this case, other measures can be taken, e.g. scrubbers can be fitted to chimneys at power plants and in large scale industries to remove the SO_2 from the flue gases.

ENVIRONMENTAL INDICATORS
Air Pollution
Emissions of NOx from fuel combustion *last update: June 2005*

	Latest year available	NOx emissions from fuel combustion	% change since 1990 combustion	NOx emissions from fuel per capita
		1000 tonnes	%	kg
Algeria*	1995	177.3[1]	...	6.4
Argentina	1997	703.0	43.2	19.7
Armenia	1990	72.9	..	20.6
Australia	2002	1 611.3	20.5	82.4
Austria	2002	197.9	-1.9	24.4
Barbados	1997	0.1	...	0.2
Belarus	2002	172.0	...	17.3
Belgium	2002	280.7	-19.1	27.3
Belize	1994	2.9	...	14.1
Benin	1995	8.5	...	1.6
Bhutan	1994	0.7	...	0.4
Bolivia*	2000	46.0	46.6	5.5
Bulgaria	2002	114.3	...	14.3
Burkina Faso	1994	4.3	...	0.4
Burundi	1998	10.9	...	1.8
Cambodia	1994	16.7	...	1.5
Cape Verde	1995	0.7	...	1.8
Chile	1994	161.7	...	11.6
Colombia	1994	230.1	-7.9	6.1
Comoros	1994	0.4	...	0.7
Congo	1994	8.0	...	2.8
Costa Rica	1996	24.7	-17.8	6.9
Côte d'Ivoire	1994	114.2	...	8.1
Croatia	2002	92.6	1.9	20.9
Cuba	1996	96.5	-25.0	8.8
Czech Republic	2002	311.3	...	30.4
Democratic Republic of the Congo*	1994	0.1	42.9	0.0
Denmark	2002	197.1	-29.7	36.8
Djibouti	1994	1.4	...	2.6
Dominica	1994	0.4	...	5.8
Dominican Republic	1994	53.4	43.0	7.1
Ecuador	1990	85.9	..	8.4
El Salvador	1994	31.0	...	5.6
Eritrea	1994	0.1	...	0.0
Estonia	2002	46.5	...	34.8
Ethiopia	1995	86.0	13.2	1.5
Finland	2002	210.6	-32.3	40.5
France	2002	1 412.8	-26.4	23.6
Georgia*	2002	16.0	-85.9	3.1
Germany	2002	1 385.9	-48.4	16.8
Greece	2002	314.5	11.0	28.7
Guatemala*	1990	36.9	..	4.2
Guinea	1994	14.2	...	2.0
Guyana	1998	12.0	...	16.0
Haiti	1994	4.6	...	0.6
Honduras	1995	29.9	...	5.3
Hungary	2002	179.0	...	18.0
Iceland	2002	26.0	-2.0	90.6
Indonesia	1994	818.3	...	4.2
Iran (Islamic Republic of)	1994	1 184.4	...	19.3
Ireland	2002	121.2	6.2	31.0

Air Pollution: *Emissions of NOx from fuel combustion*

	Latest year available	NOx emissions from fuel combustion	% change since 1990 combustion	NOx emissions from fuel per capita
		1000 tonnes	%	kg
Israel*	2002	374.1[2]	156.9	59.3
Italy	2002	1 239.3	-35.0	21.6
Jamaica	1994	30.9	...	12.6
Japan	2002	1 854.6	-2.6	14.5
Kazakhstan	1994	165.5	-86.2	9.9
Kenya	1994	46.7	...	1.8
Kyrgyzstan	2000	73.2	-44.8	14.9
Lao People's Dem. Rep.	1990	4.2	0.0	1.0
Latvia	2002	40.1	-51.5	17.2
Lebanon	1994	54.1	...	17.7
Lesotho*	1998	4.9	...	2.8
Lithuania	2002	57.5	-62.9	16.6
Luxembourg	2002	16.2	...	36.2
Mali	1995	6.1	...	0.6
Malta	1994	10.8	...	29.0
Mauritania	1995	6.9	...	3.0
Mauritius	1995	9.8	...	8.7
Mexico	1990	962.8	..	11.6
Micronesia, Federated States of	1994	2.3	...	21.3
Monaco*	2002	0.6	16.1	18.1
Mongolia	1994	2.6	...	1.1
Morocco	1994	152.0	...	5.8
Netherlands	2002	427.7	-27.8	26.6
New Zealand	2002	198.2	47.0	51.5
Nicaragua	1994	17.0	...	3.9
Norway	2002	197.4	-3.0	43.7
Panama*	2002	39.4	...	12.9
Paraguay	1994	2.7	...	0.6
Peru	1994	118.0	...	5.0
Philippines	1994	297.7	...	4.4
Portugal	2002	281.1	12.7	28.0
Republic of Moldova	1998	38.5	-71.8	8.9
Romania	2002	357.2	-28.1	16.0
Saint Lucia	1994	1.3	...	9.7
Senegal	1994	1.2	...	0.1
Seychelles	1995	0.6	...	7.9
Slovakia	2002	101.7	...	18.8
Slovenia	2002	59.6	3.3	30.0
Spain	2002	1 867.4	56.8	45.6
Sri Lanka	1995	59.0	...	3.3
St. Vincent and the Grenadines	1997	0.4	29.5	3.7
Swaziland	1994	7.5	...	8.1
Sweden	2002	228.5	-26.1	25.8
Switzerland	2002	78.4	-48.4	10.9
Tajikistan	1998	9.1	-87.0	1.5
Thailand	1994	271.9	...	4.8
Togo	1995	10.4	...	2.7
Trinidad and Tobago*	1990	35.1[3]	..	28.9
Tunisia	1994	72.0	...	8.2
Turkmenistan	1994	83.6	...	20.4
Tuvalu	1994	0.0	...	0.0
Uganda	1994	23.4	...	1.2
Ukraine	2002	844.6	...	17.3

Air Pollution: *Emissions of NOx from fuel combustion*

	Latest year available	NOx emissions from fuel combustion	% change since 1990 combustion	NOx emissions from fuel per capita
		1000 tonnes	%	kg
United Kingdom	2002	1 579.8	-42.4	26.7
United States	2002	19 043.2	-13.8	65.4
Uruguay	1998	46.2	59.6	14.0
Uzbekistan	1994	242.0	-28.8	10.8
Vanuatu	1994	0.1	...	0.5
Yemen	1995	87.8	...	5.8
Zimbabwe	1994	10.1	9.7	0.9

Sources:
UN Framework Convention on Climate Change (UNFCCC) Secretariat (see: http://unfccc.int).
UNSD/UNEP 2004 questionnaire on Environment statistics, Air section.
UN Population Division.
Most data are from UNFCCC, except data for countries with "*" are from UNSD/UNEP 2004 questionnaire.
Footnotes:
1. Emissions from power stations in the north of the country + emissions from main industries + emissions from car traffic in the north of the country.
2. The total refers to emissions from fuel combustion, sectoral approach.
3. Refers to emissions from fuel combustion in energy industries, industry, and transport only.

Definitions & Technical notes:
Data on emissions of NOx are usually estimated according to international methodologies on the basis of national statistics on energy, industrial and agricultural production, waste management and land use, etc. The most widely used methodologies are the 1996 Guidelines of the Intergovernmental Panel for Climate Change (IPCC) (see http://www.ipcc-nggip.iges.or.jp/public/gl/invs4.htm) which is the basis for reporting to the UNFCCC. In earlier years the guidelines produced for the UNECE Convention on Long Range Transboundary Air Pollution were widely used in Europe, and are still used in some countries. The main source for NOx is burning of fuels, particularly petroleum products. In some countries agriculture and burning of savannas is also an important contributor, but estimating these emissions is more difficult and often data are not available. Therefore the data shown refer only to emissions from fuel combustion. This covers the combustion of fuels in the energy industries, all other industries and transport, except international aviation and marine transport as well as small combustion activities such as in commercial, institutional or residential buildings, fuel combustion in agriculture and in all other activities.

Data Quality:
Although standardised methods for calculating NOx emissions have been available for many years, calculating emissions of NOx is more difficult than for SO_2, as many more parameters need to be taken into account. Therefore the quality of data on NOx emissions is considered to be only fair.

Policy Relevance:
In certain conditions, local NOx emissions in urban areas with high traffic intensity lead to the formation of tropospheric ozone, which affects human health. NOx can be transported over large distances and deposited many kilometres away from the source, contributing to a number of environmental problems, including acidification of soils and eutrophication of soil and water bodies. Emissions arise primarily from the reaction of nitrogen and oxygen during the combustion of fossil fuels, particularly gasoline and diesel fuel, but also from selected production processes. However, road vehicles are the major source. In most developed countries the fitting of catalytic converters to reduce emissions of NOx is obligatory. But with the increased use of road vehicles, particularly for short journeys where the engine has not enough time to reach the temperature needed for the catalyser to function efficiently, NOx emissions are proving more difficult to reduce than SO_2 emissions. This is particularly the case in developing countries where diesel is the most commonly used fuel, the vehicle fleet is old and not well-maintained, and catalytic converters are rare. Together with climatic conditions that favour the production of tropospheric ozone and prevent it from dispersing, this means that urban populations in some developing countries, who also spend more time outdoors and exposed to the smog, suffer more health effects from NOx emissions than the levels of emissions would suggest.

ENVIRONMENTAL INDICATORS
Climate Change
Greenhouse gas emissions *last update: April 2007*

	Latest year available	Total GHG emissions mio. tonnes of CO_2 equivalent	% change since 1990 %	GHG emissions per capita tonnes of CO_2 equivalent/person
Albania	1994	5.53	-22.5	1.72
Algeria	1994	91.61	...	3.35
Antigua and Barbuda	1990	0.39	0.0	6.19
Argentina	1997	279.68	20.6	7.84
Armenia	1990	25.31	0.0	7.14
Australia	2004	529.23	25.1	26.54
Austria	2004	91.30	15.7	11.17
Azerbaijan	1994	42.75	-29.7	5.56
Bahamas	1994	2.20	14.9	7.91
Bahrain	1994	19.47	...	34.34
Bangladesh	1994	45.93	...	0.38
Barbados	1997	4.06	24.8	15.34
Belarus	2004	74.36	-41.6	7.58
Belgium	2004	147.87	1.4	14.22
Belize	1994	6.34	...	30.50
Benin	1995	39.35	...	7.19
Bhutan	1994	1.29	...	0.72
Bolivia	2000	21.46	40.1	2.58
Botswana	1994	9.29	...	6.15
Brazil	1994	658.98	11.1	4.16
Bulgaria	2004	67.51	-41.0	8.68
Burkina Faso	1994	5.97	...	0.60
Burundi	1998	2.00	...	0.33
Cambodia	1994	12.76	...	1.15
Cameroon	1994	165.73	...	12.69
Canada	2004	758.07	26.6	23.72
Cape Verde	1995	0.29	...	0.74
Central African Republic	1994	38.34	...	11.72
Chad	1993	8.02	...	1.26
Chile	1994	54.66	...	3.91
China	1994	4057.31	...	3.36
Colombia	1994	137.49	22.8	3.64
Comoros	1994	0.52	...	0.88
Congo	1994	1.38	...	0.49
Cook Islands	1994	0.08	...	4.22
Costa Rica	1996	10.50	72.2	2.95
Croatia	2004	29.43	-5.4	6.48
Cuba	1996	40.13	-36.9	3.64
Czech Republic	2004	147.11	-25.0	14.38
Dem. Rep. of the Congo	1994	44.53	...	1.03
Denmark	2004	69.62	-1.1	12.86
Djibouti	1994	0.51	...	0.91
Dominica	1994	0.15	-98.8	2.02
Dominican Republic	1994	20.44	...	2.71
Ecuador	1990	30.77	0.0	3.00
Egypt	1990	117.27	0.0	2.10
El Salvador	1994	11.92	...	2.15
Eritrea	2000	0.60	...	0.16
Estonia	2004	21.32	-51.0	15.97
Ethiopia	1995	47.75	11.0	0.83

Climate Change: *Greenhouse gas emissions*

	Latest year available	Total GHG emissions mio. tonnes of CO_2 equivalent	% change since 1990 %	GHG emissions per capita tonnes of CO_2 equivalent/person
Fiji	1994	1.39	...	1.83
Finland	2004	81.43	14.5	15.55
France	2004	562.63	-0.8	9.34
Gabon	1994	6.52	...	6.05
Gambia	1993	4.24	...	4.07
Georgia*	2002	19.75	-57.4[1, 2]	3.81
Germany	2004	1015.27	-17.2	12.28
Ghana	1996	13.40	20.1	0.75
Greece	2004	137.63	26.6	12.40
Grenada	1994	1.61	...	19.22
Guatemala	1990	14.74	0.0	1.68
Guinea	1994	5.06	...	0.71
Guyana	1998	3.07	40.8	4.08
Haiti	1994	5.13	...	0.70
Honduras	1995	10.83	...	1.92
Hungary	2004	83.92	-19.4	8.29
Iceland	2004	3.11	-5.1	10.65
India	1994	1214.25	...	1.33
Indonesia	1994	323.26	21.2	1.66
Iran (Islamic Republic of)	1994	385.43	...	6.27
Ireland	2004	68.46	23.1	16.78
Israel*	2000	75.24	...	12.45
Italy	2004	582.52	12.1	10.04
Jamaica	1994	116.23	...	47.44
Japan	2004	1355.17	6.5	10.59
Jordan	1994	21.94	...	5.41
Kazakhstan	1994	219.24	-18.8	13.14
Kenya	1994	21.47	...	0.81
Kiribati	1994	0.03	...	0.39
Korea, Dem. People's Rep.	1990	201.93	0.0	10.12
Korea, Republic of	1990	289.46	0.0	6.75
Kyrgyzstan	2000	15.05	-58.3	3.06
Lao People's Dem. Rep.	1990	6.87	0.0	1.66
Latvia	2004	10.75	-58.5	4.64
Lebanon	1994	15.70	...	5.13
Lesotho	1994	1.82	...	1.10
Liechtenstein	2004	0.27	...	7.89
Lithuania	2004	20.19	...	5.86
Luxembourg	2004	12.72	...	27.71
Madagascar	1994	21.93	...	1.64
Malawi	1994	7.07	...	0.71
Malaysia	1994	136.36	...	6.87
Maldives	1994	0.48	...	1.98
Mali	1995	8.67	...	0.84
Malta	2000	2.85	...	7.32
Mauritania	1995	4.33	...	1.88
Mauritius*	2002	3.36	...	2.78
Mexico	1990	383.08	0.0	4.60
Micronesia, Federated States of	1994	0.25	...	2.36
Monaco	2004	0.10	-7.0	2.87
Mongolia	1998	15.90	...	6.48
Morocco	1994	44.37	...	1.68
Mozambique	1994	8.19	...	0.53

Climate Change: *Greenhouse gas emissions*

	Latest year available	Total GHG emissions mio. tonnes of CO_2 equivalent	% change since 1990 %	GHG emissions per capita tonnes of CO_2 equivalent/person
Namibia	1994	5.60	...	3.51
Nauru	1994	0.04	...	3.81
Nepal	1994	31.19	...	1.52
Netherlands	2004	218.09	...	13.44
New Zealand	2004	75.09	...	18.82
Nicaragua	1994	7.65	...	1.78
Niger	1990	4.86	0.0	0.64
Nigeria	1994	242.63	...	2.51
Niue	1994	4.42	...	2038.75
Norway	2004	54.93	10.3	11.95
Pakistan	1994	160.60	...	1.32
Palau	1994	0.13	...	7.77
Panama	1994	10.69	...	4.09
Papua New Guinea	1994	5.01	...	1.09
Paraguay	1994	140.46	114.6	29.85
Peru	1994	57.58	...	2.46
Philippines	1994	100.87	...	1.51
Poland	2004	388.06	-15.4	10.06
Portugal	2004	84.55[3]	41.0	8.10
Republic of Moldova	1998	10.51	-68.4	2.44
Romania	2004	154.63	-32.8	7.10
Saint Kitts and Nevis	1994	0.16	...	3.71
Saint Lucia	1994	0.89	...	6.42
Samoa	1994	0.56	...	3.41
Senegal	1995	9.57	...	1.15
Seychelles	1995	0.26	...	3.47
Singapore	1994	26.86	...	7.96
Slovakia	2004	51.03	-30.4	9.45
Slovenia	2004	20.06	8.7	10.20
Solomon Islands	1994	0.29	...	0.80
South Africa	1994	379.84	9.4	9.46
Spain	2004	427.90	49.0	10.03
Sri Lanka	1995	29.13	...	1.64
St. Vincent and the Grenadines	1997	0.41	4.6	3.54
Sudan	1995	54.24	...	1.93
Suriname	2003	3.34	...	7.67
Swaziland	1994	2.64	...	2.87
Sweden	2004	69.85	-3.5	7.75
Switzerland	2004	53.02	0.4	7.32
Tajikistan	1998	4.29	-81.9	0.72
Thailand	1994	223.98	...	3.92
The Former Yugoslav Rep. of Macedonia	1998	15.07	-2.4	7.54
Togo	1998	6.28	...	1.47
Tonga	1994	0.23	...	2.32
Trinidad and Tobago	1990	16.39	0.0	13.49
Tunisia	1994	25.14	...	2.85
Turkey	2004	293.81	72.6	4.07
Turkmenistan	1994	52.31	...	12.74
Tuvalu	1994	0.01	...	1.06
Uganda	1994	42.60	...	2.16
Ukraine	2004	413.41	-55.3	8.80
United Kingdom	2004	665.33	-14.3	11.19
United Rep. of Tanzania	1994	39.24	-5.3	1.31

Climate Change: *Greenhouse gas emissions*

	Latest year available	Total GHG emissions mio. tonnes of CO_2 equivalent	% change since 1990 %	GHG emissions per capita tonnes of CO_2 equivalent/person
United States	2004	7067.57	15.8	23.92
Uruguay	1998	33.57	21.4	10.20
Uzbekistan	1994	153.89	-5.7	6.89
Vanuatu	1994	0.30	...	1.79
Venezuela	1999	192.19	...	8.08
Viet Nam	1994	84.45	...	1.18
Yemen	1995	17.87	...	1.18
Zambia	1994	32.77	...	3.59
Zimbabwe	1994	27.59	...	2.40

Sources:
UN Framework Convention on Climate Change (UNFCCC) Secretariat (see: http://unfccc.int).
UNSD/UNEP 2004 questionnaire on Environment statistics, Air section, marked with "*".
UN Population Division.

Footnotes:
1. In 1990, CO_2 and CH_4 data were calculated according to methodology used in the former USSR and the IPCC Guidelines for Greenhouse Gas Inventories, version 1-3 Hadley Centre, UK.
2. In 1990, CO_2 emission refers to emissions from Energy and Industrial processes and CH_4 emission does not include emissions from other fuel combustion.
Definitions & Technical notes:
In this table, greenhouse gases (GHG) refer to carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). These three gases account for around 98% of the environmental pressure leading to climate change. Each of these gases has a potential to trap heat in the atmosphere: i.e. methane is 21 times more powerful as a GHG than CO_2, while N_2O is 310 times more powerful. In order to aggregate the three gases to give total emissions of GHG, the data were weighted according to these CO_2 equivalents, also known as Global Warming Potentials. Data on greenhouse gas emissions are usually estimated according to international methodologies on the basis of national statistics on energy, industrial and agricultural production, waste management and land use, etc. The best known and most widely used methodology is the 1996 Guidelines of the Intergovernmental Panel for Climate Change (IPCC) (see http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm) which is the basis for reporting to the UNFCCC. The latest revision and update of this guideline is 2006 IPCC Guidelines for National Greenhouse Gas Inventories (see http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.htm).

Data Quality:
Countries should report their greenhouse gas emissions to UNFCCC according to the IPCC Guidelines. The quality of data is regularly checked by UNFCCC for the Annex 1 parties to the Convention that report annually. Non-Annex 1 countries do not report on a regular basis and their data are not subject to the same thorough checking. Data quality depends on the quality of statistics underlying the calculations or estimates and is usually the best for energy related emissions; for other sources, the data should be used with caution when comparing countries.

Policy Relevance:
The Earth's average surface temperature rose by around 0.6°C during the 20th century and most scientific advisors to the world's governments conclude that evidence is growing that most of the warming over the last 50 years is attributable to human activities, such as burning of fossil fuels and deforestation. The resulting increased energy in the weather system is already resulting in increased storms and rainfall in some areas, while others suffer drought. This is expected to increase in future, and while how fast and where this will happen is still controversial, there is consensus in the scientific community that the consequences may be serious. In 1992 the United Nations Conference on Environment and Development, in Rio de Janeiro, adopted the Framework Convention on Climate Change as the basis for global political action. As a result of this convention, commitments to reduce emissions of greenhouse gases were agreed in Kyoto in December 1997. The Kyoto Protocol, which entered into force on 16 February 2005, stipulates that Annex 1 Parties (mainly industrialized countries) shall individually or jointly reduce their aggregate emissions of a "basket" of six greenhouse gases to 5% below 1990 levels by the period 2008-2012. In contrast to this political target the Inter-governmental Panel on Climate Change (IPCC) indicates the need for an immediate 50-70% reduction in global CO_2 emissions in order to stabilise global CO_2 concentrations at the 1990 level by 2100. The World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 made commitments towards the urgent and substantial increase in the use of renewable (non-carbon) energy sources as well as the setting-up of programmes leading to more sustainable consumption and production patterns, including a reduction in energy use.

ENVIRONMENTAL INDICATORS

Climate Change

CO_2 emissions *last update: April 2007*

	Latest year available	CO_4 emissions	% change since 1990	CO_2 emissions per capita	CO_2 emissions per km²
		mio. tonnes	%	tonne/person	tonne/km²
Afghanistan	2003	0.70	-73.1	0.03	1.08
Albania	2003	3.05	-58.2	0.98	105.92
Algeria	2003	163.95	112.6	5.14	68.83
American Samoa	2003	0.29	2.1	4.72	1467.34
Angola	2003	8.63	85.5	0.57	6.93
Antigua and Barbuda	2003	0.40	32.6	5.01	902.71
Argentina	2003	127.73	16.2	3.36	45.94
Armenia	2003	3.43	...	1.13	115.17
Aruba	2003	2.16	17.2	22.30	11983.33
Australia	2003	371.70	32.3	18.80	48.02
Austria	2003	76.21	24.4	9.40	908.80
Azerbaijan	2003	29.22	...	3.52	337.45
Bahamas	2003	1.87	-4.0	5.96	134.96
Bahrain	2003	21.91	86.8	31.04	31573.49
Bangladesh	2003	34.69	125.5	0.25	240.91
Barbados	2003	1.19	10.7	4.44	2772.09
Belarus	2003	52.59	-48.6	5.30	253.32
Belgium	2003	126.20	6.0	12.20	4133.91
Belize	2003	0.78	149.2	3.01	33.96
Benin	2003	2.05	186.0	0.26	18.16
Bermuda	2003	0.50	-15.6	7.82	9396.23
Bhutan	2003	0.39	202.3	0.19	8.23
Bolivia	2003	7.91	43.6	0.90	7.20
Bosnia and Herzegovina	2003	19.16	...	4.89	374.26
Botswana	2003	4.12	89.7	2.33	7.09
Brazil	2003	298.90	47.3	1.65	35.10
British Virgin Islands	2003	0.08	57.1	3.59	509.93
Brunei Darussalam	2003	4.56	-21.8	12.75	790.63
Bulgaria	2003	53.32	-45.9	6.80	480.74
Burkina Faso	2003	1.04	4.5	0.08	3.80
Burundi	2003	0.24	22.3	0.03	8.48
Cambodia	2003	0.54	18.4	0.04	2.96
Cameroon	2003	3.54	120.3	0.22	7.45
Canada	2003	586.07	27.5	18.50	58.78
Cape Verde	2003	0.14	73.5	0.30	35.71
Cayman Islands	2003	0.30	22.1	7.05	1151.52
Central African Republic	2003	0.25	26.0	0.06	0.40
Chad	2003	0.12	-18.7	0.01	0.09
Chile	2003	58.59	65.6	3.67	77.49
China	2003	4151.41	72.8	3.19	432.58
China, Hong Kong SAR	2003	37.87	44.4	5.50	34454.05
China, Macao SAR	2003	1.87	81.5	4.11	71846.16
Colombia	2003	55.63	-2.2	1.26	48.85
Comoros	2003	0.09	36.9	0.12	39.82
Congo	2003	1.38	17.6	0.37	4.04
Cook Islands	2003	0.03	40.9	1.70	131.36
Costa Rica	2003	6.34	117.0	1.52	124.07
Cote d'Ivoire	2003	5.72	6.1	0.33	17.75
Croatia	2003	23.00	-0.2	5.10	406.81
Cuba	2003	25.30	-21.2	2.25	228.17
Cyprus	2003	7.29	56.6	8.93	788.13

Climate Change: *CO_2 emissions*

	Latest year available	CO_4 emissions	% change since 1990	CO_2 emissions per capita	CO_2 emissions per km²
		mio. tonnes	%	tonne/person	tonne/km²
Czech Republic	2003	127.12	-22.5	12.40	1611.85
Dem. Rep. of the Congo	2003	1.79	-55.0	0.03	0.76
Denmark	2003	60.75	12.0	11.30	1409.71
Djibouti	2003	0.37	3.7	0.48	15.78
Dominica	2003	0.14	137.9	1.76	183.75
Dominican Republic	2003	21.35	122.9	2.47	438.60
Ecuador	2003	23.25	40.1	1.81	81.98
Egypt	2003	139.89	85.1	1.96	139.69
El Salvador	2003	6.55	150.0	0.99	311.44
Equatorial Guinea	2003	0.17	41.9	0.34	5.92
Eritrea	2003	0.70	...	0.17	5.97
Estonia	2003	19.11	-49.9	14.20	423.73
Ethiopia	2003	7.35	147.5	0.10	6.65
Faeroe Islands	2003	0.66	7.0	14.22	474.52
Falkland Islands (Malvinas)	2003	0.05	21.1	15.06	3.78
Fiji	2003	1.12	37.3	1.34	61.29
Finland	2003	73.19	30.0	14.00	216.45
France	2003	408.16	2.8	6.80	740.09
French Guiana	2003	1.00	24.8	5.64	11.17
French Polynesia	2003	0.69	13.6	2.79	173.50
Gabon	2003	1.23	-79.6	0.91	4.58
Gambia	2003	0.28	48.2	0.20	25.06
Georgia	2003	3.73	...	0.82	53.54
Germany	2003	865.37	-14.7	10.50	2423.86
Ghana	2003	7.74	105.4	0.37	32.47
Gibraltar	2003	0.36	495.1	13.04	60500.00
Greece	2003	109.98	30.9	9.90	833.45
Greenland	2003	0.57	2.7	10.03	0.26
Grenada	2003	0.22	84.2	2.17	642.44
Guadeloupe	2003	1.71	33.5	3.88	1004.69
Guam	2003	4.09	80.0	24.95	7444.44
Guatemala	2003	10.71	110.3	0.89	98.37
Guinea	2003	1.34	32.2	0.15	5.45
Guinea-Bissau	2003	0.27	29.2	0.18	7.47
Guyana	2003	1.63	43.9	2.18	7.59
Haiti	2003	1.74	75.0	0.21	62.74
Honduras	2003	6.51	150.9	0.94	58.05
Hungary	2003	60.46	-28.7	6.00	649.88
Iceland	2003	2.18	4.8	7.50	21.17
India	2003	1275.61	87.9	1.19	388.05
Indonesia	2003	295.60	97.7	1.36	155.20
Iran (Islamic Republic of)	2003	382.09	74.8	5.60	231.82
Iraq	2003	73.01	50.2	2.67	166.56
Ireland	2003	44.45	39.8	11.10	632.53
Israel	2003	68.43	106.2	10.57	3089.95
Italy	2003	487.28	13.2	8.40	1617.16
Jamaica	2003	10.74	34.7	4.09	976.89
Japan	2003	1259.43	12.2	9.90	3332.95
Jordan	2003	17.12	67.8	3.16	191.59
Kazakhstan	2003	159.49	...	10.74	58.53
Kenya	2003	8.79	50.7	0.27	15.15
Kiribati	2003	0.03	40.9	0.32	42.70
Korea, Dem. People's Rep.	2003	77.60	-68.3	3.48	643.79

Climate Change: *CO_2 emissions*

	Latest year available	CO_4 emissions	% change since 1990	CO_2 emissions per capita	CO_2 emissions per km²
		mio. tonnes	%	tonne/person	tonne/km²
Korea, Republic of	2003	456.75	89.1	9.62	4588.71
Kuwait	2003	78.60[1]	73.4	31.13[1]	4411.38
Kyrgyzstan	2003	5.33	...	1.04	26.65
Lao People's Dem. Rep.	2003	1.25	445.2	0.22	5.30
Latvia	2003	7.43	-60.2	3.20	115.02
Lebanon	2003	19.00	108.6	5.42	1826.73
Lesotho	1994	0.64	...	0.38	20.95
Liberia	2003	0.46	-0.6	0.14	4.17
Libyan Arab Jamahiriya	2003	50.27	32.9	8.93	28.57
Liechtenstein	2003	0.24	4.3	7.10	1500.00
Lithuania	2003	12.29	-68.4	3.60	188.21
Luxembourg	2003	10.69	-16.2	23.60	4133.80
Madagascar	2003	2.35	148.7	0.13	3.99
Malawi	2003	0.88	47.3	0.07	7.47
Malaysia	2003	156.68	183.0	6.41	475.01
Maldives	2003	0.44	187.0	1.41	1483.22
Mali	2003	0.55	31.0	0.04	0.45
Malta	2003	2.47	10.4	6.20	7806.96
Martinique	2003	1.34	-35.0	3.42	1216.88
Mauritania	2003	2.50	-5.2	0.87	2.44
Mauritius	2003	3.15	115.0	2.58	1544.12
Mexico	2003	416.70	10.9	3.99	212.80
Micronesia, Federated States of	1994	0.24	...	2.20	336.14
Monaco	2003	0.13	44.4	3.80	65000.00
Mongolia	2003	7.99	-20.1	3.09	5.11
Montserrat	2003	0.06	79.4	15.99	598.04
Morocco	2003	37.97	61.4	1.24	85.03
Mozambique	2003	1.57	57.3	0.08	1.96
Myanmar	2003	9.47	121.6	0.19	13.99
Namibia	2003	2.33	38750.0	1.17	2.83
Nauru	2003	0.14	6.8	10.76	6714.29
Nepal	2003	2.95	367.6	0.11	20.08
Netherlands	2003	176.86	11.9	11.00	4258.81
Netherlands Antilles	2003	4.06	236.8	22.70	5073.75
New Caledonia	2003	1.87	16.0	8.20	100.78
New Zealand	2003	34.70	37.1	8.80	128.26
Nicaragua	2003	3.92	47.9	0.74	30.13
Niger	2003	1.21	15.0	0.09	0.95
Nigeria	2003	52.28	15.1	0.42	56.59
Niue	2003	0.00	0.0	2.01	11.54
Norway	2003	43.22	25.6	9.40	112.21
Oman	2003	32.31	214.1	12.87	104.39
Pakistan	2003	114.36	67.8	0.75	143.65
Palau	2003	0.24	3.8	12.30	529.41
Panama	2003	6.03	92.5	1.93	79.92
Papua New Guinea	2003	2.52	3.4	0.44	5.43
Paraguay	2003	4.14	83.0	0.70	10.19
Peru	2003	26.20	24.4	0.96	20.38
Philippines	2003	77.10	75.3	0.96	256.98
Poland	2002	308.28	-35.3	...	985.91
Portugal	2003	64.29	47.4	6.20	698.94
Puerto Rico	2003	2.11	-82.1	0.54	237.18
Qatar	2003	46.26	279.1	63.09	4205.64

Climate Change: *CO_2 emissions*

	Latest year available	CO_4 emissions	% change since 1990	CO_2 emissions per capita	CO_2 emissions per km²
		mio. tonnes	%	tonne/person	tonne/km²
Republic of Moldova	2003	7.24	...	1.71	213.88
Réunion	2003	2.48	101.7	3.26	987.65
Romania	2003	111.39	-39.5	5.10	467.26
Russian Federation	1999	1509.00	-36.1	...	88.25
Rwanda	2003	0.60	13.6	0.07	22.86
Saint Helena	2003	0.01	100.0	2.46	38.96
Saint Kitts and Nevis	2003	0.13	93.8	3.02	482.76
Saint Lucia	2003	0.33	100.0	2.06	604.82
Saint Pierre and Miquelon	2003	0.06	-29.3	11.32	268.60
Samoa	2003	0.15	19.8	0.83	53.34
Sao Tome and Principe	2003	0.09	35.3	0.62	95.44
Saudi Arabia	2003	302.88[1]	53.2	12.98[1]	140.90
Senegal	2003	4.85	54.5	0.44	24.63
Serbia and Montenegro	2003	50.02	...	4.76	489.59
Seychelles	2003	0.55	379.8	6.91	1202.20
Sierra Leone	2003	0.65	94.9	0.13	9.10
Singapore	2003	47.88	6.1	11.35	70109.81
Slovakia	2003	43.05	-27.6	8.00	877.98
Slovenia	2003	16.10	0.6	8.20	794.83
Solomon Islands	2003	0.18	9.2	0.39	6.16
Somalia	1997	0.00	...	0.00	0.00
South Africa	2003	364.85	27.6	7.78	298.81
Spain	2003	331.76	45.3	7.90	655.66
Sri Lanka	2003	10.32	174.1	0.51	157.31
St. Vincent and the Grenadines	2003	0.19	142.5	1.65	500.00
Sudan	2003	9.01	67.0	0.26	3.59
Suriname	2003	2.24	23.7	5.05	13.69
Swaziland	2003	0.96	125.2	0.92	55.11
Sweden	2003	56.00	-0.5	6.20	124.45
Switzerland	2003	44.72	0.8	6.20	1083.23
Syrian Arab Republic	2003	49.04	36.6	2.70	264.80
Tajikistan	2003	4.66	...	0.73	32.58
Thailand	2003	246.37	156.9	3.90	480.15
The Former Yugoslav Rep. of Macedonia	2003	10.55	...	5.20	410.10
Timor-Leste	2003	0.16	...	0.20	10.96
Togo	2003	2.20	192.6	0.38	38.74
Tonga	2003	0.11	48.1	1.12	152.61
Trinidad and Tobago	2003	28.70	69.4	22.12	5594.35
Tunisia	2003	20.91	57.4	2.11	127.80
Turkey	2003	220.41	50.5	3.09	281.29
Turkmenistan	2003	43.41	...	9.24	88.94
Turks and Caicos Islands	1990	0.00	...	0.00	0.00
Tuvalu	1994	0.00	...	0.48	178.85
Uganda	2003	1.71	110.2	0.06	7.11
Ukraine	2003	313.14	-57.6	6.60	518.70
United Arab Emirates	2003	135.29	147.0	33.56	1618.24
United Kingdom	2003	557.46	-5.3	9.40	2295.02
United Rep. of Tanzania	2003	3.81	62.9	0.10	4.03
United States	2003	5841.50	16.6	20.00	606.65
United States Virgin Islands	2003	13.55	60.1	121.30	39043.23
Uruguay	2003	4.38	11.9	1.28	25.03
Uzbekistan	2003	123.84	...	4.79	276.80
Vanuatu	2003	0.09	30.9	0.44	7.30

Climate Change: *CO_2 emissions*

	Latest year available	CO_4 emissions	% change since 1990	CO_2 emissions per capita	CO_2 emissions per km²
		mio. tonnes	%	tonne/person	tonne/km²
Venezuela	2003	144.23	22.7	5.59	158.13
Viet Nam	2003	76.24	255.9	0.93	229.86
Western Sahara	2003	0.24	21.8	0.75	0.90
Yemen	2003	17.08	...	0.87	32.35
Zambia	2003	2.20	-10.2	0.19	2.92
Zimbabwe	2003	11.49	-31.1	0.89	29.40

Sources:
UNSD Millennium Development Goals Indicators database (see http://mdgs.un.org/unsd/mdg/Data.aspx)
UN Population Division.
UNSD Demographic Yearbook (see: http://unstats.un.org/unsd/demographic/products/dyb/dyb2004.htm)

Footnotes:
1. Including part of the Neutral Zone.

Definitions & Technical notes:
CO_2 emissions from energy industry, from transport, from fuel combustion in industry, services, households, etc. and industrial processes, such as the production of cement. Changes in how land is used can also result in the emission of CO_2, or in the removal of CO_2 from the atmosphere. However, as there is not yet an agreed method for estimating this, it is not included in the figures for CO_2 emissions. Burning of biomass such as wood and straw also emits CO_2; however, unless there has been a change in land use, it is considered that CO_2 emitted from biomass is removed from the air by new growth, and therefore it should not included in the total for CO_2.

Data Quality:
For Annex 1 countries, data are from UNFCCC. UNFCCC has developed standardised methods for calculating CO_2 emissions, which are widely used. For non-Annex 1 countries, data are from estimates of CO_2 emissions made by the Carbon Dioxide Information Analysis Center (CDIAC) (see: http://cdiac.ornl.gov/). CDIAC acquires or compiles, quality assures, documents, archives, and distributes data and other information concerning carbon dioxide.

Policy Relevance:
See table on greenhouse gas emissions. CO_2 is by far the largest contributor to global warming, and the major source of CO_2 is combustion of fossil fuels. The Inter-governmental Panel on Climate Change (IPCC) indicates the need for an immediate 50-70% reduction in global CO_2 emissions in order to stabilise global CO_2 concentrations at the 1990 level by 2100. Various policy options are available to reduce emissions, including energy efficiency measures and switching to less carbon intensive fuels, e.g. from burning coal and lignite to natural gas. The World Summit on Sustainable Development (WSSD) held in Johannesburg in 2002 made commitments towards the urgent and substantial increase in the use of renewable non-carbon energy sources, such as wind, wave and solar power, but also including biomass. It also urged the setting-up of programmes to promote sustainable consumption and production patterns which should lead to reduced CO_2 emissions.

ENVIRONMENTAL INDICATORS

Climate Change

Emissions of other greenhouse gases *last update: April 2007*

	Latest year available	CH_4 emissions	% change since 1990	N_2O emissions	% change since 1990
		mio. tonnes of CO_2 equivalent	%	mio. tonnes of CO_2 equivalent	%
Albania	1994	2.14	...	0.29	...
Algeria	1994	18.77	...	9.13	...
Antigua and Barbuda	1990	0.10	0.0	0.00	0.0
Argentina	1997	87.58	15.2	60.73	-1.6
Armenia	1990	3.21	0.0	0.09	0.0
Australia	2004	117.87	-1.4	24.20	30.0
Austria	2004	7.41	-19.2	5.28	-15.4
Azerbaijan	1994	9.28	-38.9	0.66	-26.6
Bahamas	1994	0.02	0.0	0.31	...
Bahrain	1994	2.94	...	0.04	...
Bangladesh	1994	25.01	...	4.46	...
Barbados	1997	1.81	9.3	0.05	0.0
Belarus	2004	12.65	-16.4	6.72	-34.7
Belgium	2004	7.92	-26.8	11.21	-6.7
Belize	1994	5.57	...	0.17	...
Benin	1995	38.01	...	0.53	...
Bhutan	1994	0.40	...	0.66	...
Bolivia	2000	12.77	36.5	0.92	58.6
Botswana	1994	4.24	...	2.04	...
Brazil	1994	238.73	6.4	166.87	12.4
Bulgaria	2004	9.77	-47.8	4.40	-57.9
Burkina Faso	1994	4.70	...	0.37	...
Burundi	1998	0.94	...	0.91	...
Cambodia	1994	7.77	...	3.67	...
Cameroon	1994	17.71	...	145.25	...
Canada	2004	110.23	34.6	43.98	-2.5
Cape Verde	1995	0.07	...	0.01	...
Central African Republic	1994	11.84	...	26.29	...
Chad	1993	6.94	...	0.77	...
Chile	1994	10.12	...	7.39	...
China	1994	720.03	...	263.81	...
Colombia	1994	48.22	8.2	28.35	15.0
Comoros	1994	0.05	...	0.39	...
Congo	1994	0.58	...	0.12	...
Cook Islands	1994	0.01	...	0.04	...
Costa Rica	1996	3.68	16.5	2.27	1121.5
Cote d'Ivoire	1994	18.68	...	1.70	...
Croatia	2004	3.01	-6.7	3.68	-6.2
Cuba	1996	6.58	-38.4	7.03	-59.7
Czech Republic	2004	10.83	-41.6	8.31	-34.0
Dem. Rep. of the Congo	1994	40.64	...	2.56	...
Denmark	2004	5.79	1.5	7.63	-28.1
Djibouti	1994	0.24	...	0.00	...
Dominica	1994	0.06	...	0.01	...
Dominican Republic	1994	4.66	53.3	0.78	-7.4
Ecuador	1990	10.57	0.0	0.17	0.0
Egypt	1990	22.17	0.0	10.63	0.0
El Salvador	1994	3.11	...	4.09	...
Estonia	2004	1.73	-60.4	0.36	-64.4
Ethiopia	1995	37.46	-0.3	7.44	140.0
Fiji	1994	0.54	...	0.03	...

Climate Change: *Emissions of other greenhouse gases*

	Latest year available	CH_4 emissions	% change since 1990	N_2O emissions	% change since 1990
		mio. tonnes of CO_2 equivalent	%	mio. tonnes of CO_2 equivalent	%
Finland	2004	4.69	-25.7	6.90	-13.1
France	2004	58.84	-14.4	71.20	-23.6
Gabon	1994	1.17	...	0.95	...
Gambia	1993	3.99	...	0.07	...
Georgia*	2002	2.42	-67.6[1,2]	0.98	-59.8
Germany	2004	51.44	-48.4	63.86	-24.3
Ghana	1996	8.67	20.1	0.92	13.8
Greece	2004	8.41	-7.8	13.16	-6.8
Grenada	1994	1.47	...	0.00	...
Guatemala	1990	4.09	0.0	6.41	0.0
Guinea	1994	3.25	...	0.23	...
Guyana	1998	1.01	50.0	0.31	0.0
Haiti	1994	2.65	...	2.33	...
Honduras	1995	5.76	...	0.98	...
Hungary	2004	9.14	-23.4	13.89	-26.6
Iceland	2004	0.47	14.3	0.32	-10.5
India	1994	379.60	...	55.30	...
Indonesia	1994	126.88	19.6	18.17	1.0
Iran (Islamic Republic of)	1994	53.14	...	21.64	...
Ireland	2004	13.29	0.5	9.24	-5.7
Israel*	2000	9.23	...	2.23	...
Italy	2004	41.82	0.7	44.40	8.0
Jamaica	1994	1.22	...	106.44	...
Japan	2004	24.42	-26.8	25.79	-21.2
Jordan	1994	8.47	...	0.08	...
Kazakhstan	1994	39.93	2.2	0.04	-93.9
Kenya	1994	15.54	...	0.42	...
Kiribati	1994	0.01	...	0.00	...
Korea, Dem. People's Rep.	1990	20.47	0.0	12.01	0.0
Korea, Republic of	1990	28.60	0.0	4.35	0.0
Kyrgyzstan	2000	3.09	-47.5	0.28	-77.7
Lao People's Dem. Rep.	1990	6.41	0.0	0.04	0.0
Latvia	2004	1.80	-48.3	1.44	-62.3
Lebanon	1994	1.13	...	0.97	...
Lesotho	1994	0.97	...	0.21	...
Liechtenstein	2004	0.01	38.5	0.01	-2.8
Lithuania	2004	3.25	-59.1	3.55	-12.8
Luxembourg	2004	0.45	-9.0	0.22	24.1
Madagascar	1994	7.76	...	13.03	...
Malawi	1994	3.95	-44.0	2.41	619.1
Malaysia	1994	46.85	...	0.13	...
Mali	1995	7.16	...	0.55	...
Malta	2000	0.39	27.4	0.02	-5.9
Mauritania	1995	3.26	...	0.02	...
Mauritius*	2002	0.25	203.1	0.47	...
Mexico	1990	71.41	0.0	3.03	0.0
Micronesia, Federated States of	1994	0.01	...	0.00	...
Monaco	2004	0.00	...	0.00	90.6
Mongolia	1998	6.84	21.4	0.03	0.0
Morocco	1994	7.33	...	8.68	...
Mozambique	1994	5.66	13.5	0.95	32.3
Namibia	1994	3.55	...	0.23	...
Nauru	1994	0.01	...	0.00	...

Climate Change: *Emissions of other greenhouse gases*

	Latest year available	CH_4 emissions	% change since 1990	N_2O emissions	% change since 1990
		mio. tonnes of CO_2 equivalent	%	mio. tonnes of CO_2 equivalent	%
Nepal	1994	19.92	...	9.64	...
Netherlands	2004	17.30	-32.0	17.75	-16.4
New Zealand	2004	27.09	5.9	13.26	27.2
Nicaragua	1994	4.13	...	0.79	...
Niger	1990	3.44	0.0	0.82	0.0
Nigeria	1994	124.15	...	3.65	...
Niue	1994	0.01	...	0.01	...
Norway	2004	4.80	0.9	4.59	-2.4
Pakistan	1994	60.71	...	11.44	...
Palau	1994	0.03	...	0.01	...
Panama	1994	3.58	...	2.79	...
Papua New Guinea	1994	0.09	...	3.78	...
Paraguay	1994	63.42	260.7	73.23	97.3
Peru	1994	13.40	...	13.53	...
Philippines	1994	28.93	...	14.00	...
Poland	2004	39.02	-33.7	30.00	54.4
Portugal	2004	12.26	9.1	6.23	16.2
Republic of Moldova	1998	2.26	-44.4	0.13	-85.4
Romania	2004	26.94	-39.4	10.81	-34.1
Russian Federation	2004	0.00	...	0.00	...
Saint Kitts and Nevis	1994	0.06	...	0.03	...
Saint Lucia	1994	0.60	...	0.02	...
Samoa	1994	0.07	...	0.39	...
Senegal	1995	5.39	...	0.02	...
Seychelles	1995	0.05	...	0.03	...
Slovakia	2004	4.26	-33.7	4.07	-33.5
Slovenia	2004	2.08	-8.2	1.28	3.6
South Africa	1994	43.21	0.2	20.67	-11.3
Spain	2004	36.63	33.4	31.57	13.7
Sri Lanka	1995	16.02	...	7.44	...
St. Vincent and the Grenadines	1997	0.06	0.0	0.24	-4.0
Sudan	1995	39.82	...	9.92	...
Suriname	2003	0.87	...	...	...
Swaziland	1994	1.35	...	0.41	...
Sweden	2004	5.75	-13.8	7.65	-10.4
Switzerland	2004	3.68	-18.7	3.16	-10.9
Tajikistan	1998	1.89	-41.4	0.53	-55.3
Thailand	1994	65.33	...	17.19	...
The Former Yugoslav Rep. of Macedonia	1998	3.74	3.7	1.14	-23.6
Togo	1998	1.13	...	3.72	...
Tonga	1994	0.11	...	0.04	...
Trinidad and Tobago	1990	1.17	0.0	0.24	0.0
Tunisia	1994	3.78	...	4.26	...
Turkey	2004	46.37	58.0	5.49	336.9
Turkmenistan	1994	20.35	...	0.13	...
Tuvalu	1994	0.00	...	0.00	...
Uganda	1994	26.65	...	15.22	...
Ukraine	2004	74.11	-51.0	22.28	-59.2
United Kingdom	2004	51.82	-50.0	40.80	-40.3
United Rep. of Tanzania	1994	21.64	-41.5	14.38	1164.6
United States	2004	556.74	-9.9	379.87	-2.4
Uruguay	1998	15.93	14.1	11.73	19.0
Uzbekistan	1994	41.81	10.7	9.92	-8.6

Climate Change: *Emissions of other greenhouse gases*

	Latest year available	CH_4 emissions	% change since 1990	N_2O emissions	% change since 1990
		mio. tonnes of CO_2 equivalent	%	mio. tonnes of CO_2 equivalent	%
Vanuatu	1994	0.23	...	0.01	...
Venezuela	1999	61.92	...	16.15	...
Viet Nam	1994	48.89	...	10.17	...
Yemen	1995	2.69	...	4.66	...
Zambia	1994	10.70	...	19.47	...
Zimbabwe	1994	7.52	...	2.98	...

Sources:
UN Framework Convention on Climate Change (UNFCCC) Secretariat (see: http://unfccc.int).
UNSD/UNEP 2004 questionnaire on Environment statistics, Air section, marked with "*".

Footnotes:
1. Data calculated according to methodology used in the former USSR and the IPCC Guidelines for Greenhouse Gas Inventories, version 1-3 Hadley Centre, UK.
2. Data does not include emissions from other fuel combustion.

Definitions & Technical notes:
CH_4 emissions: the major sources of CH_4 are leakages during the production and transportation of natural gas and coal mining, livestock rearing, rice cultivation, and decomposition of waste in landfills. N_2O emissions: the major sources of N_2O are agriculture and industrial processes.

Data Quality:
UNFCCC has developed standardised methods for calculating greenhouse gas emissions, which are widely used. However, estimation of emissions from sources other than energy are complex. So while trend figures are fairly good, absolute levels are less reliable.

Policy Relevance:
See table on greenhouse gas emissions. Both CH_4 and N_2O are powerful greenhouse gases, many times more powerful than CO_2. CH_4, otherwise known as methane or natural gas, is a high quality fuel. Because of the different global warming potentials of the two gases, burning methane to produce CO_2 contributes less to global warming than emitting the CH_4 directly to the atmosphere. Measures to reduce leakage of methane from natural gas networks, or to capture fugitive emissions resulting from coal mining and oil and gas extraction will pay for themselves, over time. When waste landfill sites are fitted with methane recuperation systems, the gas recovered can often be used locally for heating or generating electricity, thus reducing the need for other energy sources. Similarly, the use of anaerobic digestors for farmyard manure can provide the farm with a free supply of natural gas, for energy purposes. Emissions of N_2O can be reduced by introducing proper manure handling techniques.

ENVIRONMENTAL INDICATORS
Waste
Municipal waste collection *last update: April 2007*

	Latest year available	Municipal waste collected	Population served by municipal waste collection	Municipal waste collected per capita served
		1000 tonnes	%	kg
Albania	2005	634	...	...
Algeria	2003	8500	80.0	334
Andorra	2005	38	100.0	563
Anguilla	2005	5	100.0	433
Antigua and Barbuda	2005	21[1]	100.0[1]	...
Armenia	2004	376	65.2	191
Australia	2003	8903	...	...
Austria	2004	4588	100.0	562
Azerbaijan	2005	1753[2]	...	...
Belarus	2004	2661	85.0	319
Belgium	2003	4608	100.0	447
Belize	2003	86	51.2	655
Benin	2002	986	23.0	654
Bolivia	2005	751	...	...
Bosnia and Herzegovina	1999	1765	...	...
Brazil	2000	57563	76.0	441
British Virgin Islands	2005	37	...	...
Brunei Darussalam	2002	196	...	...
Bulgaria	2002	3199	81.1	495
Canada	2004	13375[3]	99.0[4]	423[3]
Chile	2005	5459	...	...
China	2003	148565	...	...
China, Hong Kong SAR	2005	6013	100.0	854
China, Macao SAR	2005	163[5]	100.0	354[5]
Colombia	2005	20776	95.0	480
Costa Rica	2002	1280	73.0	428
Croatia	2004	1079	86.0	276
Cuba	2005	4416	75.6	519
Cyprus	2002	500	...	...
Czech Republic	2004	2841[6]	100.0	278
Denmark	2003	3618	100.0	675
Dominica	2005	21	94.0	282
Dominican Republic	2005	1016[7]	...	...
Egypt	2001	14500	...	...
Estonia	2002	524	...	...
Finland	2004	2374[8]	100.0	453
France	2005	33963	100.0	561
French Guiana	2003	110	89.0	695
Georgia	2005	1375	56.0	549
Germany	2004	48434	100.0	586
Greece	2003	4710	100.0	429
Guadeloupe	1999	217	100.0	511
Guatemala	2002	604	30.5	165
Hungary	2003	4387	89.5	496
Iceland	2004	147	100.0	503
India	2001	17569[9]	...	...
Ireland	2005	2847[10]	76.0	903
Israel	2003	5527	...	...
Italy	2005	31677	100.0	545
Jamaica	2004	709	...	...

Waste: *Municipal waste collection*

	Latest year available	Municipal waste collected	Population served by municipal waste collection	Municipal waste collected per capita served
		1000 tonnes	%	kg
Japan	2003	54367[11]	99.8	427
Jordan	2002	2227	...	...
Korea, Republic of	2004	18252	99.3[12]	386
Kuwait	2005	837	...	...
Kyrgyzstan	2004	1602[2]	...	...
Latvia	1999	292	50.0	244
Lebanon	2001	1440	...	...
Lithuania	2002	1000	...	...
Luxembourg	2003	306[13]	100.0	676
Madagascar	2004	341[14]	4.4	...
Maldives	2005	19	...	...
Malta	2003	218	...	...
Martinique	2004	340	100.0	863
Mauritius	2003	351	95.0	303
Mexico	2006	36088	90.0	...
Monaco	2002	40	100.0	1180
Morocco	2003	4710	...	...
Nepal	2002	418	...	...
Netherlands	2004	10161	100.0	626
New Zealand	1999	1541[15]	...	...
Niger	2005	9750	...	...
Norway	2004	1746[3]	99.0	384
Palestine	2001	1350[16]	...	...
Panama	1998	379	...	...
Peru	2001	4740	75.0	240
Poland	2005	9354	...	...
Portugal	2005	5009	100.0	477
Republic of Moldova	2004	1224	...	...
Réunion	2004	461	-999.0	-60
Romania	2002	6865	90.0	341
Russian Federation	2000	207400[2,17]	...	...
Serbia and Montenegro	2005	2890	...	...
Singapore	2005	5088	100.0	1176
Slovakia	2005	1468	100.0	272
Slovenia	2002	862	93.0	467
Spain	2004	22735[18]	...	...
Sri Lanka	2004	1036	...	...
St. Vincent and the Grenadines	2002	38	100.0	317
Sweden	2005	4347	100.0	481
Switzerland	2005	4855	99.0	676
Syrian Arab Republic	2003	7500	...	...
Thailand	2000	13972	...	...
The Former Yugoslav Rep. of Macedonia	2005	2526	...	...
Trinidad and Tobago	2002	425[19]	...	...
Tunisia	2004	1316	65.0	203
Turkey	2004	24237	72.8	461
Ukraine	2004	3235	...	...
United Kingdom	2005	35077	100.0	588
United States	2005	222863	100.0	747
Uruguay	2000	910	...	...
Yemen	2005	1272	...	...
Zambia	2005	389[20]	20.0	167

Waste: *Municipal waste collection*

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaires on Environment statistics, Waste section.
OECD/Eurostat 2004 questionnaire on Environment statistics, Waste section
OECD Environmental Data, Compendium 2006/2007, Waste section.
UN Population Division.

Footnotes:
1. Data refer to Antigua only.
2. Unit: thousand cubic meters.
3. Household waste generated only.
4. 1996 data.
5. Data only refer to waste collected from households and sea by a licensed company.
6. Includes amounts undergoing mechanical sorting before treatment/disposal.
7. The information Includes the National District (Capital of the Republic) and the Santo Domingo Province.
8. Data refer to total amounts of municipal waste managed.
9. Total municipal solid waste generated in 299 Class-I cities.
10. Data refer to municipal waste landfilled and recovered (include street cleansing waste).
11. Data refer to waste treated by municipalities and separate collection for recycling by the private sector.
12. 2002 data.
13. Data refer to total amounts of municipal waste managed in the country (exclude exported amounts).
14. For the calculations, only the six important locations of “Faritany” (Antanarivo, Antsiranana, Fianarantsoa, Mahajanga, Toamasia, Toliary) and the cities of Toalagnaro and Nosy-be were taken into account.
15. Data include landfilled household waste and recycled packaging waste.
16. Data refer to solid waste reaching dumping site which was taken from the Dumping Site Survey implemented in 2001.
17. Data refer to municipal waste, specifically rubbish transported by trucks and liquid wastes transported by cesspool trucks.
18. Household and similar waste.
19. Data are from Trinidad and Tobago Solid Waste Management Company Limited (SWMCOL). The landfills managed by SWMCOL collect 85% of solid waste.
20. Data refer to urban population only.

Definitions & Technical notes:
Municipal waste includes household waste and similar waste. The definition also includes bulky waste (e.g. white goods, old furniture, mattresses) and yard waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste, if managed as waste. It includes waste originating from: households, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes waste from selected municipal services, e.g. waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste), if managed as waste. The definition excludes waste from municipal sewage network and treatment, municipal construction and demolition waste. Municipal waste collected refers to waste collected by or on behalf of municipalities, as well as municipal waste collected by the private sector. It includes mixed household waste, and fractions collected separately for recovery operations (through door-to-door collection and/or through voluntary deposits). If data for municipal waste collected are not available, data for municipal waste generated is given, if available. Municipal waste collected per capita served is calculated by dividing the Municipal waste collected by the number of people served by the waste collection system.

Data Quality:
Data on municipal waste collected are usually gathered through surveys of municipalities, which are responsible for waste collection and disposal, or from transport companies that collect waste and transport it to a disposal site. Such surveys deliver fairly reliable data. However, it must be remembered that the figures only cover waste collected by or on behalf of municipalities. Therefore:
- Amounts of waste will vary, depending on how far municipal waste collection covers small industries and the services sector.
- Waste collected by the informal sector, waste generated in areas not covered by the municipal waste collection system or illegally dumped waste are nor included.
Caution is therefore advised when comparing countries.

Policy Relevance:
Although on a ‘per kilogram’ basis, municipal waste is less damaging than hazardous waste, the large number of sources (households, services, small industries), as well as the variety of wastes included and the sheer quantities generated, make the collection and disposal of municipal waste an important issue worldwide. The amount of waste a country generates depends on a number of factors, including GDP, the extent of urbanization, family structures, and lifestyles. Increasing urbanization, economic growth and the move away from traditional family groups have resulted in an increase in the amount of waste generated in recent decades. Waste management, i.e. waste collection and treatment, has become an independent economic sector, as waste becomes an environmental problem of growing concern.

The environmental impacts that are most closely associated with waste are:
- pollution of ground and surface water, through leaching and run-off;
- soil contamination and damage to nature;
- emissions of methane, a powerful greenhouse gas, from landfill sites;
- risks to health due to putrification of food waste,
- emission of dusts, odours and hazardous gases and
- unregulated fires.

The quantity of municipal waste generated will be larger than that collected if large areas of the country are not served by waste collection or if a significant percentage of illegal dumping of waste is suspected. The associated environmental impacts will also be greater, as uncontrolled landfill is generally more environmentally damaging. Some towns and cities rely heavily on the informal sector to collect and recycle household waste, and this may be the sole source of income for whole families, with women and children also actively involved. As this is totally unregulated, the workers are often subject to accidents, to respiratory illnesses, to skin infections and other health problems.

ENVIRONMENTAL INDICATORS
Waste
Municipal waste treatment *last update: April 2007*

	Latest year available	Municipal waste collected	Municipal waste landfilled	Municipal waste incinerated	Municipal waste recycled	Municipal waste recycled
		1000 tonnes	%	%	%	%
Albania	2005	634	95.1	0.0	4.9	0.0
Algeria	2003	8500	99.9	...	0.1	...
Andorra	2005	38	0.0	0.0	0.0	0.0
Anguilla	2005	5	100.0	0.0	0.0	0.0
Antigua and Barbuda	2005	21[1]	100.0[1]	...	...	...
Armenia	2004	376	100.0	...	...	...
Australia	2003	8903	69.7	...	30.3	...
Austria	2004	4588	6.7[2]	21.1	26.5	44.7[3]
Belarus	2004	2661	100.0	...	...	...
Belgium	2003	4608	12.6[5]	35.7	31.3[5]	22.8
Belize	2003	86	100.0	...	...	...
Benin	2002	986	0.0	0.0	...	...
Brazil	2000	57563	62.7	0.3	1.4	4.1
British Virgin Islands	2005	37	0.0	80.3[6]	0.0	0.0
Bulgaria	2002	3199	99.7	...	...	...
Canada	2004	13375[7]	73.3[8]	...	26.8	12.5[9]
Chile	2005	5459	100.0	...	...	...
China	2003	148565	43.1	2.5	...	4.8
China, Hong Kong SAR	2005	6013	56.9	...	43.1	...
China, Macao SAR	2005	163[10]	39.7	...	...	...
Colombia	2005	20776	80.4	...	0.9	...
Croatia	2004	1079	96.1	...	2.5	1.4
Cuba	2005	4416	84.1	0.0	4.8	11.1
Cyprus	2002	500	...	0.0	...	0.0
Czech Republic	2004	2841[11]	79.8	14.0	1.3	3.2
Denmark	2003	3618	5.1	54.0[12]	25.6	15.3
Dominica	2005	21	100.0	...	...	...
Finland	2004	2374[13]	59.9	9.9	30.1[14]	...
France	2005	33963	36.0	33.8	15.8	14.3
French Guiana	2003	110	72.7	...	...	...
Germany	2004	48434	17.7	24.6	33.1	17.1
Greece	2003	4710	91.9	0.0	8.1	0.0
Guadeloupe	1999	217	98.0	2.0	0.0	0.0
Hungary	2003	4387	90.4[15]	5.6	2.7	1.1
Iceland	2004	147	72.1	8.8	15.6	8.8
Ireland	2005	2847[16]	66.1	...	33.9[14]	...
Israel	2003	5527	79.0	0.0	21.0[17]	...
Italy	2005	31677	54.4	12.1[18]	...	33.3[19]
Japan	2003	54367[20]	3.4[21]	74.0	16.8[22]	...
Korea, Republic of	2004	18252	36.4	14.4	49.2	0.0
Kyrgyzstan	2004	1602[4]	100.0[4]	...	...	...
Latvia	1999	292	100.0	...	...	...
Lebanon	2001	1440	41.6	...	3.3	7.6
Lithuania	2002	1000	100.0	0.0	0.0	0.0
Luxembourg	2003	306[23]	18.9	38.9	23.2	19.3
Madagascar	2004	341[24]	100.0[24]	0.0	0.0	0.0
Martinique	2004	340	67.4	31.9	0.0	0.0
Mauritius	2003	351	100.0	...	...	...
Mexico	2006	36088	96.7	0.0	3.3	0.0
Monaco	2002	40	56.5[25]	...	3.7[17]	...
Morocco	2003	4710	90.0	...	10.0	...

Waste: *Municipal waste treatment*

	Latest year available	Municipal waste collected	Municipal waste landfilled	Municipal waste incinerated	Municipal waste recycled	Municipal waste recycled
		1000 tonnes	%	%	%	%
Netherlands	2004	10161	1.7	32.3	25.4	23.5
New Zealand	1999	1541[26]	84.7[27]	...	15.3[28]	...
Niger	2005	9750	64.0	12.0	4.0	...
Norway	2004	1746[7]	25.9	24.7[29]	33.6[30]	15.3
Palestine	2001	1350[31]	100.0[31]	...	...	...
Panama	1998	379	100.0	...	...	...
Peru	2001	4740	65.7	...	14.7	...
Poland	2005	9354	92.2	0.5	3.9	3.4
Portugal	2005	5009	64.1	21.1	8.6	6.3
Réunion	2004	461	89.8	...	...	5.6
Romania	2002	6865	97.5	...	2.5	...
Singapore	2005	5088	15.8	44.8	39.4	0.0
Slovakia	2005	1468	77.9	12.5	1.1	1.4
Slovenia	2002	862	81.1	0.6	10.1	1.3
Spain	2004	22735[32]	51.7	6.7	9.0[33]	32.7
St. Vincent and the Grenadines	2002	38	84.9	0.0	15.1[17]	...
Sweden	2005	4347	4.8	50.2	33.9	10.5
Switzerland	2005	4855	0.5	49.8	33.9[34]	15.9
Syrian Arab Republic	2003	7500	93.9[35]	5.3	1.1[36]	...
Thailand	2000	13972	...	0.8	14.3[17]	...
Tunisia	2004	1316	99.9	...	...	0.1
Turkey	2004	24237	97.8	0.0	0.0	1.4
United Kingdom	2005	35077	64.3	8.4	17.4	9.3
United States	2005	222863	54.3[37]	13.6[38]	23.8	8.4
Uruguay	2000	910	...	...	0.0	0.0
Yemen	2005	1272	100.0	...	...	...

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaires on Environment statistics, Waste section.
OECD/Eurostat 2004 questionnaire on Environment statistics, Waste section.
OECD Environmental Data, Compendium 2006/2007, Waste section.

Footnotes:
1. Data refer to Antigua only.
2. Direct delivery without any pretreatment.
3. Includes amounts treated in mechanical-biological facilities.
4. Unit: thousand cubic meters.
5. Includes residues from incineration.
6. Value refers to the main island of Tortola only.
7. Household waste generated only.
8. Data refer to household waste landfilled or incinerated.
9. Composting: from residential and non-residential sources.
10. Data only refer to waste collected from households and sea by a licensed company.
11. Includes amounts undergoing mechanical sorting before treatment/disposal.
12. Data refer to municipal waste incinerated with energy recovery.
13. Data refer to total amounts of municipal waste managed.
14. Includes composting.
15. Excludes residues from other operations (54000 tonnes in 2003).
16. Data refer to municipal waste landfilled and recovered (include street cleansing waste).
17. Data refer to recycling and composting together.
18. Incineration: includes refuse derived fuel.
19. Composting: includes mechanical/biological treatment.
20. Data refer to waste treated by municipalities and separate collection for recycling by the private sector.
21. Direct disposal (excluding residues from other treatments, 6.6 million t.).
22. Data refer to amounts directly recycled (incl. private collection) and recovered from intermediate processing.
23. Data refer to total amounts of municipal waste managed in the country (exclude exported amounts).
24. For the calculations, only the six important locations of “Faritany” (Antanarivo, Antsiranana, Fianarantsoa, Mahajanga, Toamasia, Toliary) and the cities of Toalagnaro and Nosy-be were taken into account.
25. Residues of incineration of waste are landfilled in France.
26. Data include landfilled household waste and recycled packaging waste.

Waste: *Municipal waste treatment*

27. Landfill: household waste excluding construction and demolition waste.
28. Packaging waste only.
29. Excluding residues landfilled.
30. Recycling: waste separately collected (excludes food, park and garden waste which is included in composting).
31. Data refer to solid waste reaching dumping site which was taken from the Dumping Site Survey implemented in 2001.
32. Household and similar waste.
33. Recycling: separate collection.
34. Excludes batteries (2.4 thousand tonnes) and electric and electronic equipment (82.5 thousand tonnes).
35. Data pertains to domestic waste (4,100,000 t/year), municipal rubble and soil (1,000,000 t/year), green waste in coastal towns (40,000 t/year), and building waste (1,900,000 t/year).
36. Data pertains to automobile waste.
37. Landfill: after recovery and incineration.
38. Incineration: after recovery.

Definitions & Technical notes:
Municipal waste includes household waste and similar waste. The definition also includes bulky waste (e.g. white goods, old furniture, mattresses) and yard waste, leaves, grass clippings, street sweepings, the content of litter containers, and market cleansing waste, if managed as waste. It includes waste originating from: households, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes waste from selected municipal services, e.g. waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste), if managed as waste. The definition excludes waste from municipal sewage network and treatment, municipal construction and demolition waste. Municipal waste collected refers to waste collected by or on behalf of municipalities, as well as municipal waste collected by the private sector. It includes mixed household waste, and fractions collected separately for recovery operations (through door-to-door collection and/or through voluntary deposits). If data for municipal waste collected are not available, data for municipal waste generated is given, if available. Landfill is the final placement of waste into or onto the land in a controlled or uncontrolled way. Municipal waste landfilled includes all amounts going to landfill, either directly, or after sorting and/or treatment, as well as residues from recovery and disposal operations going to landfill. The definition covers both landfill in internal sites (i.e. where a generator of waste is carrying out its own waste disposal at the place of generation) and in external sites. Incineration is the controlled combustion of waste with or without energy recovery. Recycling is defined as any reintroduction of waste material in a production process that diverts it from the waste stream, except reuse as a fuel. Both reprocessing as the same type of product and for different purposes are included. Recycling within industrial plants i.e. at the place where the waste is generated, is excluded. Composting is a biological process that submits biodegradable waste to anaerobic or aerobic decomposition, and that results in a product that is recovered. The sum of the different types of waste disposal may be greater than the total amount of municipal waste collected, as these facilities may be used for other types of waste, or because of double counting due to the landfilling of the residues of incineration, or to the incineration of residues from composting.

Data Quality:
Data on municipal waste collected are usually gathered through surveys of municipalities, which are responsible for waste collection and disposal, or from transport companies that collect waste and transport it to a disposal site. Such surveys deliver fairly reliable data. However, it must be remembered that the figures only cover waste collected by or on behalf of municipalities. Therefore:
- Amounts of waste will vary, depending on how far municipal waste collection covers small industries and the services sector.
- Waste collected by the informal sector, waste generated in areas not covered by the municipal waste collection system or illegally dumped waste are nor included.
Caution is therefore advised when comparing countries.

Policy Relevance:
In many cases, a considerable proportion of municipal waste, particularly glass, paper and metals can be economically recycled. Organic matter can be composted, with or without methane recovery, and used to enrich soil. Another fraction of municipal waste can be burnt as a fuel to generate heat or electricity, preferably in special incinerators that reduce emissions of dioxins and other harmful pollutants. Depending on the type of waste, how the landfill site is constructed and the hydrological conditions, landfilling can lead to environmental problems such as leaching of nutrients, heavy metals and other toxic compounds, emission of greenhouse gases (CH_4 and CO_2) and loss of natural areas. Hence, in the best case, landfill should only be used when other possible waste treatment methods have been exhausted. Some towns and cities rely heavily on the informal sector (scavengers) to recycle waste, and this may be the sole source of income for whole families, with women and children also actively involved. As this is totally unregulated, the workers are often subject to accidents, to respiratory illnesses, to skin infections and other health problems.

ENVIRONMENTAL INDICATORS

Waste

Hazardous waste generation *last update: April 2007 unit: 1000 tonne*

	1990	1995	2000	2001	2002	2003	2004	2005
Algeria	...	185.0	...	...	...	325.0	...	...
Andorra	...	...	2.6	2.5	2.4	...	0.1[1]	0.1[1]
Armenia	...	...	2.0	1.6	1.2	420.4[2]	544.7[2]	...
Australia	...	...	...	649.1	642.4	...	...	...
Austria	316.8[3]	595.0[3]	1034.8[3]	1025.7[3]	920.2[3]	...	1014.0[3]	...[3]
Azerbaijan	...	27.0	26.6	16.4	9.8	26.9	11.2	...
Belarus	...	90.3	73.0	99.1	116.9	118.5	154.2	...
Belgium	...	1113.5	...	...	...	...	...	...
Belize	...	...	0.8[4]	...	...	...	...	...
Benin	...	...	...	...	1.7[5]	...	...	...
Bosnia and Herzegovina	...	...	34.6	...	...	...	...	...
Brazil	...	...	2858.7[6]	...	...	...	...	...
Bulgaria	...	...	758.0	755.8	...	...	...	...
China	...	...	8300.0[7]	9520.0[7]	10010.0[7]	11700.0[7]	9950.0[7]	11620.0[7]
China, Hong Kong SAR	...	87.6	62.4	62.6	52.6	42.7	34.8	37.6
China, Macao SAR	...	...	0.1[4]	0.2[4]	0.2[4]	...	...	...
Croatia	...	...	26.0	58.3	47.4	48.1	42.3	...
Cyprus	...	50.0	...	...	...	...	...	...
Czech Republic	...	6005.0	2630.0[8]	2817.0[8]	1311.0[9]	1219.0	1447.0	1372.0
Denmark	...	179.0[3]	183.4[3]	200.1[3]	247.5[3]	328.3[3]	342.0[3]	340.5[3]
Estonia	...	7273.0	5965.8	...	...	...	...	...
Finland	...	...	1202.0	827.0	1188.0	...	2349.0	...
France	7000.0	...	9150.0	...	...	...	...	...
Georgia	2000.0[10]	...	...	...	...	...	...	...
Germany	13079.0	...	15542.0	15830.0	19636.0	19515.0	18401.0	...
Greece	450.0	350.0	391.0	326.4	352.7	353.8	...	...
Hungary	4691.0[11]	2274.3[12]	950.9	892.7	543.2	...	...	...
Iceland	...	6.0	7.0	8.0	8.0	8.0	8.0	...
India	...	...	7243.8	...	...	...	...	...
Ireland	66.0	248.0[13]	...	491.7[14]	...	...	673.6[15]	...
Israel	...	...	280.6	324.4	294.3	297.1	340.2	...
Italy	3246.0	2708.0	3911.0	4279.2	5024.5	5439.7	5365.4	...
Jamaica	...	10.0	...	...	...	...	...	...
Japan	2297.0	2883.0	...	...	...	...	...	...
Jordan	...	...	...	...	...	73.6	33.4	...
Kazakhstan	...	72.2[16]	102.5[16]	130.0[16]	137.1[16]	141.9	146.1	100.4
Korea, Republic of	968.3	1622.4	2779.0	2858.0	2914.5	2913.0	...	...
Kyrgyzstan	...	472.7	6204.1	6229.1	6512.8	6421.3	6410.0	...
Latvia	...	48.0	92.7	82.1	...	...	...	...
Lebanon	...	...	...	108.2	...	...	...	...
Lithuania	...	153.0	114.0	111.0	...	...	...	...
Luxembourg	...	200.0	197.1	202.0	227.5	...	...	...
Madagascar	...	...	...	...	1.9[17]	...	...	...
Malta	...	...	5.4	4.4	...	...	...	...
Mauritius	...	...	0.0	...	0.1	0.9[18]	...	...
Mexico	5657.0[19]	...	3706.8[20]	...	...	...	...	...
Monaco	...	0.3	0.3	0.3	0.6	...	...	...
Morocco	...	...	119.0	...	...	...	...	...
Netherlands	1040.0[21]	1004.0[22]	1785.0[22]	...	2159.9[22]	...	...	...
Niger	...	...	...	...	...	...	503.0	554.0
Norway	200.0[23]	650.0	673.0	655.0	...	825.0[24]	940.0	939.0
Palestine	...	...	5.0[25]	16.4[26]	...	12.5[26]	15.1[26]	11.0[26]
Poland	...	3866.0	1601.0[27]	1308.0[27]	1029.0[27]	1339.0[27]	1349.3[27]	1778.9[27]
Portugal	...	668.0	171.6	253.6	204.9	...	...	...

Waste: *Hazardous waste generation*

	1990	1995	2000	2001	2002	2003	2004	2005
Republic of Moldova	178.7	2.7	2.6	1.9	2.2	2.0	0.9	...
Réunion	...	...	9.8[28]	...	...	...	...	...
Romania	...	5710.0	896.7	...	...	...	...	...
Russian Federation	...	83330.3	127545.8	139193.5	...	...	...	...
Serbia and Montenegro	...	...	...	...	...	0.3	0.5	0.9
Singapore	2.3[29]	23.8[29]	29.7[29]	38.4[29]	42.4[29]	43.0[29]	38.2[29]	37.1[29]
Slovakia	...	1352.7	1630.0	1662.8	1441.1	1257.6	1021.2	...
Slovenia	...	170.0	...	67.5	...	...	...	...
Spain	1708.0	3394.0	3063.4	3222.9	3222.9	3222.9	3534.3[30]	...
St. Vincent and the Grenadines	...	...	...	...	0.0	...	...	...
Sweden	154.0	...	1100.0	...	...	...	1353.7	...
Switzerland	...	831.0	1114.5	1134.1	1112.0	...	...	...
Syrian Arab Republic	...	...	...	...	...	0.0	...	...
The Former Yugoslav Rep. of Macedonia	...	...	...	...	...	...	...	4.6
Tunisia	...	...	...	151.0	150.2	...	...	...
Turkey	...		1166.0[31]	...	...	...	1196.0	...
Ukraine	...		81374.9[32]	77513.5[32]	77604.9[32]	79000.9	62910.7	...
United Kingdom	2936.0[33]	2160.0[33]	5419.0[34]	5526.4[34]	5370.0[34]	4991.0[34]	5285.5[34]	...
United States	277339.0	194225.0	...	37033.2[35]	...	27375.8[36]	...	34788.4[36]
Yemen	...	38.2	...	...	...	...	...	...
Zambia	...	...	50.0	...	...	53.8	...	80.0

Sources:
UNSD/UNEP 2001, 2004 and 2006 questionnaire on Environment statistics, Waste section
OECD/Eurostat 2004 questionnaire on Environment statistics, Waste section
OECD Environmental Data, Compendium 2006/2007, Waste section.

Footnotes:
1. Starting with the exports in 2003, the data come from the regular weighing and there have been modifications of management and of the weighing methods.
2. Includes wastes from new mining operations.
3. Data refer to primary waste.
4. Waste from hospitals only.
5. Data refer to biomedical waste.
6. Data refer to hazardous waste collected (sum of collected industrial and septic hazardous waste).
7. Data refer to Industrial Solid Hazardous Waste.
8. Break in time series due to a new Waste Act in 1998. 1998 onwards: data include municipal hazardous waste.
9. Break in time series in 2002 due to a new Waste Act.
10. Data created under the inventory in 1990 reflect the amount of the waste accumulated before 1990. Therefore data do not refer to annually produced waste.
11. 1990: includes red mud.
12. Break in time series in 1995; 1995: excludes red mud.
13. Includes recovery on site.
14. Includes reported and unreported waste, contaminated soil and on-site treatment.
15. Includes reported and unreported waste, contaminated soil (2004: 307 thousand tonnes) and on-site treatment.
16. Data refer to toxic waste.
17. This quantity represents biomedical waste only.
18. Source: Basel Convention
19. Estimates and includes biological infectious waste.
20. Data are based on surveys covering 27280 enterprises; includes biological infectious waste.
21. Includes contaminated soil.
22. Excludes contaminated soil.
23. 1990 data is a rough estimate based on a study carried out in 1988 and exclude on-site treatment.
24. 2003: new type of waste are defined as hazardous in legislation.
25. Data refer to health care private centers waste taken from the Medical Environmental Survey.
26. Data refer to health care centers waste taken from the Environmental Survey for Health Care Centers.
27. 1998 onwards: data refer to a new classification based on the European Waste Catalogue.
28. Special industrial waste: dangerous waste produced by businesses (solvents, hydrocarbon sludges, used oils and batteries, sodium baths, manufacturing scrap, rejects, paints…).
29. Data refer to solid chemical and PVC wastes. Figures prior to 1993 do not include metallic sludge in solid chemical and PVC wastes.
30. Provisional data.
31. Hazardous waste from manufacturing industry.
32. Data refer to industrial hazardous wastes.
33. Production before 1997: defined by the Control of Pollution (Special Wastes) Regulations, 1980.
34. From 1997 onwards: Special wastes as defined by the Hazardous Waste List (94/904/EC) and implemented by the Special Waste Regulations, 1996.
35. From 1997, data exclude waste water.

Waste: *Hazardous waste generation*

36. Reporting requirements have been changed in 2001; includes some waste water.

Definitions & Technical notes:
Hazardous waste is waste that owing to its toxic, infectious, radioactive or flammable properties poses an actual or potential hazard to the health of humans, other living organisms, or the environment. Hazardous waste here refers to categories of waste to be controlled according to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Article 1 and Annex I). If data are not available according to the Basel Convention, amounts can be given according to national definitions.

Data Quality:
Although countries are asked to report data on hazardous waste according to the categories of the Basel Convention, most countries are not able to do so, and supply data according to national definitions. Some countries have indicated this in footnotes, but it can be assumed that this also applies to other countries. National definitions of hazardous waste may change over time, as national legislation is revised. Therefore the definition of hazardous waste varies greatly from one country to another, and sometime also over time. Moreover, data only refer to wastes declared as hazardous by the generator, or by the company responsible for disposing of the waste. How far this is represents the real amount of hazardous waste generated in the country will depend on how well the sector is regulated and policed. Data quality and comparability are therefore limited and trends should be interpreted with care.

Policy Relevance:
By definition, hazardous waste poses a threat to human and ecological health, often for many years. Correct disposal of hazardous waste is therefore a public and environmental health issue. The amount of hazardous waste generated in a country is closely linked to the country's economy; a highly industrialized country or one with a large mining industry is likely to generate more hazardous waste than a country whose economy is based more on services or on agriculture. In the 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (http://www.basel.int/), 164 countries agreed to minimize the generation of hazardous waste, to assure sound management of hazardous wastes, to control transboundary movement of hazardous wastes; and to improve institutional and technical capabilities especially for developing countries and countries with economies in transition. At later meetings, Parties agreed to ban on the export of hazardous wastes from OECD to non-OECD countries ('Basel ban'). As a general rule, companies that generate hazardous waste must bear the cost of disposing of it. In many cases this may be easier for the company to do internally, for example through recycling or high temperature incineration. These should be encouraged as they remove the need to transport the waste, and thus the risk of leakage during transport. However, the incinerators must be well regulated and regularly controlled to avoid emissions of toxic by-products from the incineration process.

ENVIRONMENTAL INDICATORS
Land Use
Total surface area *last update January 19, 2007*

	Total area km²
Afghanistan	652090
Albania	28748
Algeria	2381741
American Samoa	199
Andorra	468
Angola	1246700[1]
Anguilla	91
Antigua and Barbuda	442
Argentina	2780400
Armenia	29800
Aruba	180
Australia	7741220
Austria	83858
Azerbaijan	86600
Bahamas	13878
Bahrain	694
Bangladesh	143998
Barbados	430
Belarus	207600
Belgium	30528
Belize	22966
Benin	112622
Bermuda	53
Bhutan	47000
Bolivia	1098581
Bosnia and Herzegovina	51197
Botswana	581730
Brazil	8514877[2]
British Virgin Islands	151
Brunei Darussalam	5765
Bulgaria	110912
Burkina Faso	274000
Burundi	27834
Cambodia	181035
Cameroon	475442
Canada	9970610
Cape Verde	4033
Cayman Islands	264
Central African Republic	622984
Chad	1284000
Channel Islands	195
Chile	756096
China	9596961
China: Hong Kong SAR	1099
China: Macao SAR	26
Christmas Islands	135
Cocos (Keeling) Islands	14
Colombia	1138914

Land Use: *Total surface area*

	Total area km²
Comoros	2235
Congo	342000
Cook Islands	236[3]
Costa Rica	51100
Côte d'Ivoire	322463
Croatia	56538
Cuba	110861
Cyprus	9251
Czech Republic	78866
Democratic Republic of the Congo	2344858
Denmark	43094
Djibouti	23200
Dominica	751
Dominican Republic	48671
Ecuador	283561
Egypt	1001449
El Salvador	21041
Equatorial Guinea	28051[4]
Eritrea	117600
Estonia	45100
Ethiopia	1104300
Faeroe Islands	1393
Falkland Islands (Malvinas)	12173[5,6]
Fiji	18274
Finland	338145
France	551500
French Guiana	90000
French Polynesia	4000[7]
Gabon	267668
Gambia	11295
Georgia	69700
Germany	357022
Ghana	238533
Gibraltar	6
Greece	131957
Greenland	2175600
Grenada	344[8]
Guadeloupe	1705[9]
Guam	549
Guatemala	108889
Guinea	245857
Guinea-Bissau	36125
Guyana	214969
Haiti	27750
Holy See	0
Honduras	112088
Hungary	93032
Iceland	103000
India	3287263
Indonesia	1904569
Iran (Islamic Republic of)	1648195

Land Use: *Total surface area*

	Total area km²
Iraq	438317
Ireland	70273
Isle of Man	572
Israel	22145
Italy	301318
Jamaica	10991
Japan	377873
Jordan	89342
Kazakhstan	2724900
Kenya	580367
Kiribati	726[10]
Korea (Dem. People's Republic of)	120538
Korea (Republic of)	99538
Kuwait	17818
Kyrgyzstan	199900
Lao People's Democratic Republic	236800
Latvia	64600
Lebanon	10400
Lesotho	30355
Liberia	111369
Libyan Arab Jamahiriya	1759540
Liechtenstein	160
Lithuania	65300
Luxembourg	2586
Madagascar	587041
Malawi	118484
Malaysia	329847
Maldives	298
Mali	1240192
Malta	316
Marshall Islands	181
Martinique	1102
Mauritania	1025520
Mauritius	2040
Mexico	1958201
Micronesia Federated States of	702
Monaco	2
Mongolia	1564116[2]
Montserrat	102
Morocco	446550
Mozambique	801590
Myanmar	676578
Namibia	824292
Nauru	21
Nepal	147181
Netherlands	41528
Netherlands Antilles	800
New Caledonia	18575[11]
New Zealand	270534[12]
Nicaragua	130000
Niger	1267000

Land Use: *Total surface area*

	Total area km²
Nigeria	923768
Niue	260
Norfolk Island	36
Northern Mariana Islands	464
Norway	385155
Occupied Palestinian Territory	6020
Oman	309500
Pakistan	796095
Palau	459
Panama	75517
Papua New Guinea	462840[13]
Paraguay	406752
Peru	1285216
Philippines	300000
Pitcairn	5
Poland	312685[14]
Portugal	91982[15]
Puerto Rico	8875
Qatar	11000
Republic of Moldova	33851
Réunion	2510
Romania	238391
Russian Federation	17098242
Rwanda	26338
Saint Helena	308
Saint Kitts and Nevis	261
Saint Lucia	539
Saint Pierre and Miquelon	242
Saint Vincent and the Grenadines	388[16]
Samoa	2831
San Marino	61
Sao Tome and Principe	964
Saudi Arabia	2149690
Senegal	196722
Serbia and Montenegro	102173
Seychelles	455
Sierra Leone	71740
Singapore	683
Slovakia	49033
Slovenia	20256
Solomon Islands	28896[17]
Somalia	637657
South Africa	1221037
Spain	505992[18]
Sri Lanka	65610
Sudan	2505813
Suriname	163820
Svalbard and Jan Mayen Islands	62422
Swaziland	17364
Sweden	449964
Switzerland	41284

Land Use: *Total surface area*

	Total area km²
Syrian Arab Republic	185180
Tajikistan	143100
Thailand	513115
The Former Yugoslav Rep. of Macedonia	25713
Timor-Leste	14874
Togo	56785
Tokelau	12
Tonga	747
Trinidad and Tobago	5130
Tunisia	163610
Turkey	783562
Turkmenistan	488100
Turks Caicos Islands	948
Tuvalu	26
Uganda	241038
Ukraine	603700
United Arab Emirates	83600[19]
United Kingdom	242900[20]
United Republic of Tanzania	945087
United States	9629091
United States Virgin Islands	347
Uruguay	175016
Uzbekistan	447400
Vanuatu	12189
Venezuela (Bolivarian Republic of)	912050
Viet Nam	331689
Wallis and Futuna Islands	200
Western Sahara	266000[21]
Yemen	527968
Zambia	752618
Zimbabwe	390757

Source:
United Nations Statistics Division (UNSD)

Footnotes:
1. Including the enclave of Cabinda.
2. Exact reference date unknown.
3. Excluding Niue, shown separately, which is part of Cook Islands, but because of remoteness is administered separately.
4. Comprising Bioko (which includes Pagalu) and Rio Muni (which includes Corisco and Elobeys).
5. Excluding dependencies, of which South Georgia (area 3 755 km2) had an estimated population of 499 in 1964 (494 males, 5 females). The other dependencies namely, the South Sandwich group (surface area 337 km2) and a number of smaller islands, are presumed to be uninhabited.
6. A dispute exists between the governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).
7. Comprising Austral, Gambier, Marquesas, Rapa, Society and Tuamotu Islands.
8. Including Carriacou and other dependencies in the Grenadines.
9. Including dependencies: Marie-Galante, la Désirade, les Saintes, Petite-Terre, St. Barthélemy and French part of St. Martin.
10. Including Christmas, Fanning, Ocean and Washington Islands.
11. Including the islands of Huon, Chesterfield, Loyalty, Walpole and Belep Archipelago.
12. Including Campbell and Kermadec Islands (population 20 in 1961, surface area 148 km2) as well as Antipodes, Auckland, Bounty, Snares, Solander and Three Kings island, all of which are uninhabited.
13. Comprising eastern part of New Guinea, the Bismarck Archipelago, Bougainville and Buka of Solomon Islands group and about 600 smaller islands.
14. Includes inland waters as well as part of internal waters.
15. Including the Azores and Madeira Islands.
16. Including Bequia and other islands in the Grenadines.
17. Comprising the Solomon Islands group (except Bougainville and Buka which are included with Papua New Guinea shown separately), Ontong, Java, Rennel and Santa Cruz Islands.

Land Use: *Total surface area*

18. Including the Balearic and Canary Islands, and Alhucemas, Ceuta, Chafarinas, Melilla and Penon de Vélez de la Gomera.
19. Comprising 7 sheikdoms of Abu Dhabi, Dubai, Sharjah, Ajaman, Umm al Qaiwain, Ras al Khaimah and Fujairah, and the area lying within the modified Riyadh line as announced in October 1955.
20. Excluding Channel Islands and Isle of Man, shown separately.
21. Comprising the Northern Region (former Saguia el Hamra) and Southern Region (former Rio de Oro).

Definitions & Technical notes:
Total surface area refers to the total area of the country which comprises land area and inland waters.
0 - magnitude not zero, but less than half of unit employed

ENVIRONMENTAL INDICATORS

Land Use

Forest area *last update: April 2007*

	Forest area in 1990	Forest area in 2005	% change since 1990	% of land area covered by forest in 1990	% of land area covered by forest in 2005
	km²	km²	%	%	%
Afghanistan	13 090	8 670	-33.8	2.0	1.3
Albania	7 890	7 940	0.6	28.8	29.0
Algeria	17 900	22 770	27.2	0.8	1.0
American Samoa	180	180	0.0	91.9	89.4
Andorra	160	160	0.0	35.6	35.6
Angola	609 760	591 040	-3.1	48.9	47.4
Anguilla	60	60	0.0	71.4	71.4
Antigua and Barbuda	90	90	0.0	21.4	21.4
Argentina	352 620	330 210	-6.4	12.9	12.1
Armenia	3 460	2 830	-18.2	12.3	10.0
Aruba	...	...	...	2.2	2.2
Australia	1 679 040	1 636 780	-2.5	21.9	21.3
Austria	37 760	38 620	2.3	45.6	46.7
Azerbaijan	9 360	9 360	0.0	11.3	11.3
Bahamas	5 150	5 150	0.0	51.5	51.5
Bahrain	...	...	...	0.3	0.6
Bangladesh	8 820	8 710	-1.2	6.8	6.7
Barbados	20	20	0.0	4.0	4.0
Belarus	73 760	78 940	7.0	35.6	38.0
Belgium	6 770	6 670	-1.5	22.4	22.0
Belize	16 530	16 530	0.0	72.5	72.5
Benin	33 220	23 510	-29.2	30.0	21.3
Bermuda	10	10	0.0	20.0	20.0
Bhutan	30 350	31 950	5.3	64.6	68.0
Bolivia	627 950	587 400	-6.5	57.9	54.2
Bosnia and Herzegovina	22 100	21 850	-1.1	43.6	43.1
Botswana	137 180	119 430	-12.9	24.2	21.1
Brazil	5 200 270	4 776 980	-8.1	62.2	57.2
British Virgin Islands	40	40	0.0	24.7	24.4
Brunei Darussalam	3 130	2 780	-11.2	59.4	52.8
Bulgaria	33 270	36 250	9.0	30.1	32.8
Burkina Faso	71 540	67 940	-5.0	30.6	29.0
Burundi	2 890	1 520	-47.4	11.3	5.9
Cambodia	129 460	104 470	-19.3	73.3	59.2
Cameroon	245 450	212 450	-13.4	52.7	45.6
Canada	3 101 340	3 101 340	0.0	33.6	33.6
Cape Verde	580	840	44.8	14.3	20.7
Cayman Islands	120	120	0.0	48.4	48.4
Central African Republic	232 030	227 550	-1.9	37.2	36.5
Chad	131 100	119 210	-9.1	10.4	9.5
Channel Islands	10	10	0.0	4.1	4.1
Chile	152 630	161 210	5.6	20.4	21.5
China	1 571 410	1 972 900	25.5	16.8	21.2[1]
Colombia	614 390	607 280	-1.2	59.1	58.5
Comoros	120	50	-58.3	6.5	2.9
Congo	227 260	224 710	-1.1	66.5	65.8
Cook Islands	150	160	6.7	63.9	66.5
Costa Rica	25 640	23 910	-6.7	50.2	46.8
Cote d'Ivoire	102 220	104 050	1.8	32.1	32.7
Croatia	21 160	21 350	0.9	37.8	38.2
Cuba	20 580	27 130	31.8	18.7	24.7

Land Use: *Forest area*

	Forest area in 1990	Forest area in 2005	% change since 1990	% of land area covered by forest in 1990	% of land area covered by forest in 2005
	km²	km²	%	%	%
Cyprus	1 610	1 740	8.1	17.4	18.9
Czech Republic	26 300	26 480	0.7	34.0	34.3
Dem. Rep. of the Congo	1 405 310	1 336 100	-4.9	62.0	58.9
Denmark	4 450	5 000	12.4	10.5	11.8
Djibouti	60	60	0.0	0.2	0.2
Dominica	500	460	-8.0	66.7	61.3
Dominican Republic	13 760	13 760	0.0	28.4	28.4
Ecuador	138 170	108 530	-21.5	49.9	39.2
Egypt	440	670	52.3	0.0	0.1
El Salvador	3 750	2 980	-20.5	18.1	14.4
Equatorial Guinea	18 600	16 320	-12.3	66.3	58.2
Eritrea	16 210	15 540	-4.1	16.0	15.4
Estonia	21 630	22 840	5.6	51.0	53.9
Ethiopia	151 140	130 000	-14.0	13.8	11.9
Faeroe Islands	...	...	...	0.1	0.1
Falkland Islands (Malvinas)	0	0	...	...	...
Fiji	9 790	10 000	2.1	53.6	54.7
Finland	221 940	225 000	1.4	72.9	73.9[2]
France	145 380	155 540	7.0	26.4	28.3
French Guiana	80 910	80 630	-0.3	91.8	91.8[3]
French Polynesia	1 050	1 050	0.0	28.7	28.7
Gabon	219 270	217 750	-0.7	85.1	84.5
Gambia	4 420	4 710	6.6	39.1	41.7
Georgia	27 600	27 600	0.0	39.7	39.7
Germany	107 410	110 760	3.1	30.8	31.7
Ghana	74 480	55 170	-25.9	32.7	24.2
Gibraltar	0	0	...	...	...
Greece	32 990	37 520	13.7	25.6	29.1
Greenland	...	...	...	0.0	0.0
Grenada	40	40	0.0	12.2	12.2
Guadeloupe	840	800	-4.8	49.4	47.2
Guam	260	260	0.0	47.1	47.1
Guatemala	47 480	39 380	-17.1	43.8	36.3
Guinea	74 080	67 240	-9.2	30.1	27.4
Guinea-Bissau	22 160	20 720	-6.5	78.8	73.7
Guyana	151 040	151 040	0.0	76.7	76.7
Haiti	1 160	1 050	-9.5	4.2	3.8
Holy See	0	0	...	...	...
Honduras	73 850	46 480	-37.1	66.0	41.5
Hungary	18 010	19 760	9.7	19.6	21.5
Iceland	250	460	84.0	0.2	0.5
India	639 390	677 010	5.9	21.5	22.8
Indonesia	1 165 670	884 950	-24.1	64.3	48.8
Iran (Islamic Republic of)	110 750	110 750	0.0	6.8	6.8
Iraq	8 040	8 220	2.2	1.8	1.9
Ireland	4 410	6 690	51.7	6.4	9.7
Isle of Man	30	30	0.0	...	...
Israel	1 540	1 710	11.0	7.5	8.3
Italy	83 830	99 790	19.0	28.5	33.9
Jamaica	3 450	3 390	-1.7	31.9	31.3
Japan	249 500	248 680	-0.3	68.4	68.2
Jordan	830	830	0.0	0.9	0.9
Kazakhstan	34 220	33 370	-2.5	1.3	1.2
Kenya	37 080	35 220	-5.0	6.5	6.2

Land Use: *Forest area*

	Forest area in 1990	Forest area in 2005	% change since 1990	% of land area covered by forest in 1990	% of land area covered by forest in 2005
	km²	km²	%	%	%
Kiribati	20	20	0.0	3.0	3.0
Korea, Dem. People's Rep.	82 010	61 870	-24.6	68.1	51.4
Korea, Republic of	63 710	62 650	-1.7	64.5	63.5
Kuwait	30	60	100.0	0.2	0.3
Kyrgyzstan	8 360	8 690	3.9	4.4	4.5
Lao People's Dem. Rep.	173 140	161 420	-6.8	75.0	69.9
Latvia	27 750	29 410	6.0	44.7	47.4
Lebanon	1 210	1 360	12.4	11.7	13.3
Lesotho	50	80	60.0	0.2	0.3
Liberia	40 580	31 540	-22.3	42.1	32.7
Libyan Arab Jamahiriya	2 170	2 170	0.0	0.1	0.1
Liechtenstein	60	70	16.7	40.6	43.1
Lithuania	19 450	20 990	7.9	31.0	33.5
Luxembourg	860	870	1.2	33.2	33.5
Madagascar	136 920	128 380	-6.2	23.5	22.1
Malawi	38 960	34 020	-12.7	41.4	36.2
Malaysia	223 760	208 900	-6.6	68.1	63.6
Maldives	10	10	0.0	3.0	3.0
Mali	140 720	125 720	-10.7	11.5	10.3
Malta	0	...	...	1.1	1.1
Marshall Islands	0	...	...	0.0	...
Martinique	460	460	0.0	43.9	43.9
Mauritania	4 150	2 670	-35.7	0.4	0.3
Mauritius	390	370	-5.1	19.2	18.2
Mexico	690 160	642 380	-6.9	36.2	33.7
Micronesia, Federated States of	630	630	0.0	90.6	90.6
Monaco	0	0	...	...	...
Mongolia	114 920	102 520	-10.8	7.3	6.5
Montserrat	40	40	0.0	35.0	35.0
Morocco	42 890	43 640	1.7	9.6	9.8
Mozambique	200 120	192 620	-3.7	25.5	24.6
Myanmar	392 190	322 220	-17.8	59.6	49.0
Namibia	87 620	76 610	-12.6	10.6	9.3
Nauru	0	0	...	0.0	...
Nepal	48 170	36 360	-24.5	33.7	25.4
Netherlands	3 450	3 650	5.8	10.2	10.8
Netherlands Antilles	10	10	0.0	1.5	1.5
New Caledonia	7 170	7 170	0.0	39.2	39.2
New Zealand	77 200	83 090	7.6	28.8	31.0
Nicaragua	65 380	51 890	-20.6	53.9	42.7
Niger	19 450	12 660	-34.9	1.5	1.0
Nigeria	172 340	110 890	-35.7	18.9	12.2
Niue	170	140	-17.6	66.2	54.2
Northern Mariana Islands	350	330	-5.7	75.3	72.4
Norway	91 300	93 870	2.8	29.8	30.7
Oman	20	20	0.0	0.0	0.0
Pakistan	25 270	19 020	-24.7	3.3	2.5
Palau	380	400	5.3	82.9	87.6
Palestine	90	90	0.0	...	...
Panama	43 760	42 940	-1.9	58.8	57.7
Papua New Guinea	315 230	294 370	-6.6	69.6	65.0
Paraguay	211 570	184 750	-12.7	53.3	46.5
Peru	701 560	687 420	-2.0	54.8	53.7
Philippines	105 740	71 620	-32.3	35.5	24.0

Land Use: *Forest area*

	Forest area in 1990	Forest area in 2005	% change since 1990	% of land area covered by forest in 1990	% of land area covered by forest in 2005
	km²	km²	%	%	%
Pitcairn	40	40	0.0	...	...
Poland	88 810	91 920	3.5	29.2	30.0[4]
Portugal	30 990	37 830	22.1	33.9	41.3
Puerto Rico	4 040	4 080	1.0	45.5	46.0
Qatar	0	...	...	0.0	0.0
Republic of Moldova	3 190	3 290	3.1	9.7	10.0
Réunion	870	840	-3.4	34.9	33.6
Romania	63 710	63 700	0.0	27.8	27.7[4]
Russian Federation	8 089 500	8 087 900	0.0	47.9	47.9
Rwanda	3 180	4 800	50.9	12.9	19.5
Saint Helena	20	20	0.0	...	...
Saint Kitts and Nevis	50	50	0.0	14.7	14.7
Saint Lucia	170	170	0.0	27.9	27.9
Saint Pierre and Miquelon	30	30	0.0	...	...
Samoa	1 300	1 710	31.5	45.9	60.4
San Marino	...	...	...	1.6	1.6
Sao Tome and Principe	270	270	0.0	28.4	28.4
Saudi Arabia	27 280	27 280	0.0	1.3	1.3
Senegal	93 480	86 730	-7.2	48.6	45.0
Serbia	25 590	26 940	5.3	...	...
Serbia and Montenegro	29 010	...	...	25.1	26.4
Seychelles	400	400	0.0	88.9	88.9
Sierra Leone	30 440	27 540	-9.5	42.5	38.5
Singapore	20	20	0.0	3.4	3.4
Slovakia	19 220	19 290	0.4	40.0	40.1
Slovenia	11 880	12 640	6.4	59.0	62.8
Solomon Islands	27 680	21 720	-21.5	98.9	77.6
Somalia	82 820	71 310	-13.9	13.2	11.4
South Africa	92 030	92 030	0.0	7.6	7.6
Spain	134 790	179 150	32.9	27.0	35.9
Sri Lanka	23 500	19 330	-17.7	36.4	29.9
St. Vincent and the Grenadines	90	110	22.2	24.2	27.4
Sudan	763 810	675 460	-11.6	32.1	28.4
Suriname	147 760	147 760	0.0	94.7	94.7
Swaziland	4 720	5 410	14.6	27.4	31.5
Sweden	273 670	275 280	0.6	66.5	66.9
Switzerland	11 550	12 210	5.7	29.2	30.9
Syrian Arab Republic	3 720	4 610	23.9	2.0	2.5
Tajikistan	4 080	4 100	0.5	2.9	2.9
Thailand	159 650	145 200	-9.1	31.2	28.4
The Former Yugoslav Rep. of Macedonia	9 060	9 060	0.0	35.8	35.8
Timor-Leste	9 660	7 980	-17.4	65.0	53.7
Togo	6 850	3 860	-43.6	12.6	7.1
Tokelau	0	0	...	...	...
Tonga	40	40	0.0	5.0	5.0
Trinidad and Tobago	2 350	2 260	-3.8	45.8	44.1
Tunisia	6 430	10 560	64.2	4.1	6.8
Turkey	96 800	101 750	5.1	12.6	13.2
Turkmenistan	41 270	41 270	0.0	8.8	8.8
Turks and Caicos Islands	340	340	0.0	80.0	80.0
Tuvalu	10	10	0.0	33.3	33.3
Uganda	49 240	36 270	-26.3	25.0	18.4
Ukraine	92 740	95 750	3.2	16.0	16.5
United Arab Emirates	2 450	3 120	27.3	2.9	3.7

Land Use: *Forest area*

	Forest area in 1990	Forest area in 2005	% change since 1990	% of land area covered by forest in 1990	% of land area covered by forest in 2005
	km²	km²	%	%	%
United Kingdom	26 110	28 450	9.0	10.8	11.8
United Rep. of Tanzania	414 410	352 570	-14.9	46.9	39.9
United States	2 986 480	3 030 890	1.5	32.6	33.1
United States Virgin Islands	120	100	-16.7	35.0	27.9
Uruguay	9 050	15 060	66.4	5.2	8.6
Uzbekistan	30 450	32 950	8.2	7.4	8.0
Vanuatu	4 400	4 400	0.0	36.1	36.1
Venezuela	520 260	477 130	-8.3	59.0	54.1
Viet Nam	93 630	129 310	38.1	28.8	39.7
Wallis and Futuna Islands	60	50	-16.7	...	...
Western Sahara	10 110	10 110	0.0	3.8	3.8
Yemen	5 490	5 490	0.0	1.0	1.0
Zambia	491 240	424 520	-13.6	66.1	57.1
Zimbabwe	222 340	175 400	-21.1	57.5	45.3

Source:
Food and Agriculture Organization of the United Nations (FAO).
Millennium Indicators Database.

Footnote:
1. Hong Kong SAR of China and Macao SAR of China included.
2. The land area of Finland is still slightly increasing due to the postglacial crustal uplift. On the other hand, the construction of artificial lakes for generating hydro power has decreased the land area during the past 50 years. The land area of Finland is thus not constant. Furthermore, a significant error was discovered in the land area statistics on 1.1.2000, maintained by the National Land Survey of Finland. This erroneous area (30 459, 1000 ha) is also in the records by FAOSTAT. These are the reasons that the official land area by the National Land Survey of Finland on 1.1. 2004 (30 447.4, 1000 ha) is used instead of that by FAOSTAT.
3. The total land area decreased with 28 000 ha (in 1995) due to construction of an artificial lake.
4. Total land area is not constant corrected every year in FAOSTAT.

Definitions & Technical notes:
Forest includes natural forests and forest plantations. It is used to refer to land with a tree canopy cover of more than 10 per cent and area of more than 0.5 ha. Forests are determined both by the presence of trees and the absence of other predominant land uses. The trees should be able to reach a minimum height of 5 m. Young stands that have not yet but are expected to reach a crown density of 10 percent and tree height of 5 m are included under forest, as are temporarily unstocked areas. The term includes forests used for purposes of production, protection, multiple-use or conservation (i.e. forest in national parks, nature reserves and other protected areas), as well as forests stands on agricultural lands (e.g. windbreaks and shelterbelts of trees with a width of more than 20 m), and rubberwood plantations and cork oak stands. The term specifically excludes stands of trees established primarily for agricultural production, for example fruit tree plantations. It also excludes trees planted in agroforestry systems.

Data Quality:
Although there is an agreed and clear definition of forest, not all countries apply this definition. In many northern countries, areas with a crown cover of less than 20% are not considered as real forest land. 'Temporarily unstocked areas' refer to areas that have been designated as forest area, but not yet planted, or more often, areas where storm or fire has removed a large part of the forest cover. Unless aggressively restocked with trees, such areas can take a long time to re-establish forests naturally.

Policy Relevance:
It is difficult to overstate the importance of forests. They provide a habitat for a wide range of biodiversity, which provide food and medicines for local peoples, and provide fuelwood, when other cheap alternatives are not available. When exploited commercially, wood and other forest products can bring much needed foreign currency, as can tourism that exploits the unique wildlife and flora of the forest. But even if not exploited commercially, forests play an important role in maintaining an areas integrity: they naturally regulate water, absorbing rainwater during a storm and, by preventing quick evaporation, can help recharge groundwater. They maintain humidity, thus providing a micro-climate in which crops grown nearby can thrive. Forests are also instrumental in preventing floods and holding soil in place, thus preventing the loss of life and livelihoods landslides can bring. A growing forest acts as a lung removing CO_2 from the atmosphere, thus partly off-setting the emissions of CO_2 released during the combustion of fossil fuels. The percentage of land area covered by forest is one of the MDG indicators.

ENVIRONMENTAL INDICATORS

Land Use

Agricultural land *last update: April 2007*

	Latest year available	Agricultural area km²	% change since 1990 %	% of total land area %	Arable land km²	Land under permanent crops km²	Land under permanent pasture km²
Afghanistan	2003	380 480	0.0	58.3	79 100	1 380	300 000
Albania	2005	11 230	0.2	41.0	5 780	1 220	4 230
Algeria	2003	399 560	3.3	16.8	75 450	6 700	317 410
American Samoa	2003	50	25.0	25.0	20	30	...
Andorra	2005	260	0.0	55.3	10	...	250
Angola	2003	575 900	0.3	46.2	33 000	2 900	540 000
Antigua and Barbuda	2003	140	0.0	31.8	80	20	40
Argentina	2003	1 287 470	1.1	47.0	279 000	10 000	998 470
Armenia	2005	13 900	...	49.3	4 950	600	8 350
Aruba	2003	20	0.0	10.5	20	...	...
Australia	2005	4 451 490	-4.2	57.9	494 020	3 400	3 954 070
Austria	2005	32 630	-6.8	39.6	13 870	660	18 100
Azerbaijan	2005	47 586	...	57.6	18 432	2 215	26 939
Bahamas	2003	140	16.7	1.4	80	40	20
Bahrain	2005	100	25.0	14.1	20	40	40
Bangladesh	2005	90 150	-10.2	69.3	79 550	4 600	6 000
Barbados	2003	190	0.0	44.2	160	10	20
Belarus	2005	88 600	...	42.7	54 550	1 160	32 890
Belgium	2005	13 860	...	45.8	8 440	230	5 190
Belize	2003	1 520	20.6	6.7	700	320	500
Benin	2003	34 670	52.7	31.3	26 500	2 670	5 500
Bermuda	2003	10	0.0	20.0	10	...	...
Bhutan	2005	5 920	37.0	12.6	1 590	180	4 150
Bolivia	2003	370 870	4.6	34.2	30 500	2 060	338 310
Bosnia and Herzegovina	2005	21 470	...	41.9	10 000	970	10 500
Botswana	2003	259 800	-0.2	45.8	3 770	30	256 000
Brazil	2003	2 636 000	9.1	31.2	590 000	76 000	1 970 000
British Virgin Islands	2003	90	0.0	60.0	30	10	50
Brunei Darussalam	2005	250	92.3	4.7	140	50	60
Bulgaria	2005	52 650	-14.5	48.5	31 730	2 010	18 910
Burkina Faso	2003	109 000	13.8	39.8	48 400	600	60 000
Burundi	2003	23 450	10.4	91.3	9 900	3 650	9 900
Cambodia	2005	53 560	-0.1	30.3	37 000	1 560	15 000
Cameroon	2003	91 600	-0.1	19.7	59 600	12 000	20 000
Canada	2003	675 050	-0.4	7.4	456 600	64 550	153 900
Cape Verde	2003	740	8.8	18.4	460	30	250
Cayman Islands	2003	30	0.0	11.5	10	...	20
Central African Republic	2003	51 490	2.9	8.3	19 300	940	31 250
Chad	2003	486 300	0.7	38.6	36 000	300	450 000
Chile	2003	152 420	-4.1	20.4	19 820	3 250	129 350
China	2005	5 554 880	4.7	59.8	1 426 880	128 000	4 000 000
China, Hong Kong SAR	2005	70	-12.5	6.7	50	10	10
Colombia	2005	425 570	-5.6	38.4	20 040	16 090	389 440
Comoros	2003	1 470	14.8	65.9	800	520	150
Congo	2003	105 470	0.2	30.9	4 950	520	100 000
Cook Islands	2003	60	0.0	25.0	40	20	...
Costa Rica	2003	28 650	0.9	56.1	2 250	3 000	23 400
Cote d'Ivoire	2003	199 000	5.1	62.6	33 000	36 000	130 000
Croatia	2005	26 950	...	48.2	11 100	1 160	14 690
Cuba	2003	66 550	-1.3	60.6	30 630	7 250	28 670
Cyprus	2005	1 430	-11.7	15.5	1 000	390	40

Land Use: *Agricultural land*

	Latest year available	Agricultural area	% change since 1990	% of total land area	Arable land	Land under permanent crops	Land under permanent pasture
		km²	%	%	km²	km²	km²
Czech Republic	2005	42 590	...	55.1	30 470	2 380	9 740
Dem. Rep. of the Congo	2003	228 000	-0.3	10.1	67 000	11 000	150 000
Denmark	2005	25 890	-7.1	61.0	22 370	70	3 450
Djibouti	2003	17 010	30.9	73.4	10	...	17 000
Dominica	2003	230	27.8	30.7	50	160	20
Dominican Republic	2003	36 960	3.0	76.4	10 960	5 000	21 000
Ecuador	2005	75 520	-3.7	27.3	13 480	12 140	49 900
Egypt	2005	35 200	32.9	3.5	30 000	5 200	...
El Salvador	2003	17 040	17.5	82.2	6 600	2 500	7 940
Equatorial Guinea	2003	3 340	0.0	11.9	1 300	1 000	1 040
Eritrea	2003	75 320	...	74.6	5 620	30	69 670
Estonia	2005	8 340	...	19.7	5 910	120	2 310
Ethiopia	2003	317 690	...	31.8	110 560	7 130	200 000
Faeroe Islands	2003	30	0.0	2.1	30	...	...
Falkland Islands (Malvinas)	2003	11 300	-5.0	92.9	...	...	11 300
Fiji	2003	4 600	12.2	25.2	2 000	850	1 750
Finland	2005	22 660	-5.5	7.4	22 340	60	260
France	2005	295 690	-3.3	53.8	185 070	11 280	99 340
French Guiana	2003	230	9.5	0.3	120	40	70
French Polynesia	2003	450	4.7	12.3	30	220	200
Gabon	2003	51 600	0.1	20.0	3 250	1 700	46 650
Gambia	2003	7 790	22.3	77.9	3 150	50	4 590
Georgia	2005	30 060	...	43.3	8 020	2 640	19 400
Germany	2005	170 300	-5.6	48.8	119 030	1 980	49 290
Ghana	2003	147 350	16.9	64.8	41 850	22 000	83 500
Greece	2005	83 590	-9.4	64.8	26 270	11 320	46 000
Greenland	2003	2 350	0.0	0.6	...	...	2 350
Grenada	2003	130	0.0	38.2	20	100	10
Guadeloupe	2003	460	-13.2	27.2	200	50	210
Guam	2003	200	0.0	36.4	20	100	80
Guatemala	2003	46 520	8.6	42.9	14 400	6 100	26 020
Guinea	2003	124 500	3.6	50.7	11 000	6 500	107 000
Guinea-Bissau	2003	16 300	8.9	58.0	3 000	2 500	10 800
Guyana	2003	17 400	0.5	8.8	4 800	300	12 300
Haiti	2003	15 900	-0.4	57.7	7 800	3 200	4 900
Honduras	2003	29 360	-11.6	26.2	10 680	3 600	15 080
Hungary	2005	58 640	-9.4	65.4	46 000	2 070	10 570
Iceland	2005	22 810	0.0	22.8	70	...	22 740
India	2005	1 801 800	-0.5	60.6	1 596 500	100 000	105 300
Indonesia	2005	478 000	6.0	26.4	230 000	136 000	112 000
Iran (Islamic Republic of)	2005	616 000	1.8	37.6	161 000	15 000	440 000
Iraq	2003	100 190	4.5	22.9	57 500	2 690	40 000
Ireland	2005	42 270	-25.2	61.4	12 150	20	30 100
Israel	2005	5 170	-10.7	23.9	3 170	750	1 250
Italy	2005	146 940	-12.7	50.0	77 440	25 390	44 110
Jamaica	2003	5 130	7.8	47.4	1 740	1 100	2 290
Japan	2005	46 920	-17.6	12.9	43 600	3 320	...
Jordan	2005	10 120	-2.7	11.5	1 840	860	7 420
Kazakhstan	2005	2 075 980	...	76.9	223 640	1 360	1 850 980
Kenya	2003	265 120	2.0	46.6	46 500	5 620	213 000
Kiribati	2003	370	-5.1	50.7	20	350	...
Korea, Dem. People's Rep.	2005	30 500	21.1	25.3	28 000	2 000	500
Korea, Republic of	2005	18 930	-13.1	19.2	16 350	2 000	580

Land Use: *Agricultural land*

	Latest year available	Agricultural area	% change since 1990	% of total land area	Arable land	Land under permanent crops	Land under permanent pasture
		km²	%	%	km²	km²	km²
Kuwait	2005	1 540	9.2	8.6	150	30	1 360
Kyrgyzstan	2005	107 450	...	56.0	12 840	720	93 890
Lao People's Dem. Rep.	2005	19 590	18.0	8.5	10 000	810	8 780
Latvia	2005	17 340	...	27.8	10 920	130	6 290
Lebanon	2003	3 290	3.8	32.2	1 700	1 430	160
Lesotho	2003	23 340	0.6	76.9	3 300	40	20 000
Liberia	2003	26 020	-0.2	27.0	3 820	2 200	20 000
Libyan Arab Jamahiriya	2003	154 500	0.0	8.8	18 150	3 350	133 000
Liechtenstein	2005	90	-10.0	56.3	40	...	50
Lithuania	2005	28 370	...	45.3	19 060	400	8 910
Luxembourg	2005	1 290	...	49.8	600	20	670
Madagascar	2003	275 500	0.8	47.4	29 500	6 000	240 000
Malawi	2003	44 400	17.8	47.2	24 500	1 400	18 500
Malaysia	2003	78 700	8.9	24.0	18 000	57 850	2 850
Maldives	2003	140	55.6	46.7	40	90	10
Mali	2005	394 790	23.0	32.4	48 000	400	346 390
Malta	2005	100	-23.1	31.3	90	10	...
Marshall Islands	2005	140	...	77.8	20	80	40
Martinique	2003	320	-17.9	30.2	100	110	110
Mauritania	2003	397 500	0.2	38.8	4 880	120	392 500
Mauritius	2005	1 130	0.0	55.7	1 000	60	70
Mexico	2003	1 073 000	3.8	56.2	248 000	25 000	800 000
Micronesia, Federated States of	2003	470	...	67.1	40	320	110
Mongolia	2003	1 305 000	3.9	83.3	11 980	20	1 293 000
Montserrat	2003	30	0.0	30.0	20	...	10
Morocco	2003	303 760	0.1	68.1	84 840	8 920	210 000
Mozambique	2003	485 800	1.9	62.0	43 500	2 300	440 000
Myanmar	2003	112 930	8.3	17.2	100 930	8 880	3 120
Namibia	2003	388 200	0.4	47.2	8 150	50	380 000
Nepal	2005	42 220	1.7	29.5	23 570	1 300	17 350
Netherlands	2005	19 210	-4.2	56.7	9 080	330	9 800
Netherlands Antilles	2003	80	0.0	10.0	80	40	...
New Caledonia	2003	2 490	7.3	13.6	60	18 720	2 390
New Zealand	2003	172 350	-0.7	64.3	15 000	...	138 630
Nicaragua	2003	69 760	10.6	57.5	19 250	2 360	48 150
Niger	2003	385 000	16.5	30.4	144 830	170	240 000
Nigeria	2003	726 000	0.7	79.7	305 000	29 000	392 000
Niue	2003	80	14.3	30.8	30	40	10
Norfolk Island	2003	10	0.0	25.0	...	...	10
Northern Mariana Islands	2003	130	...	28.3	60	20	50
Norway	2005	10 260	5.1	3.4	8 590	...	1 670
Oman	2003	10 800	0.0	3.5	370	430	10 000
Pakistan	2005	270 700	4.4	35.1	212 750	7 950	50 000
Palau	2003	90	...	19.6	40	20	30
Palestine	2005	3 720	-1.3	61.8	1 070	1 150	1 500
Panama	2003	22 300	5.0	30.0	5 480	1 470	15 350
Papua New Guinea	2003	10 500	15.8	2.3	2 250	6 500	1 750
Paraguay	2003	248 360	6.6	62.5	30 400	960	217 000
Peru	2003	212 100	-2.9	16.6	37 000	6 100	169 000
Philippines	2003	122 000	9.5	40.9	57 000	50 000	15 000
Poland	2005	159 060	-15.4	51.9	121 410	3 780	33 870
Portugal	2005	38 150	-3.7	41.7	15 340	7 740	15 070

Land Use: *Agricultural land*

	Latest year available	Agricultural area	% change since 1990	% of total land area	Arable land	Land under permanent crops	Land under permanent pasture
		km²	%	%	km²	km²	km²
Puerto Rico	2005	2 230	-48.7	25.1	710	420	1 100
Qatar	2005	710	16.4	6.5	180	30	500
Republic of Moldova	2005	25 180	...	76.6	18 480	2 980	3 720
Réunion	2003	490	-23.4	19.6	350	40	100
Romania	2005	145 130	-1.7	63.1	92 880	5 400	46 850
Russian Federation	2005	2 156 800	...	13.2	1 217 810	18 000	920 990
Rwanda	2003	19 350	3.0	78.4	12 000	2 700	4 650
Saint Helena	2003	120	20.0	38.7	40	...	80
Saint Kitts and Nevis	2003	100	-16.7	27.8	70	10	20
Saint Lucia	2003	200	-4.8	32.8	40	140	20
Saint Pierre and Miquelon	2003	30	0.0	13.0	30	...	...
Samoa	2003	1 310	6.5	46.3	600	690	20
San Marino	2003	10	0.0	16.7	10	...	...
Sao Tome and Principe	2003	560	33.3	58.3	80	470	10
Saudi Arabia	2003	1 737 980	40.7	80.8	36 000	1 980	1 700 000
Senegal	2003	81 570	0.8	42.4	24 600	470	56 500
Serbia and Montenegro	2005	55 900	...	54.8	35 050	3 170	17 680
Seychelles	2003	70	16.7	15.2	10	60	...
Sierra Leone	2003	28 450	3.7	39.7	5 700	750	22 000
Singapore	2005	8	-60.0	1.2	6	2	...
Slovakia	2005	19 410	...	40.4	13 910	260	5 240
Slovenia	2005	5 080	...	25.2	1 760	270	3 050
Solomon Islands	2003	1 170	8.3	4.2	180	590	400
Somalia	2003	440 710	0.1	70.3	10 450	260	430 000
South Africa	2003	996 400	2.9	82.0	147 530	9 590	839 280
Spain	2005	290 300	-4.7	58.2	137 000	49 300	104 000
Sri Lanka	2003	23 560	0.7	36.5	9 160	10 000	4 400
St. Vincent and the Grenadines	2003	160	14.3	41.0	70	70	20
Sudan	2003	1 346 000	9.2	56.6	170 000	4 200	1 171 800
Suriname	2003	890	1.1	0.6	580	100	210
Swaziland	2003	13 920	9.8	80.9	1 780	140	12 000
Sweden	2005	32 190	-5.8	7.8	27 030	30	5 130
Switzerland	2005	15 250	-24.5	38.1	4 100	240	10 910
Syrian Arab Republic	2005	140 080	3.8	76.2	48 730	8 690	82 660
Tajikistan	2003	42 550	...	30.4	9 300	1 270	31 980
Thailand	2003	184 870	-13.5	36.2	141 330	35 540	8 000
The Former Yugoslav Rep. of Macedonia	2005	12 420	...	48.8	5 660	460	6 300
Timor-Leste	2003	3 400	6.9	22.9	1 220	680	1 500
Togo	2003	36 300	13.8	66.7	25 100	1 200	10 000
Tonga	2003	300	-6.3	41.7	150	110	40
Trinidad and Tobago	2003	1 330	1.5	25.9	750	470	110
Tunisia	2003	97 840	13.2	63.0	27 900	21 400	48 540
Turkey	2005	412 230	3.9	53.6	238 300	27 760	146 170
Turkmenistan	2003	329 660	...	70.2	22 000	660	307 000
Turks and Caicos Islands	2003	10	0.0	2.3	10	...	...
Tuvalu	2003	20	0.0	66.7	...	20	...
Uganda	2003	124 620	4.2	63.2	52 000	21 500	51 120
Ukraine	2005	413 040	...	71.3	324 520	9 010	79 510
United Arab Emirates	2003	5 590	96.1	6.7	640	1 900	3 050
United Kingdom	2005	169 560	-6.9	70.1	57 290	470	111 800
United Rep. of Tanzania	2003	481 000	1.5	54.4	40 000	11 000	430 000

Land Use: *Agricultural land*

	Latest year available	Agricultural area	% change since 1990	% of total land area	Arable land	Land under permanent crops	Land under permanent pasture
		km²	%	%	km²	km²	km²
United States	2005	4 147 780	-2.9	45.3	1 744 480	27 300	2 376 000
United States Virgin Islands	2003	60	-45.5	17.1	20	10	30
Uruguay	2003	149 550	0.9	85.4	13 700	420	135 430
Uzbekistan	2003	272 590	...	64.1	47 000	3 400	222 190
Vanuatu	2003	1 470	5.0	12.1	200	850	420
Venezuela	2003	216 400	-1.0	24.5	26 000	8 000	182 400
Viet Nam	2005	95 920	42.6	30.9	66 000	23 500	6 420
Wallis and Futuna Islands	2003	60	0.0	42.9	10	50	...
Western Sahara	2003	50 050	0.0	18.8	50	...	50 000
Yemen	2003	177 340	0.2	33.6	15 370	1 320	160 650
Zambia	2003	352 890	0.1	47.5	52 600	290	300 000
Zimbabwe	2003	205 500	1.9	53.1	32 200	1 300	172 000

Source:
Food and Agriculture Organization of the United Nations (FAO).

Definitions & Technical notes:
Agricultural area refers to the sum of area under arable land, permanent crops, and permanent pastures. Arable land refers to land under temporary crops (double-cropped areas are counted only once), temporary meadows for mowing or pasture, land under market and kitchen gardens and land temporarily fallow (less than five years). The abandoned land resulting from shifting cultivation is not included in this category. Data for "Arable land" are not meant to indicate the amount of land that is potentially cultivable. Land under permanent crops refers to land cultivated with crops that occupy the land for long periods and need not be replanted after each harvest, such as cocoa, coffee and rubber; this category includes land under flowering shrubs, fruit trees, nut trees and vines, but excludes land under trees grown for wood or timber. Land under permanent pastures refers to land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land). % change since 1990 and Agricultural area as a % of total land area in 2002 are calculated by UNSD based on FAO data.

Data Quality:
FAO promotes national censuses of agricultural land use every 10 years, with varying degrees of success. Standardised definitions exist but can pose problems when land is used for multiple purposes. In many parts of the world, for example, livestock graze in orchards and among other permanent crops. Moreover, land removed from production under set-aside schemes intended to reduce overproduction, is not always reflected adequately in the figures. Agricultural surveys and censuses are generally confined to farmland. However, in many countries common land is used for grazing and may or may not be included in the figures for permanent pastures.

Policy Relevance:
The ability of a given country to produce enough food to feed its own people will depend largely on the climate, on the availability of fertile land and on competing uses for that land. In many parts of the world, forest, wetlands and other natural land is still being cleared for conversion to agriculture, while in others, there are moves to return agricultural land to nature. And everywhere, cities and towns continue their sprawl in river valleys, often the areas with the most fertile soils.

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Note: Page numbers in **boldface** refer to volume numbers and major topics. Article titles are in **boldface.**

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